Proceedings of the invited lecturers' reports presented at the COST E4 Management Committee and Working Groups Meeting in Ljubljana, Slovenia

Forest Reserves Research Network

Virgin Forests and Forest Reserves in Central and East European Countries

Univerza v Ljubljani
Biotehniška fakulteta

Edited by
Jurij Diaci

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Forest Reserves Research Network

European Commission

University of Ljubljana
Biotechnical Faculty
Department of Forestry and Renewable Forest Resources
Slovenia

PROCEEDINGS OF THE INVITED LECTURERS' REPORTS PRESENTED AT THE COST E4 MANAGEMENT COMMITTEE AND WORKING GROUPS MEETING IN LJUBLJANA, SLOVENIA

VIRGIN FORESTS AND FOREST RESERVES IN CENTRAL AND EAST EUROPEAN COUNTRIES

HISTORY, PRESENT STATUS AND FUTURE DEVELOPMENT

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Proceedings of the invited lecturers' reports

VIRGIN FORESTS AND FOREST RESERVES IN CENTRAL AND EAST EUROPEAN COUNTRIES

CONTENTS

PREFACE

Background information on the meeting

Protection of virgin forests and establishing new forest reserves are preconditions for successful scientific research in natural science. They are also of importance for conservation of the natural heritage and promotion of other social functions of the forest.

For forest management practice it is vitally important to gain insight into the structure and development of natural forests. Therefore, forest reserves are reference sites for assessing the efficiency of close-to-nature forest management.

Since nature protection and close-to-nature forest management are slowly gaining recognition all over Europe, the awareness of the significance of forest reserves has also arisen. A number of countries started recently to develop or to widen the existing network of forest reserves and to study them regularly. The fast development of this field has also been promoted by international co-operation and a joint research approach, such as the COST Action E4 'Forest Reserves Research Network'[1]. Slovenia has actively participated in this project since its beginning in November 1996. The initiative to organise a meeting in Slovenia was accepted at the meeting of the COST Action E4 in Brussels in November 1997. The main reason for entrusting the task to Slovenia is its tradition of virgin forest research and the efficient transfer of results to forest management practice.

The international professional public is well acquainted with the fact that the largest remains of temperate virgin forests in Europe are situated in Eastern and Central Europe, for instance, Bialowieza in Poland or Peručica in Bosnia and Herzegovina. It is less well known, however, that in these countries there is a rich tradition of protection and research of forest reserves. In Austria-Hungary, for example, some of the most important remains of virgin forests were protected as early as the last century (JOHANN 1990). In Bohemia 'Žofinský virgin forest' in the Novohradské Mts. was protected as early as 1838 on the owner's initiative (the study by HORT *et al.* in the proceedings, pp. 25-44), while in Poland 'Ziesbuch forest' was protected in 1827 (ZIELONY *ibid*., pp. 45-66). In Slovenia the protection of virgin forests was introduced in 1892 when virgin forests were first mentioned in forest management plans of the Kočevje region (HARTMAN *ibid*., pp. 111-120).

After the Second World War foresters in particular undertook systematic investigation of virgin forests in Central and Eastern Europe. Professor Leibundgut and his associates (LEIBUNDGUT 1959) played a key role in studying the importance of virgin forests and forest reserves in Europe. He initiated the first basic research in virgin forests of Central and Eastern Europe. His research team developed a network of new forest reserves in Switzerland, where only two minor virgin forest remains (Scatle, Derborence) were

[1] The COST Action E4 is presented in the Introduction by the Chairman of the Action. More detailed presentation with preliminary results of the Action are given in Parviainen's paper on pages 145-171 of the proceedings.

preserved, and took on systematic research. The example was followed by Slovenia (MLINŠEK 1967, 1976) and other Central and East European countries (PINTARIČ 1978, PRÙŠA 1985, KORPEL 1995, PRPIČ and SELETKOVIČ 1996).

Organisation of the meeting and preparation of the proceedings

The third plenary session of the management committee and of the working groups of the COST meeting started with a two-days excursion to virgin forests of the Koèevje region, to mountain forests of Pokljuka (the Triglav National Park) and to the littoral part of Slovenia (Karst). Thirteen experts from Slovenia and 46 from other European countries participated. Prominent scientists from Central and East European countries with a rich tradition of protection and investigation of forest reserves, which do not formally co-operate in the COST Action E4, were also invited to take part in the meeting. In invited lecturers' reports they presented the development of the concept of forest reserves and their current situation in individual countries. Their reports represent an important contribution to the Action and are published in the proceedings. An important part of the meeting was held in the field, therefore some of the more extensive contributions presented in the field are also included in the proceedings. The reports of the remaining Central and East European countries that participate in the Action (Slovenia, Slovakia, Russia and Hungary) are published in the joint proceedings of the Action (PARVIAINEN 1999). A short summary of the country reports by Mr Parviainen is presented in this proceedings on pages 162-171.

In the present proceedings, the reports have been arranged alphabetically according to participating countries. They are published as they were presented at the meeting but in a smaller format and with some graph or chart changes to achieve better resolution. The contents of each individual report are the sole responsibility of the author.

All involved in the organisation of the meeting in Slovenia wish that the present proceedings will contribute to a further insight into different approaches to the investigation of virgin forests in Europe and to a link between them, as well as to a broader discussion and further research in this field.

ACKNOWLEDGEMENTS

The meeting in Slovenia and the publication of the proceedings were made possible by:

The Department of Forestry and Renewable Forest Resources of the Biotechnical Faculty, University of Ljubljana, the COST Action E4 of the European Union, and the Ministry of Science and Technology of the Republic of Slovenia within the framework of projects MS-42797 and J4-0513-0488-98. Objectives of the meeting were successfully achieved with the aid of the Forest Institute of Slovenia, the Slovenian Forest Service, and the Triglav National Park.

Our particular thanks for assistance in the organisation of the meeting are due to:

– Mr. Albin Babič of the Ministry of Science and Technology of the Republic of Slovenia,

– Professor Milan Hočevar, Director, Assistant Professor Hojka Kraigher, and Dr. Primož Simončič of the Forest Institute of Slovenia,
– Professor Miha Adamič, Head, Professor Dušan Mlinšek, Professor Boštjan Anko, and Assistant Professor Andrej Bončina of the Department of Forestry and Renewable Forest Resources,
– Mr. Tomaž Hartman, Mr. Mladen Prebevšek, and Mr. Miro Kapus of the Slovenian Forest Service,
– Mr. Martin Šolar of the Triglav National Park,
– Mr. Dušan Roženbergar and Ms. Lena Marion, the students of the Forestry Department.

We owe special thanks to Mr. Uroš Kolar for his dedicated and unremitting help with the organisation of the meeting and preparation of the proceedings.

REFERENCES

KORPEL, Š. (1995) Die Urwälder der Westkarpaten. Gustav Fischer Verlag, Stuttgart, Jena, New York, 310 pp.

LEIBUNDGUT, H. (1959) Über Zweck und Methodik der Struktur- und Zuwachsanalyse von Urwäldern. Schweiz. Z. Forstwes. 110 (3), pp. 111-124.

MLINŠEK, D. (1967) Verjüngung und Entwicklung der Dickungen im Tannen-Buchen Urwald 'Rog' (Slowenien). München, 14. IUFRO Kongress, Referate, Band IV, pp. 436-442.

MLINŠEK, D. (1976) Zur Ausscheidung von neuen Wald - und Urwaldreservaten (am Beispiel von Slowenien). IUFRO-Beitrag, Oslo Kongress Gruppe S1, pp. 1-3.

PARVIAINEN, J. et al. (eds.) (1999) Research in Forest Reserves and Natural Forests in European Countries, EFI Proceedings No. 16, pp. 9-35.

PINTARIČ, K. (1978) Urwald Peruèica als natürliches Forschungslaboratorium. Allg. Forstzeitschrift, 24, pp.702-707.

PRPIČ, B. / SELETKOVIČ, Z. (1996) The research in Croatian virgin forests and the application of results to natural forests. In: Mayer, B., Skrb za hrvatske šume od 1946. do 1996.: Unapređenje proizvodnje biomase šumskih ekosustava. Zagreb, 1, pp. 97-104.

PRÙŠA, E. (1985) Die böhmischen und mährischen Urwälder - ihre Struktur und Ökologie, Praga, Verlag der Tschechoslowakischen Akademie der Wisenschaften, 578 pp.

JOHANN, E. (1990) Forestry as opposed to nature conservation?: The development of Austrian silviculture during the first half of the twentieth century and its contribution to nature and landscape protection. IUFRO XIX World Congress, Montreal, Canada, Aug. 8-11, 1990, pp. 187- 198.

Jurij Diaci
National co-ordinator
of the COST Action E4 for Slovenia
January 1999

INTRODUCTION

The European Union COST Action E4: 'Forest Reserves Research Network' was established by the COST Commission in 1995 in order to promote the co-ordination between countries and focus research on 'natural' forests. The primary objective is to create a European network of forest reserves, to collect ongoing research, to standardise research methodology and to create an accessible central data bank. Results from 'natural' forest research are important for the application of ecologically oriented silviculture, for improved forest management and for future planning of the forest protection network.

There are still approximately 3 mill. hectares of natural forests left in Europe. This area is equivalent to 1.7% of the total forest area in Europe. The widest continuous natural forests can be found in Finland and Sweden and in the remote mountainous areas of Central and Eastern Europe. Most of these remnants are located in forest reserves, which are protected by law. These natural forests are left to develop freely in the state which is as original as possible.

COST is a framework for scientific and technical co-operation, allowing the co-ordination of national programmes on a European level. Within this framework, financial support is given for the organisation of meetings, specific co-ordination tasks and for Short Term Scientific Missions. The research to be co-ordinated is funded nationally. The duration of the Action E4: 'Forest Reserves Research Network' is 4 years, ending in 1999. Nineteen (19) European COST member countries and over 100 researchers and environmental officials are involved in this project.

The main results of the action are the publication of the country reports with data and definitions on forest protection and a list of research in the natural forests and reserves, and a review of the models and methods used for describing the structure of natural forests. A data bank on forest reserves, organisations, publications, research and the main results with free access for the participants will be established. This data bank on European forest reserves will be located at the European Forest Institute, Joensuu, Finland (for more information see home page on Internet:

http://www.efi.fi/Database_Gateway/FRRN/).

The 5th Management Committee meeting with excursions to the natural forests of Slovenia was held in April 1998 in Ljubljana. One important goal of this meeting was to integrate the research in natural forests of the non-EU member countries with the Action's activities. Invited speakers were asked to present the state of the art of natural forest research and forest protection in Bosnia and Herzegovina, Croatia, Czech Republic, Poland, Romania, Slovenia and Switzerland. These country reports are collected and published in this publication.

The country reports of the COST Action E4 member countries and Russia are published in the Proceedings N^{o}16 of the European Forest Institute. A compiled summarising article and table from all the contributed countries is presented also as Appendix 1 (see Table 1 on page 169) in this publication.

Jari Parviainen
Chairman of the COST Action E4

FORESTRY AND FOREST RESERVES IN BOSNIA AND HERZEGOVINA

by Konrad PINTARIĆ *

ABSTRACT

In the paper the data on forests and forest reserves in Bosnia and Herzegovina are presented. The country is predominantly mountainous. Main tree species are: oak, beech, silver fir, Norway spruce, black and Scotch pine. All high forests and coppices are natural forests, and are managed by the single tree selection system or by the group selection system. In future the forest management will remain the same as today, aiming to increase wood production and to reach higher quality of growing stock. Conversion of coppices into high forests through tending will take place, and in smaller parts by clear cutting and change of tree species.

The actual surface of protected forests of all sorts will be enlarged, specially the stands of the endemic species of *Pinus heldreichii*.

INTRODUCTION

Bosnia and Herzegovina is situated in the north-west of the Balkan Peninsula, lying between $42^0$26' and $45^0$15' of the northern latitude, and between $15^0$44' and $19^0$41' of the eastern longitude. Predominantly it lies on mountainous land. Out of the total area of 51,130 km^2, 5% is flat, 24% is hilly, 42% is mountainous, and 29% is karst region. The mean height above sea level is 500 m (from Neum-Klek at 0 m to Magliæ at 2387 m above sea level). On the hydrographic display the whole area is divided into Adriatic and Black Sea confluence, nevertheless most of the rivers belong to the Black Sea confluence (Una, Vrbas, Bosna, Drina).

Due to the geographical position - proximity of the Adriatic Sea and the relief itself - the northern part of the country has a moderate continental climate with July temperatures ranging around 22^0C, but only with 700 - 800 mm precipitation annually. The middle mountainous part has severe and snowy winters, and an abundant precipitation (1000 - 1200 mm annually with equal distribution over a year).

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The Mediterranean climate, in the middle and lower course of the River Neretva, has temperate winters (3.5^0C to -5.0^0C), and hot dry summers (up to 24^0C). In this region the maximum temperatures sometimes reach 40^0C to 45^0C, and the minimum winter temperatures reach -9^0C to -17^0 C. In this region the annual precipitation is very high, from 1000 to 1500 mm annually, with the minimum in summer and the maximum in winter time. In this Mediterranean region the snow is very rare and remains for a very short period of time.

Due to different bedrock (Figure 1) and soil conditions, Bosnia and Herzegovina has also very different forest associations (Figure 2 and 3).

The total surface of Bosnia and Herzegovina is 5.113,000 ha, forest and woody landscape cover 2.701,000 ha (i.e. 53% of the total country surface). This area is subdivided into:

High forests	1.266,000 ha (46.9%)
Irregular coppices	927,000 ha (34.3%)
Bare lands appropriate for afforestation	396,000 ha (14.7%)
Unproductive areas	112,000 ha (4.1%)

The following forest types appear:

High forests (Total)	**1.266,000 ha (100%)**
Oak forests	115,000 ha (9%)
Beech forests	389,000 ha (30%)
Mixed forests of beech, Norway spruce and silver fir	630,000 ha (50%)
Scotch and Black pine	96,000 ha (8%)
Other high forests	36,000 ha (3%)
Coppices (Total)	**927,000 ha (100%)**
Coppices of sessile oak (*Quercus sessiliflora*)	218,000 ha (23.5%)
Coppices of beech	351,000 ha (38.9%)
Coppices of thermophile oaks (Adriatic region)	316,000 ha (34.1%)
Other coppices	42,000 ha (4.5%)

About 20% of high forests are privately owned and the growing stock per hectare is five times lower than that of the state high forests. Approximately 65% of coppice area, and 77% of bare land is owned by the state.

All forests (high forests and coppices) are of natural origin, and biodiversity is remarkable. In addition to the main tree species there are more than twenty other tree species in all forest types. (see Table 1).

Figure 1: Geological map of Bosnia and Herzegovina (after ŠUMARSKA ENCIKLOPEDIJA, Zagreb 1980)

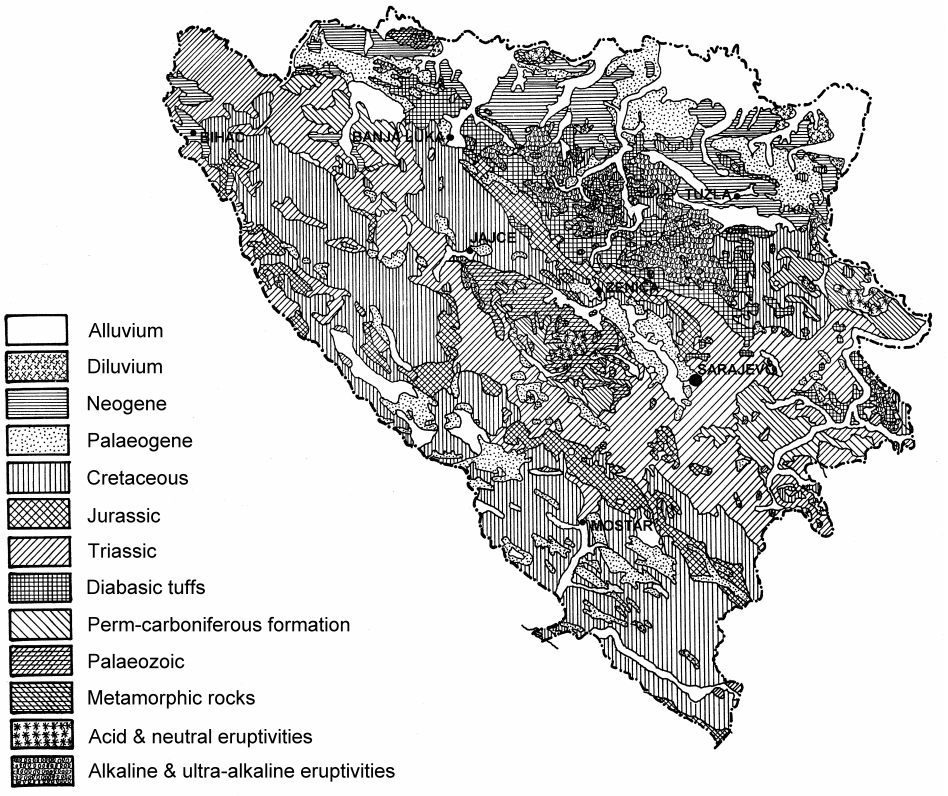


Figure 2: Forest associations in Bosnia and Herzegovina (after ŠUMARSKA ENCIKLOPEDIJA, Zagreb 1980)

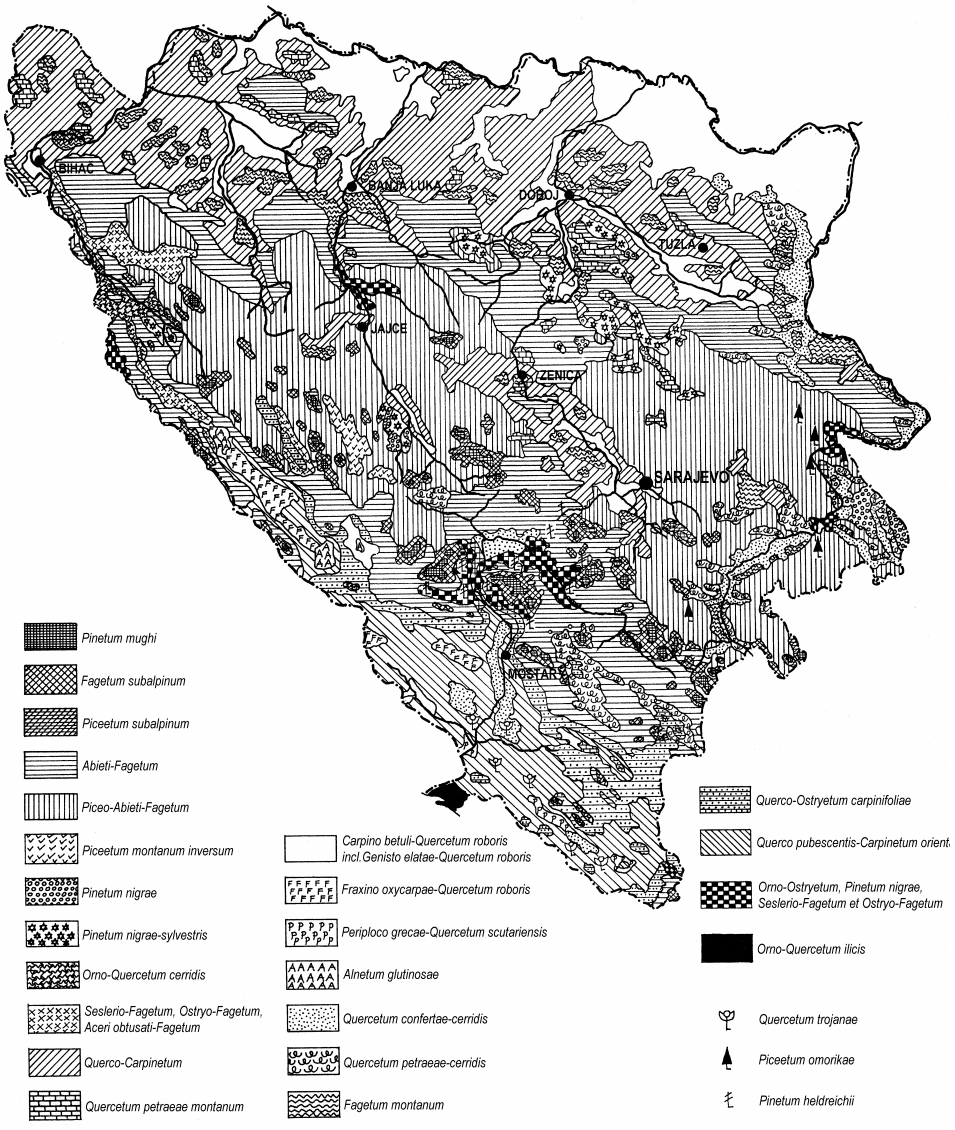
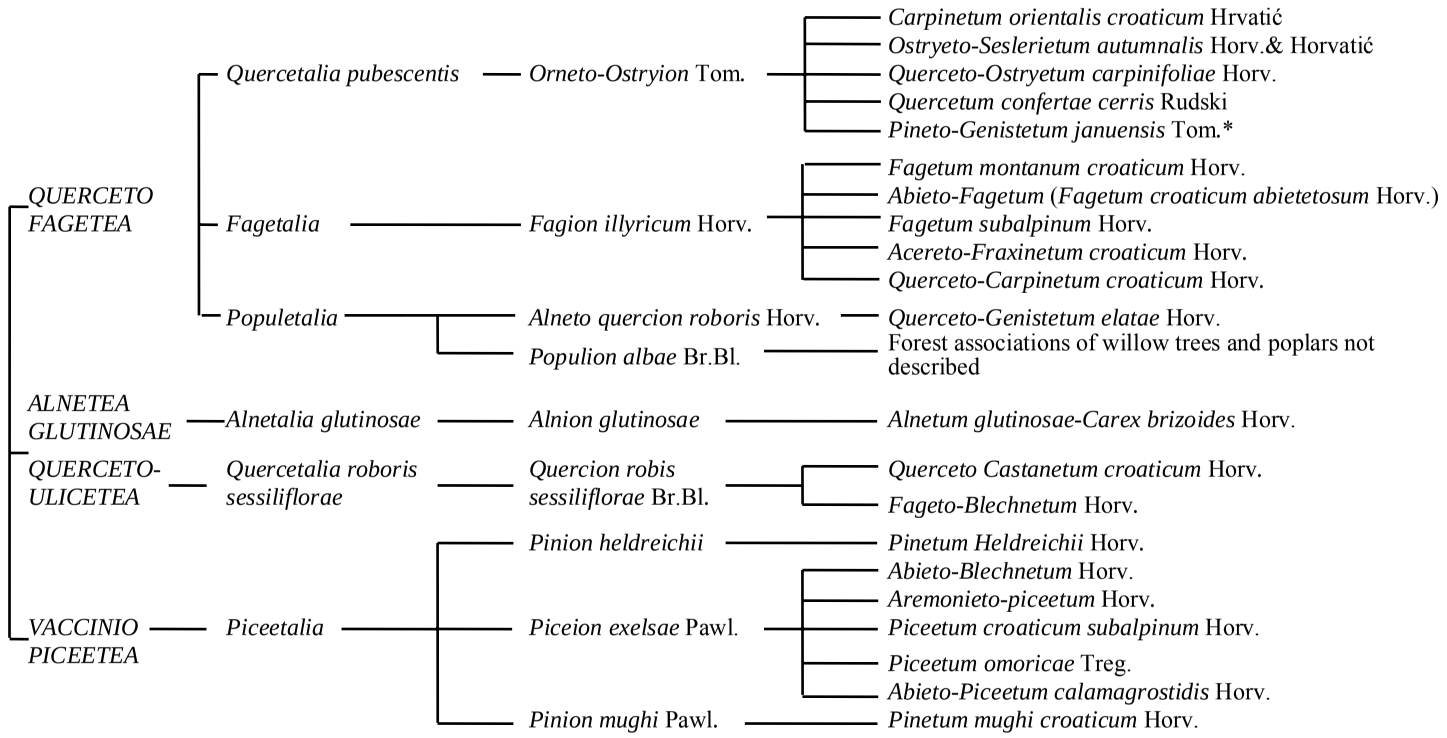


Figure 3: Forest associations in Bosnia and Herzegovina



* No research was carried out on pine forests in Bosnia, but according to BECK (cit. HORV. 55) primarily floristic elements prevail in the referred forest association.

Table 1: Biodiversity in the main high forests

	Oak forests	Beech forests	Beech, Fir, Spruce forests	Scotch and Black pine forests
		%		
Abies alba	+	+	40.4	0.8
Pinus silvestris	-	+	0.6	19.2
Picea abies	-	+	25.7	4.8
Pinus nigra	0.7	+	0.2	59.4
Pinus heldreichii	-	-	+	-
Picea omorica Panč.	-	-	+	-
Fagus silvatica	6.5	91.4	30.7	3.3
Quercus pedunculata	0.3	-	-	-
Quercus sessiliflora	76.2	1.6	0.2	10.6
Quercus conferta	0.1	+	+	0.1
Quercus cerris	11.5	0.3	+	+
Quercus pubescens	0.1	-	-	-
Acer pseudoplatanus	0.1	2.6	0.9	0.1
Acer obtusatum	0.5	0.8	+	0.2
Acer platanoides	+	0.6	+	-
Fraxinus excelsior	0.1	0.4	0.1	-
Fraxinus ornus	0.6	+	-	+
Ulmus sp.	-	0.2	0.4	+
Carpinus betulus	1.7	1.3	+	0.5
Ostrya carpinifolia	+	-	+	0.1
Carpinus orientalis	+	-	+	0.1
Tilia sp.	0.3	0.4	0.2	+
Castanea vesca (sativa)	+	+	-	-
Betula verucosa alba	+	0.4	+	0.6
Alnus glutinosa	0.1	+	+	+
Alnus incana	0.1	+	+	-
Acer heldreichii	-	+	+	-
Juglans regia	-	+	-	-
Salix sp.	-	+	0.1	-
Populus sp.	+	+	+	-
Other broad-leaved trees	1.0	-	0.5	0.3

Afforestation to a grater scale began after the Second World War. In the period from 1945 to 1992 about 200,000 ha were afforested, and now the oldest man made forests are about 50 years old. Afforestation was carried out mainly on bare lands and on clear-cuts of coppice with ambition to obtain stands of high mixed forests. For afforestation the following tree species were utilised: Norway spruce (*Picea abies* L.), Scotch pine (*Pinus silvestris* L.), and Black pine (*Pinus nigra* Arn.). Some not native tree species were planted on a very small scale, e.g. European Larch (*Larix decidua* Mill.), Japanese Larch (*Larix leptolepis* Gord.), Douglas fir (*Pseudotsuga menziesii* Mirb.) and Eastern white pine (*Pinus strobus* L.).

Table 2: Growing stock (over 7 cm d.b.h.)

Forest type	Surface ha	Conifers m^3/ha	Broad-leaved trees m^3/ha	Total m^3/ha
High forests	1.260,000	88	130	218
Coppices	927,000	-	57	57
Total	2.187,000			

The ratio of conifers to broad-leaved trees is 1 to 1.5.

Table 3: The mean volume increment (over 7 cm d.b.h. - per ha)

	Conifers m^3/ha	Broad-leaved trees m^3/ha	Total m^3/ha
High forests	2.46	3.11	5.57
Coppices	-	1.98	1.98
Total	2.46	5.09	-

Due to absence of tending, and because some forests are still the remains of virgin forests - forests of virgin origin - trees in these forests are of poor quality. In the beech and oak high forests only 13% of the trees are of higher quality, and in mixed high forests of beech, spruce and fir, every third conifer tree and every sixth broad-leaved tree are of higher quality.

Table 4: Allowable mean cutting per hectare

	Conifers m^3 / ha / year	Broad-leaved trees m^3 / ha / year	Total m^3 / ha / year
High forests	2.16	3.47	5.63
Coppices	-	1.07	1.07
Total	2.16	4.54	-

Before the War of 1992, the annual felling was roughly 5.47 million m^3 of the growing stock (conifers 2.19 and broad-leaved trees 3.28 million m^3 annually).

Before 1878 almost all forests in Bosnia and Herzegovina were natural-virgin forests. Nowadays there are no second growth forests, and in all types of forests we can find remains of former virgin forests (trees of worst quality).

In all types of high forest the classical selection system management is applied (felling of a single selected tree), or the selection system management in small groups with natural regeneration is applied (Fenel System).

THE FUTURE GOALS IN FORESTRY

The future goals in the forestry of the country are:

1. To increase the growing stock from 266 m^3/ha to 350 - 400 m^3/ha.
2. To increase the quality and value of forests by tending.
3. To change the ratio of conifers to broad-leaved trees from 40%**:**60% to 60%**:**40% in high forests. This goal can be achieved only by tending in the first stage age.
4. Natural regeneration in all high forests.
5. The conversion of coppices into high forests by tending.
6. The conversion of smaller sections of coppices into mixed stands of broad-leaved trees and conifers through afforestation.
7. Afforestation of bare lands and the karst area.
8. Increasing the multiple use of forests, especially the protective and recreational functions of forests.

THE TASKS OF RESEARCH

The Forestry Faculty and The Institute for Researches in Forestry and Wood Industry in Sarajevo are carrying out researches in forestry and wood industry.

The spheres of investigations are:

1. Dendrology
2. Plant physiology
3. Soil science
4. Forest ecology and phytosociology
5. Silviculture
6. Forest mensuration, forest taxation and forest inventory
7. Forest utilisation
8. Forest protection.

PROTECTED FORESTS AND FOREST RESERVES

In Bosnia and Herzegovina there are many protected forests with diverse level of protection. Geographical location of the protected forests are shown in the Appendix A and B (Figure 4 and 5).

Table 5: Protected forests of Bosnia and Herzegovina

Object No.	Name of the object	Commune	Surface (ha)
	National parks		
1.	N.P. »Sutjeska«	Foča	17 250
2.	N.P. »Kozara«	Prijedor	3 375
	Virgin forest reserves		
3.	»Peručica«	Foča	1 434
4.	»Janj«	Šipovo	195
5.	»Lom«	Bosan. Petrovac	295
6.	»Žuča-Ribnica«	Kakanj	30
7.	»Pleševica«	Bihać	50
	Forest reserves		
8.	»Bukov do«	Ljubinje	100
9.	»Mastna luka«	Posušje	400
10.	»Omar«	Skender Vakuf	97
	Special reserves		
	a.) Forest on moor		
11.	»Han Kram«	Sokolac	5
12.	»Đilda«	Vareš	10
13.	»Zvijezda«	Vareš	10
	b.) Reserves of *Picea omorica* Panæ.		
14.	»Tovarnica«	Višegrad	2
15.	»Karaula Stule«	Višegrad	2
16.	»Božurevac«	Višegrad	10
17.	»Veliki Stolac«	Višegrad	10
18.	»Gostilja«	Višegrad	50
19.	»Panjak«	Rogatica	30
20.	»Novo Brdo«	Rogatica	20
21.	»Pliština«	Srebrenica	20
22.	»Strugovi«	Srebrenica	30
23.	»Viogor«	Čajniče	40
24.	»Sokolina«	Foča	30
	Total *Picea omorica* Panæ.		**244**
	Parks - Forests		
25.	»Trebević«	Sarajevo	1 000
26.	»Bašajkovac«	Livno	10
27.	»Suvajsko Međugorje«	Bos. Krupa	50
28.	»Kruščica«	Travnik	50
29.	»Tisovac«	Busovača	50
30.	»Bistričak«	Zenica	30
	Total Parks-forests		**1 190**
	Natural Park		
31.	»Jahorina«	Pale	2 000

Table 6: Reserves of *Pinus heldreichii*

Name of the object	Commune	Surface (ha)
»Vran«	Prozor	65
»Prenj«	Konjic	40
»Rujište	Mostar	50
»Čvrsnica«	Posušje	50
»Hranisava«	Hadžići	50
Total reserves of *Pinus heldreichii*		**255**

Table 7: Recapitulation

Name of the object	Surface (ha)	Share of total forest area (%)
National Parks (without »Peručica«)	19,191 ha	0.71%
Virgin reserves	2,004 ha	0.07%
Forest reserves	597 ha	0.03%
Special reserves	269 ha	0.01%
Park Forests	1,190 ha	0.04%
Natural parks	2,000 ha	0.07%
Reserves of *Pinus heldreichii*	255 ha	0.01%
Total	**25,506 ha**	**0.94%**

Forest associations in the National Park »Kozara«, the surface of 3,375 ha, are: Sessile oak (*Querceto-Carpinetum*) and Beech (*Fagetum*). The Virgin forest »Peručica« (1,434 ha) is located in the National Park »Sutjeska« (17,250 ha), the area with altitudes ranging from 500 m to 2387 m. Due to its great variance of bedrock and soil conditions, different forest associations developed here (more than twenty), ranging from *Carpinetum orientalis* to *Pinetum mughi*. In 1954 Prof. Leibundgut and myself measured perhaps the highest spruce in Europe located in the Virgin forest »Peručica«. The height was 64 m and the breast diameter 190 cm.

In other virgin forests (»Janj«, »Lom« and »Žuča-Ribnica«) we find mixed forests of beech, spruce and fir with some maple (*Acer sp*.), elm (*Ulmus sp*.) and many other species of broad-leaved trees because they have similar geological and soil substrate (limestone and brown soils).

Projection for new National Parks

The Institute of Cultural, Historical and Natural Heritage Protection of Bosnia and Herzegovina in Sarajevo took the initiative to declare the National parks:

1. The mountain region of Prenj-Čvrsnica-Čabulja in Herzegovina (the endemic center of the Prenj Mountain), and
2. The mountain region of Treskavica-Bjelašnica-Igman in Bosnia near Sarajevo.

The River Una valley in the west Bosnia should be declared a Nature Reserve.

Research in forest reserves

On account of its great ecological differences in altitude (0 - 2387 m), in climate (continental, oceanic, mediterranean), in soils, etc., Bosnia and Herzegovina is classified into the following major regions where biological research is carried out:

1. Illyric region (Western humid region)
2. Moesiac region (Eastern arid region)
3. Central European region (Northern part of Bosnia)
4. Eumediterranean region (Evergreen region)
5. Mediterranean mountain region

In accordance with proposal of professor Dušan Mlinšek (in 1980) a network of plots will be established in these regions, with a minimum surface of 20 ha, and surrounded by a protection belt. A research in these plots will be carried out in the domain of:

- the main ecological characteristics of plots (climate, soil, etc.),
- the dynamic of forest population, fructification, regeneration, growing,
- how the energy, biomass, water and minerals travel through the ecosystem,
- the development in the past and in the future,
- the structure and functions of flora and fauna,
- what are the main impacts on the ecosystems,
- research into the structure and dynamics of old growth forests in Bosnia and Herzegovina,
- comparative researches into the patterns of natural disturbances and regeneration in old growth and management of natural forests,
- natural regeneration and changing of tree species by natural regeneration.

SUMMARY

Bosnia and Herzegovina is situated in the north-west of the Balkan Peninsula. It is predominantly mountainous (5% flat lowlands, 24% hilly, 42% mountainous, and 29% karst region). High forests, coppices and bare-lands represent 53% of the total land surface. This area of forest landscape is covered by 46.9% of high forests, 34.3% of coppices, and 18.8% of bare lands.

In the high forest main tree species are: oak, beech, silver fir, Norway spruce, and black and Scotch pine. In the coppices, beech and sessile oak are the main tree species. Approximately 90% of the forest landscape represents natural forest which has great diversity of tree species. Roughly only 10% of the forest landscape represents afforestation aged 50 years or less.

In the high forests the growing stock (more than 7 cm d.b.h.) is approximately 218 m^3/ha, and 50 m^3/ha in the coppices. The mean volume increment is more or less 5.57 m^3/ha annually in the high forests (2.46 m^3/ha in conifer forests, 3.11 m^3/ha in broad-leaved tree forests). In the high forests annual permissible cutting is 5.63 m^3/ha (2.16 m^3/ha in conifer forests, 3.47 m^3/ha in broad-leaved tree forests).

The single tree selection or the group selection system is applied in all types of high forests.

In the future the main goals are:

- to exercise the same forest management system as it exists today,
- to increase the growing stock and its quality through tending,
- to practice natural regeneration in all high forests,
- to convert the essential part of coppices into high forests through tending,
- to extend the multiple use of the forests.

The total surface of protected forests of all categories is approximately 25,500 ha (0.94% of the total forest area).

In the next 10 years, the area of all protected reserves will be enlarged, especially in the mountain region Prenj-Čvrsnica-Čabula, which is the centre of the endemic tree species *Pinus heldreichii*. In addition to this the region of Igman-Bjelašnica near Sarajevo, and the river Una in the western part of Bosnia, will be enlarged.

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REFERENCES

ALIFALFIĆ, F. (1965) Prašumski rezervati Peručica. Narodni šumar, sv. 7-8, p. 237-246, Sarajevo.

DRINIĆ, P. (1965) Taksacioni elementi sastojina jele, smrče i bukve prašumskog tipa u Bosni. Radovi Poljoprivredno-šumskog tipa u Bosni. Radovi Poljoprivredno-šumarskog fakulteta Broj 1 B, p. 107-160.

DRINIĆ, P. (1957) Taksacioni elementi bukovih sastojina prašumskog tipa u Donjoj Drinjači. Radovi Poljoprivredno-šumarskog fakulteta, broj 1/B, p. 105-140, Sarajevo.

ERAK, S. (1986) Utezanje prašumske jelovine iz Gospodarske jednice Vitoroga »Glamoč. Šumarstvo i prerada drveta, broj 7-9, p. 321.326, Sarajevo.

FUKAREK, D. (1957) Prašumski rezervat »Peručica«, Narodni šumar, 10-12, p. 389-393, Sarajevo.

FUKAREK, P. / ŠTEFANOVIĆ, V. (1958) Prašuma Peručica i njena vegetacija. Radovi Poljoprivredno-šumarskog fakulteta, B Šumarstvo III/3, p. 93-146, Sarajevo.

FUKAREK, P. (1962) Prašumski rezervat Peručica. Narodni šumar, sv. 10-12, Sarajevo.

FUKAREK, P. (1964) Prašuma Peručica nekad i danas (I), Narodni šumar, sv. 9-10, p. 433-456, Sarajevo.

FUKAREK, P. (1964) a) Prašuma Peručica nekad i danas (II) Narodni šumar, sv. 1-2, p. 29-50 Sarajevo.

FUKAREK, P. (1970) Šumske zajednice prašumskog rezervata Peručica. Akademija nauke i umjetnosti BiH, Posebno izdanje XV, knjiga 4, p. 157-262, Sarajevo.

FUKAREK, P. (1970) Južno evropske prašume i njihov značaj za nauku i praksu. Akademija nauke i umjetnosti BiH, Posebno izdanje, knjiga 4, p. 21-40, Sarjevo.

FUKAREK, P. (1978) Zu den südeuropäischen Urwäldern. Allgemeine Forstzeitschrift, No 24, München.

LEIBUNDGUT, H. (1982) Europäische Urwälder der Bergstufe. Haupt, Bern.

LEIBUNDGUT, H. (1993) Europäische Urwälder, Haupt, Bern.

MANUŠEVA, L. / ĆIRIĆ, M. (1969) On the special properties of humus in Virgin Forest soils of Bosnia and Herzegovina. Sulhurile muntilor Bucegi, p. 231-240, Bucarest.

MAYER, H. (1992) Waldbau auf soziologisch-ökologischer Grundlage, IV Auflage, G. Fischer Verlag, Stuttgart, Jena, New York.

PINTARIĆ, K. (1959) Urwald in Jugoslawien. Schweizerische Zeitschrift für Forstwesen, sv. 3, p. 1-6, Bern.

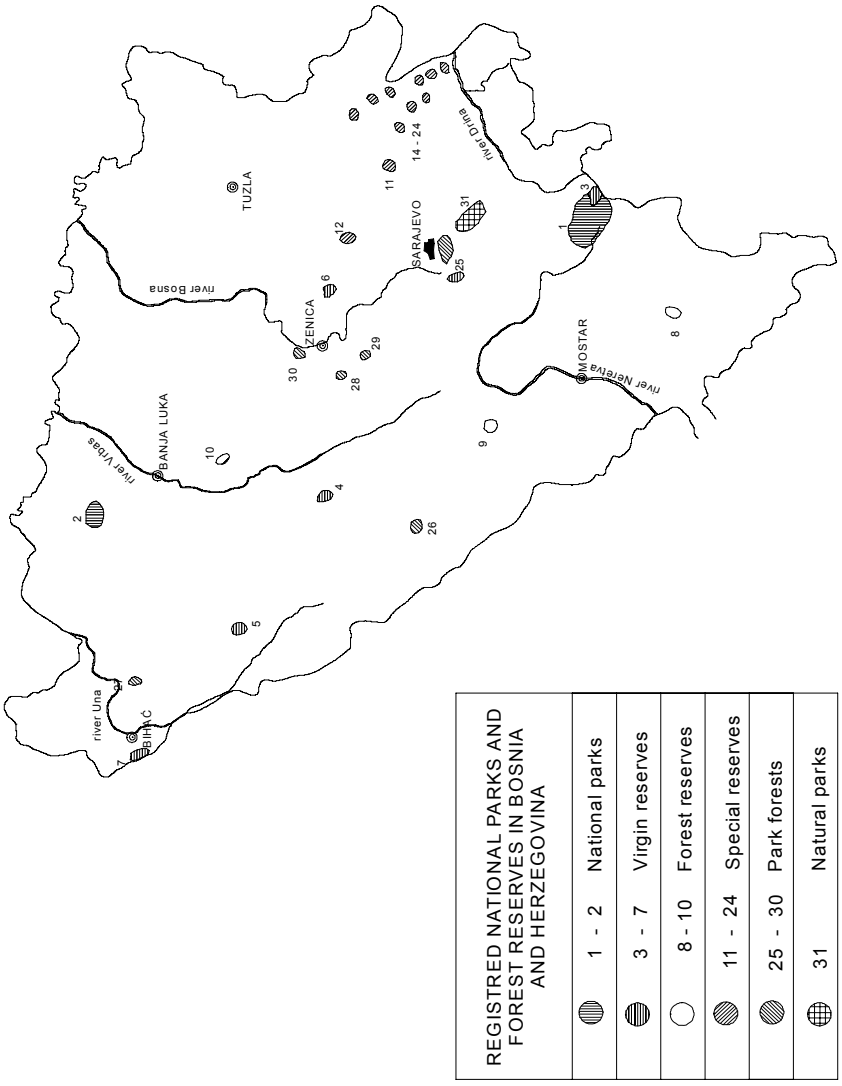
PINTARIĆ, K. (1978) Urwald Peručica als natürliches Forschungslaboratorium. Allgemeine Forstzeitschrift, heft 24, p. 702-707, München.

STEFANOVIĆ, V. (1970) Jedan pogled na recentnu sukcesiju bukovih-jelovih šuma prašumskog karaktera u Bosni. Radovi Akademije nauka i umjetnosti BiH. XV, knjiga 4, p. 141-150, Sarajevo.

STEFANOVIĆ, V. (1988) Prašumski rezervati Jugoslavije, dragulji iskonske prirode. Biološki list, br. 9-10, p. 1-5, Sarajevo.

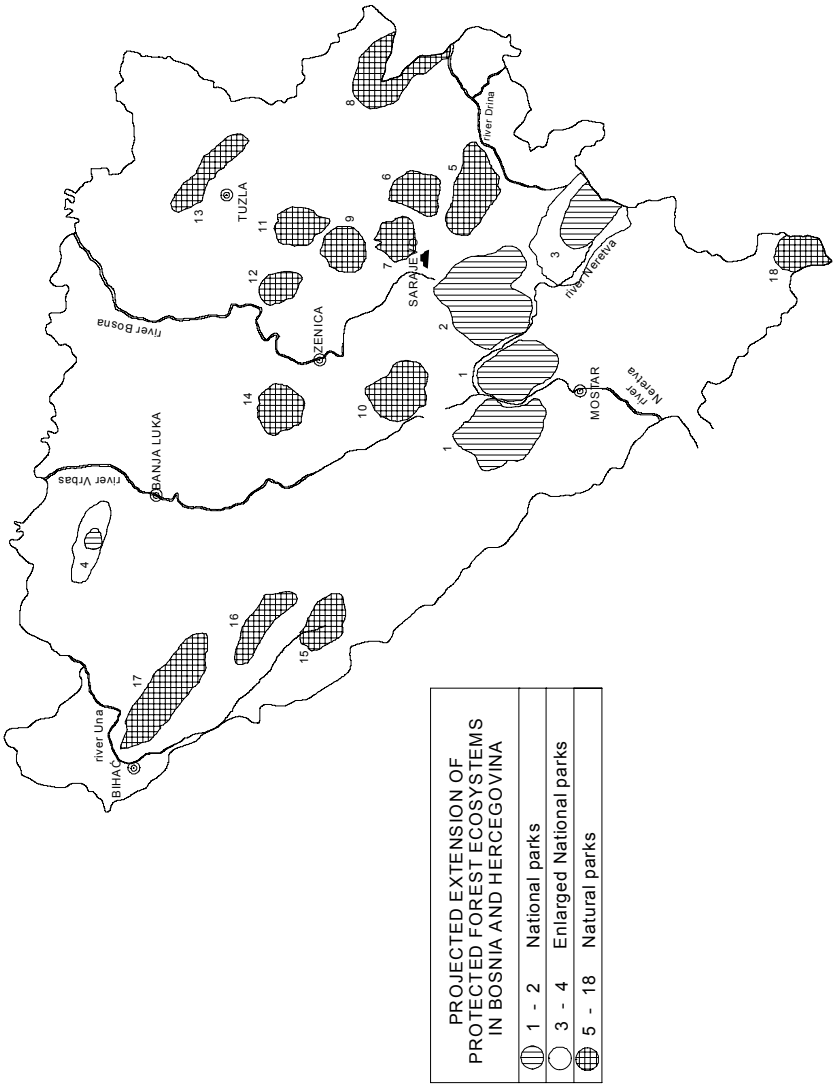
Appendix A

Figure 4: The geological locations of the protected forests



Appendix B

Figure 5: The enlargement of the protected forests and forest reserves in the next ten years



THE FORESTS OF CROATIA – COUNTRY REPORT

by Slavko MATIĆ *

ABSTRACT

The Republic of Croatia is one of the countries in which the protection of nature and the preservation of environment has a tradition of several centuries. Although systematic activities to this end began in the middle of the 19th century, we should point out that the oldest regulations on forest management, prescribing treatments aimed at the protection and preservation of nature, date back to the 18th century.

Legal acts and magazine articles make it possible for us to trace the history of nature protection and environment conservation through the history of forestry. Forestry and forest science in Croatia, whose continuous development is over 225 years long, was born out of justifiable fear that chaotic and unsystematic treatment of forests at that time would lead to their destruction and disappearance. As a result, about 95% of the forests were developed by natural regeneration. The preservation of their natural structure and biodiversity, sustainability and natural regeneration are fundamental postulates of past, present and future management.

The proclamation of first protected nature areas and facilities in Croatia was preceded both by the enactment of various acts, regulations and laws, and by the publishing activity of Croatian naturalists.

In Croatia there are ten categories of nature protection. The Law prescribes activities to be carried out in each of these categories, management practices, proclamation of new categories, methods of protection, compensation for damage, surveillance and punitive measures.

INTRODUCTION

Forests and forest land in Croatia covers 2.485,300 ha, which is 43.5% of the total area. Forests in their various silvicultural forms take up 83.6%, or 2.078,00 ha, and productive and unproductive forest land accounts for 16.4% or 406,000 ha. On average, there is 0.51 ha of forests per capita.

Forests in Croatia inhabit three zones with characteristic ecological and vegetational features. These are: the zone of lowland forests covering 910,000 ha in total and having a growing stock of 150 million m^3, the zone of hills and mountains with an area of 775,200 ha, and a growing stock of 100 million m^3, and the Mediterranean or sub-Mediterranean zone with an

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area of 800,100 ha and a growing stock of 80 million m^3. In terms of ownership, 82% of the forests are state-owned, and only 18% are privately-owned.

In Croatia, forests have mostly developed with natural regeneration. Of the total forest area, only about 5%, or 100,000 ha, are covered with broadleaves and conifer cultures and plantations. The rest of the forests are natural. About 1.200,000 ha, or 58%, are high silvicultural forms, about 500,000 ha, or 24%, are low silvicultural forms or coppices, and about 300,000 ha, or 13%, are various degraded stages (maquis, garrigues, brushwood, thickets).

About 54% of the forest area are continental forests on altitudes ranging between 100 and 1,600 metres above sea level. The following belts can be distinguished: the belt of oak forests, the belt of beech and fir forests, the belt of sub-Alpine beech, and the belt of Mugho pine. The Mediterranean belt is divided into the zone belonging to holm oak and Aleppo pine (EU-Mediterranean) and the belt with pubescent oak and black pine (sub-Mediterranean).

The total growing stock in the forests of Croatia is 324.257,000 m^3, the annual increment is 9.643,000 m^3, and the felling quantity is 5.354,000 m^3, which is 55% of the total annual increment.

Of the total growing stock, beech takes up 36%, or 89.140,490 m^3, pedunculate oak 16%, or 40.541,780 m^3, European fir 12%, or 30.975,420 m^3, sessile oak takes up 9%, or 22.976,488 m^3, other hard broadleaves 18%, or 45.076,990 m^3, other soft broadleaves 4%, or 10.245,387 m^3, and other conifers 5%, or 11.869,893 m^3.

Over 225 years of forestry tradition in Croatia is well documented. The first forests stations were established as early as in 1769, at the same time as in some central European countries. The Forest Association, founded in 1846, has been working continuously up to present time. The first forestry teaching facility was established in Križevci in 1860, while a specialized magazine "Journal of Forestry" (Šumarski list) saw its first publication in 1877. University forestry education began in Zagreb in 1898 in the form of Forest Academy, which was transformed into Faculty of Agriculture and Forestry in 1919. Since 1960 it has been an independent Faculty of Forestry. The scientific journal of the Forestry Faculty, called "Forest Experiments" (Glasnik za šumske pokuse), first published in 1926, has been coming out regularly up to now. Another important year is 1996, when the Academy of Forest Science was established, gathering top scientists from the field of forestry.

The distinctive feature of Croatian forestry is the management of natural forests and the use of natural regeneration as a basic method of forest regeneration. The reason why Croatian forests have retained their natural structure lies in natural or artificial regeneration, strict adherence to the principles of natural regeneration, and the abolishment of clear cutting as a method of forest regeneration. The forests are characterized with factors such as stability, productivity and biodiversity, which are conducive to sustainable management and natural regeneration.

This laudable state of Croatian forestry is due primarily to the renowned Zagreb School of Silviculture, which has developed in the course of long forestry history and tradition. Its basic postulates are:

- management with natural forests,
- preservation of natural structure and diversity,
- the use of natural regeneration as a regeneration method,

- maintenance of stability, diversity, natural structure and good market and non-market values,
- using forests and forestry in the light of environmental protection.

The first scientific research into the forests took place in the middle of last century, and have continued with unabated intensity until present time. The problems of regenerating and tending natural forests, and regenerating desiccated, degraded and endangered forest are in the focus of scientific research by the scientists of the Faculty of Forestry in Zagreb, and the Forestry Institute in Jastrebarsko.

THE HISTORY OF NATURE RESERVES IN CROATIA

The Republic of Croatia is one of the countries in which the protection of nature and the preservation of environment has a tradition of several centuries. Although systematic activities to this end began in the middle of the 19th century, we should point out that the oldest regulations on forest management, prescribing treatments aimed at the protection and preservation of nature, date back to the 18th century.

Legal acts and magazine articles make it possible for us to trace the history of nature protection and environment conservation through the history of forestry. Forestry and forest science in Croatia, whose continuous development is over 225 years long, was born out of justifiable fear that chaotic and unsystematic treatment of forests at that time would lead to their destruction and disappearance. As a result, about 95% of the forests were developed by natural regeneration. The preservation of their natural structure and biodiversity, sustainability and natural regeneration are fundamental postulates of past, present and future management.

The proclamation of first protected nature areas and facilities in Croatia was preceded both by the enactment of various acts, regulations and laws, and by the publishing activity of Croatian naturalists.

One of the more important events took place in 1769, when a legal act on forest management was passed containing regulations on forest protection and conservation. In 1843, the Hunting Act prescribed the protection of birds and rare game species. The Forest Act from 1930 listed the procedures for proclaiming protected nature facilities, and prescribed the maintenance of nature monuments and particularities of plant and animal world. A regulation on national parks was passed in 1938. The Institute for the Protection of Natural Rarities was founded in 1946, and the Law on the protection of cultural monuments and rare natural features was passed. The basic legal acts regulating the protection of nature and environment today are: The Constitution of the Republic of Croatia, the Forest Act, the Act on Area Planning, the Law on Nature Protection, and the Law on Ratification of the Convention on the Protection of World Cultural and Natural Heritage.

Croatian naturalists have published numerous articles on the protection of nature in various magazines, some of which have a century-long tradition, and are among the oldest dealing with this problem matter. Journal of Forestry (Šumarski list 1877), Journal of the Croatian Natural Scientists' Association (Glasnik Horvatskoga naravoslovnoga društva 1886), Hunting and Fishing News (Lovačko-ribarski viestnik 1892), The Croatian Mountaineer (Hrvatski planinar 1898), Nature (Priroda 1911), Forest Experiments (Glasnik za šumske pokuse 1926), and Nature Conservation (Zaštita prirode 1938).

Today, 746 facilities in Croatia are under protection, of which 322 are protected areas covering 447,197.17 ha, or 7.3% of the total surface area of the Republic. Protected facilities are divided into ten protective categories. Their number and area are shown in Table 1.

Table 1: Protected categories in the Republic of Croatia

Category	Number	Area (ha)
Strict reserves	2	2,395.35
National parks	7	69,420.00
Nature parks	6	317,502.00
Special reserves	70 (forests: 32)	31,680.09
Park forests	23	7,659.91
Significant landscapes	28	17,544.52
Natural monuments	72	82.87
Architectural park monuments	114	912.43
Animal species	380	-
Plant species	44	-
Total	**746**	**447,197.17**

Apart from legally protected natural facilities, there is also a category of protective forests covering an area of 99,412.00 ha. These forests are excluded from regular management due to their multipurpose protective functions. They provide protection against erosions, avalanches, and winds, as well as protection of forest roads, special facilities or areas, etc.

CLASSIFICATION OF FOREST PROTECTION AREAS

In Croatia there are ten categories of nature protection. The Law prescribes activities to be carried out in each of these categories, management practices, proclamation of new categories, methods of protection, compensation for damage, surveillance and punitive measures.

Strict reserves are areas in which nature is either unaltered or only slightly altered by human activity. All activities and practices of harmful nature are strictly prohibited. Strict reserves in Croatia are *Hajdučki and Rožanski kukovi*, and *Bijele and Samarske stijene.*

National parks are large areas with special natural, scientific, educational, aesthetic, tourist and recreational values, and comprise one or more preserved or slightly altered ecosystems. Activities which do not endanger authentic plant and animal world, those that do not harm hydrographic, geomorphological, geological, and landscape values, and those which maintain or establish natural balance are allowed. There are 7 national parks in Croatia: the Plitvice Lakes (Plitvička jezera), Paklenica, Risnjak, the Island of Mljet, the Kornati Archipelago, the Brijuni Islands, and the River Krka. The first national park, proclaimed in 1949, was the Plitvice Lakes. The Society for the Enhancement of the Beauty of Plitvice Lakes was founded in 1893, and proposed that Plitvice Lakes be proclaimed a national park as early as in 1914.

Nature park is a spacious uncultivated or partly cultivated area with distinct ecological, aesthetic, tourist and recreational values. Activities which do not endanger the basic features and functions of the park are allowed. The 6 nature parks in Croatia are: Kopački rit,

Medvednica, Velebit, Biokovo, Telašćica, and Lonjsko polje. Mount Velebit is the most important mountain in Croatia in terms of its relief and vegetation. The UNESCO proclaimed Mount Velebit a world biosphere reserve in 1978.

Park forest is a natural or planted forest of high landscape value intended for rest and recreation. Activities concerned with its conservation and regulation are allowed.

Significant landscape is a natural or cultivated area of high aesthetic or cultural-historical values, or an area featuring a characteristic landscape. Activities harming the features for which the area was proclaimed a significant landscape are not allowed.

Monument of nature is an individual item or a collection of items in their authentic form belonging to live or still nature having scientific, aesthetic or cultural-historical value.

Architectural park monument is a specially designed area (park, botanical garden, arboretum, city park, avenue, an individual or a group of trees, and other forms of garden and park design) of aesthetic, stylistic, artistic, cultural-historical or scientific value.

Endangered or rare plant and animal species are protected by the State. All activities which might disturb or interfere with the natural life and development of protected species are forbidden.

Special reserve is an area with one or more distinct nature elements (plant and animal species, their communities, relief, water), which have scientific importance and purpose. Special reserves can include: forest vegetation, and botanical, zoological, geological and other features. Activities which might harm the features for which an area was proclaimed a special reserve are not allowed. There are 70 special reserves in all, of which 32 are the reserves of forest vegetation. (See Table 2 on the next page.)

The best preserved forests in Croatia are virgin forests of beech and fir (*Abieti Fagetum illyricum* Hor. 1938), occurring in several places in the Dinaric range. The best known are Čorkova uvala in the National Park of Plitvice Lakes, Devčića tavani, Štirovača, and Klepina duliba in north Velebit, Javorov kal in the National Park of Risnjak, and Velika Plješivica on the border with Bosnia and Herzegovina. Of lowland forests, a virgin forest of pedunculate oak and common hornbeam (*Carpino betuli Quercetum roboris* Rauš 1971), and a Slavonian forest of pedunculate oak and greenweed with remote sedge (*Genisto elatae Quercetum roboris caricetosum remotae* Ht. 1938) are protected in Prašnik near Okučani. Virgin forests of beech inhabit the localities of Ramino korito, on south Velebit and in Muški bunar on Psunj. These are stands of mountain forests of beech and mountain forests of beech with sessile oak (*Lamio orvale Fagetum sylvaticae* Ht. 1938).

Table 2: Special reserves of forest vegetation in Croatia

Name of forest reserve	Basic features	Area (ha)
Velika Plješivica-Drenovača	Beech and fir forest (virgin f.)	156.84
Velika Plješivica-Javornik-Tisov vrh	Beech and fir forest (virgin f.)	122.50
Muški bunar	Beech and sessile oak stand on Psunj (virgin f.)	58.67
Prašnik	Pedunculate oak and common hornbeam stand and pedunculate oak with greenweed (virgin f.)	58.00
Čorkova uvala	Beech and fir stand in the National Park Plitvice Lakes (virgin f.)	75.00
Stupnički lug-Čret	Pedunculate oak and common hornbeam stand with beech (secondary virgin f.)	18.00
Štirovača-Klepina duliba	Beech and fir forest (secondary virgin f.)	118.50
Lokrum-Dubrovnik	Stand of holm oak and maquis with Aleppo pine	72.37
Dundo	Holm oak stand on Island Rab	106.00
Bliznec-Šumarev grob	Beech and fir stand on Medvednica	175.73
Gračec-Lukovica-Rebar	Thermophilous stand of pubescent oak and black hornbeam on Medvednica	23.41
Mikulić potok-Vrabečka gora	Beech stand on Medvednica	90.93
Pušinjak-Gorščica	Beech stand on Medvednica	189.79
Rauchova lugarnica-Desna trnava	Beech and fir stand on Medvednica	101.01
Tusti vrh-Kremenjak	Beech and sessile oak stand on Medvednica	20.00
Babji zub-Ponikve	Sessile oak and beech stand on Medvednica	148.60
Markovčak-Bistra	Beech and fir stand on Medvednica	250.24
Motovunska šuma	Pedunculate oak and narrow-leaved ash stand in the lower course of River Mirna in Istria	281.42
Debela lipa-Vila rebar	Beech and fir stand and fir stand on stone blocks at Lokve, Gorski kotar	178.55
Kontija	Pubescent oak and white hornbeam stand above the Limski Fjord in Istria	39.88
Crni jarci	Black alder stand near Kalinovac	132.71
Velika dolina	Holm oak stand in National Park Mljet	15.00
Sekulinačke	Beech stand on Papuk	11.00
Glavotok	Holm oak stand on island Krk	1.00
Dugačko brdo	Beech stand and sessile oak and common hornbeam on Bilogora	10.91
Lože	Pedunculate oak and hornbeam stand, pedunculate oak with greenweed and remote sedge stand, and pedunculate oak with greenweed and Acer tataricum near Otok	110.41
Japetić	Beech stand	28.80
Radiševo	Stand of pedunculate oak and common hornbeam with beech near Vrbanja	4.10
Novakuša	Pedunculate oak and hornbeam stand	2.28
Česma	Pedunculate oak and hornbeam stand and black alder stand	48.53
Varoški lug	Pedunculate oak and hornbeam stand, pedunculate oak with greenweed and remote sedge stand within a special zoological reserve Varoški lug	91.00
Vukovarske dunavske ade	Alluvial forests of willow and poplar on Danubian islets near Vukovar	115.00

The total area of forest vegetation reserves is 2,856.18 ha. In the lowland belt of the continental region (Table 3) there are 10 reserves covering an area of 861.45 ha. These are primarily the reserves of renowned forests of Slavonian pedunculate oak (*Quercus robur ssp. slavonica*) and one reserve of an alluvial forest of poplars and willows on Danubian islets near Vukovar. The reserve of Prašnik deserves special mention. The oak trees there are between 250 and 300 years old, their breast diameters range from 70 to 200 cm, while in height they reach some 36 metres. The latest measurements revealed a total of 993 old oak trees with wood volume of about 15,000 m^3. The wood volume of some samples exceed 50 m^3.

Table 3: Special reserves of forest vegetation with reference to altitudinal belts

Height belt (altitude)	Number of reserves	Area (ha)	%
Lowland (< 130 m)	10	861.45	30.2
Hilly (130–400 m)	1	23.41	0.8
Low mountains (400–700 m)	8	808.94	28.3
Mountains (700–1,200 m)	9	928.13	32.5
Mediterranean region	5	234.25	8.2
Total	**32**	**2,856.18**	**100.0**

In the belt of low mountains there are 8 reserves of forest vegetation, whose total area is 808.94 ha. The reserve of Muški Bunar on Psunj is an example of 300-year-old virgin forests of beech, and beech and sessile oak. Beech trees reach some 40 m in height, with breast diameters of up to 200 cm. Wood volume per hectare is over 800 m^3.

The Čorkova uvala virgin forest is an example of beech and fir. According to the latest mensuration, this stand has 439 trees per hectare, a basal area of 52.38 m^2/ha, and wood volume of 922.71 m^3/ha.

There are 5 special reserves of forest vegetation in the Mediterranean region, of which Dundo on the Island of Rab deserves special mention, as it is one of the rare preserved forests of holm oak in the Mediterranean.

REFERENCES

MATIĆ, S. / MEŠTROVIĆ, Š. / VUKELIĆ, J. (1997) Gospodarenje šumama i šumskim prostorom na području Grada Zagreba i Zagrebačke županije. Šumarski fakultet Sveučilišta u Zagrebu, 213 pp., Zagreb.

MATIĆ, S. / PRPIĆ, B. / RAUŠ, Đ. / VRANKOVIĆ, A. / SELETKOVIĆ, Z. (1979) Ekološko-uzgojne osobine specijalnih rezervata šumske vegetacije Prašnik i Muški bunar u Slavoniji. In: Rauš, Đ. (ed.), Drugi kongres ekologa Jugoslavije, Savez društava ekologa Jugoslavije, 767-823, Zadar-Plitvice.

PRPIĆ, B. (1972) Neke značajke prašume Čorkova uvala. Šum. list 9-10: 325-333.

PRPIĆ, B. (1979) Struktura i funkcioniranje prašume bukve i jele (*Abieti-Fagetum illyricum* Horv. 1938) u dinaridima Hrvatske. In: Rauš, Đ. (ed.), Drugi kongres ekologa Jugoslavije, Savez društava ekologa Jugoslavije, 899-928, Zadar-Plitvice.

PRPIĆ, B. / SELETKOVIĆ, Z. (1996) Istraživanja u hrvatskim prašumama i korišćenje rezultata u postupku s prirodnom šumom. In: Mayer, B. (ed.), Unapređenje proizvodnje biomase šumskih ekosustava, Šumarski fakultet Sveučilišta u Zagrebu & Šumarski institut, Jastrebarsko, 97-103, Zagreb.

RAUŠ, Đ. / MEŠTROVIĆ, Š. / TRINAJSTIĆ, I. / VUKELIĆ, J. / ŠPANJOL, Ž. (1992) Zaštićeni prirodni objekti u hrvatskih šumama. In: Rauš, Đ. (ed.), Šume u Hrvatskoj/Forests of Croatia, Šumarski fakultet Sveučilišta u Zagrebu & Hrvatske šume, p.o. Zagreb, 197-222, Zagreb.

ŠPANJOL, Ž. (1994) Problematika nacionalnih parkova u svijetu i Republici Hrvatskoj. Glas. šum. pokuse 30: 61-94.

Zakon o zaštiti prirode. Narodne novine 30/94.

FOREST RESERVE RESEARCH NETWORK

The Czech Republic Country Report

by Libor Hort * , Vladimír Tesař ** , Tomáš Vrška ***

ABSTRACT

This report gives a view of the state of the establishing of forest reserves, their conservation and their use in the forest research. The chapter "*Forest Condition*" contains a brief view of the state of the forests in the Czech Republic. The text is accompanied by tables and Figures. The chapter "*History of the Establishment of Nature Reserves*" summarizes the development of this topic from the establishing of the first forest reserve (in 1838) until now. The following chapter specifies the conditions of the legal protection of natural forests in the Czech Republic. The following two chapters briefly summarize the development and the present state of the research of forest reserves in the Czech Republic. The most extensive and comprehensive work on this theme was done by eng. Eduard PRŮŠA, CSc., who carried out a detailed survey in 13 of the best preserved reserves. The recent project "*The Study of Dynamics of Virgin Forest Reserves in the Czech Republic*" (the responsible chief manager Dr. eng. Tomáš VRŠKA) follows up this survey. The chapter "*References*" gives a view of the most important works on natural forest research in the Czech Republic.

FOREST CONDITION

(*Extracted from the Report on Forestry of the Czech Republic, by December 31,1996 - Ministry of Agriculture of the Czech Republic, Prague 1997, 162 pp.*)

Since 1790 when the first data was recorded, the forest area on the territory of our state has increased by 657,000 ha and the forest cover has increased from 25% to 33%. In the last years this area has increased merely slightly – by 2,000 ha in five years – and made up in total 2,631 ha in 1996. The additions only closely surpassed the losses. At present, there is 0.25 ha of forest land per capita. In 1996, high forest covered 99.9% and coppice

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only 0.1%. Since 1950 the share of non-coniferous tree species has increased from 12.5% to 20.8% in 1990, and to 21.6% in 1996. Since 1920, the average rotation period has increased until the present by more than 20 years, and since 1950 by 13 years to the present 114.6 years (commercial forest 111.2 years, protection forest 155.0 years, forest of special purpose 116.6 years). The share of age classes I-III is lower than the calculated standard. The share of stands older than 80 years continues to increase. Above all, this development is a consequence of a high share of incidental fellings without subsequent afforestation obligation. The development of growing stock volumes is favourable. In 1996, growing stock increased at 600 million m^3 (the figures are given in m^3 under bark). Total average increment in the mentioned year was 16.5 million m^3 (6.4 m^3/ha) and the overall current addition was 18.0 million m^3 (7.0 m^3/ha). Thus fellings were 83% of total average increment and 76% of total current increment. This means that growing stock will further increase.

See Tables 1-16 and Figures 1-10.

Table 1: Forest land area in the Czech Republic

Year	1920	1930	1945	1950	1960	1970	1980	1990	1996
Area 1,000 ha	2369	2354	2420	2479	2574	2606	2623	2629	2631

Figure 1: Forest land area in the Czech Republic

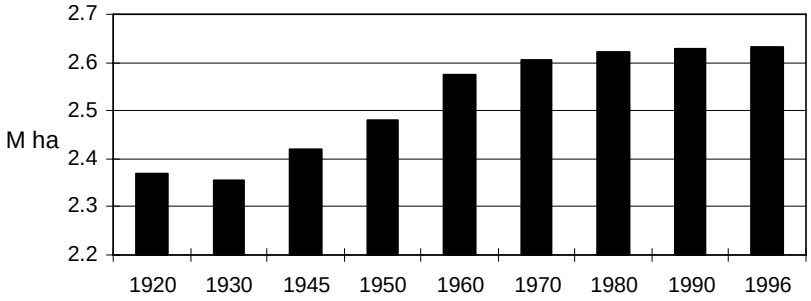


Table 2: Forest coverage in the Czech Republic

	Czech Kingdom			Czech Republic	
Year	1790	1865	1910	1990	1996
Forest coverage	25.0 %	28.0 %	30.0 %	33.3 %	33.3 %

Figure 2: Forest coverage in the Czech Republic

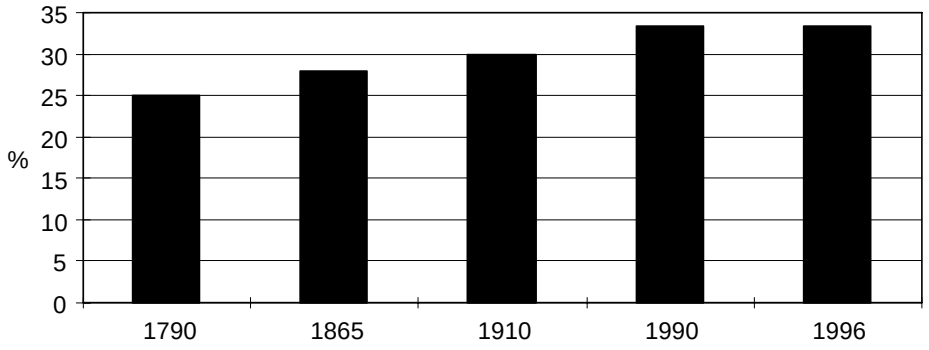


Table 3: Species composition of forests in the Czech Republic

Species	Year				
	1950[1)]	1970	1980	1990	1996
	area of timber land in ha / %				
Spruce	60.0	55.6	55.7	54.7	54.6
Fir	2.9	2.1	1.7	1.1	0.9
Pine	21.2	19.2	18.3	17.8	17.7
Larch	1.5	2.2	2.7	3.2	3.5
Other coniferous	0.2	0.6	0.8	0.8	0.2
Oak	3.6	5.5	5.7	6.0	6.2
Beech	4.5	5.0	5.3	5.4	5.7
Birch	-	2.6	2.5	2.9	2.9
Other non-coniferous	4.4	6.5	6.5	6.5	6.8
Coniferous	85.8	79.7	79.2	77.6	76.9
Non-coniferous	12.5	19.6	20.0	20.8	21.6
Total without unstocked areas	98.3	99.3	99.2	98.4	98.5

[1)] **Note:** High forest available for wood supply only (including forests smaller than 10 ha in size). Birch has been included into soft non-coniferous and is mentioned as one of the other non-coniferous species.

Table 4: Natural and current composition of forests in the Czech Republic - %

Composition	Natural	Current
Spruce - (SP)	11.2	55.4
Fir - (FR)	19.8	1.0
Pine - (PN)	3.4	18.0
Larch - (LA)	0.0	3.6
Other coniferous	0.3	0.2
Total coniferous	**34.7**	**78.1**
Oak	19.4	6.3
Beech - (BE)	40.2	5.8
Hornbeam - (HB)	1.6	1.2
Ash	0.6	1.0
Maple - (MP)	0.7	0.8
Elm	0.3	0.0
Birch - (BI)	0.8	3.0
Linden - (LI)	0.8	0.9
Alder - (AL)	0.6	1.4
Other non-coniferous.	0.3	1.5
Total non-coniferous	**65.3**	**21.6**

Note: Temporary unstocked area is included into species composition for giving comparison of natural and current conditions.

Figure 3: Natural and current composition of forests in the Czech Republic - %

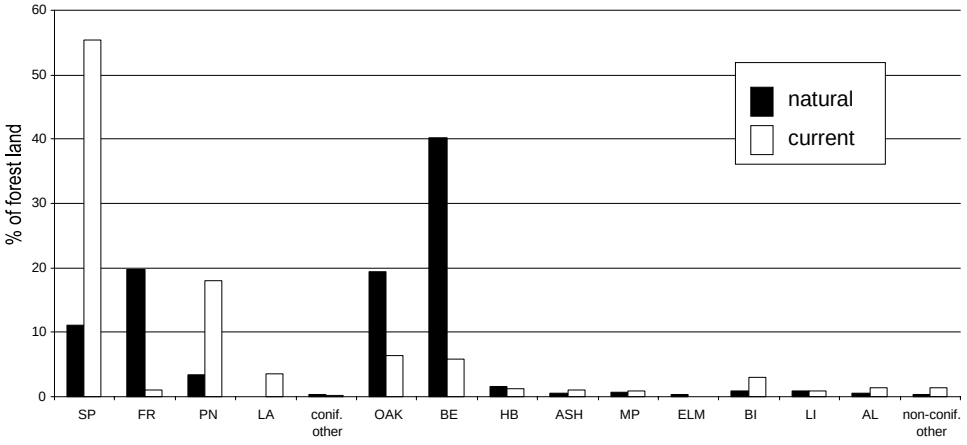


Table 5: Rotation period in forests of the Czech Republic

Year								
1920	**1930**	**1940**	**1950**	**1960**	**1970**	**1980**	**1990**	**1996**
Rotation period, years								
93.4	92.5	95.4	101.1	101.2	102.6	108.1	112.4	114.6

Table 6: Age categories in forests of the Czech Republic

	Age category (years)							
	Unstocked area	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**
		1-20	**21-40**	**41-60**	**61-80**	**81-100**	**101-120**	**121 +**
Year	% of timber land							
1920	1	23	24	22	17	10	3	0
1930	2	21	21	21	19	11	5	0
1950	2	18	21	21	19	12	7	0
1960	1	17	21	20	19	13	6	3
1970	1	17	20	19	20	13	7	3
1980	1	17	15	20	20	15	8	4
1990	1.5	16.1	14.7	19.4	18.9	16.8	8.2	4.4
1996	1.5	16.2	15.5	16.5	18.5	17.6	9.3	4.9
Normality	-	17.9	17.9	17.7	17.3	15.9	9.4	3.9

Note: Data before 1990 cannot be specified in decimals.

Table 7: Age structure of forest stands in the Czech Republic

	Year					
	1950 [1)]	**1960**	**1970**	**1980**	**1990**	**1996**
Age range	**forest stand area, ha**					
0 - unstocked area	64 281	23 335	18 627	19 796	40 562	38 086
1 - 40	948 040	941 218	940 665	834 913	791 948	820 377
41 - 80	945 123	951 215	999 090	1 022 009	975 060	904 418
81 - 120	475 760	474 077	527 635	593 707	662 853	695 406
121 +	---	72 914	81 291	101 641	112 357	126 343

[1)] **Note:** Including non-forest land to be afforested and forests not available for wood supply. Forest stands older than 120 years were not separated and are included into age category of 81-120 years. Unstocked area on non-forest land was 21,084 ha.

Table 8: Changes in forest categories in the Czech Republic

Year	Forest category		
	commercial forest	protection forest	special purpose forest
1980	78.2 **%**	4.0 **%**	17.8 **%**
1985	68.2 **%**	3.1 **%**	28.7 **%**
1990	58.4 **%**	2.5 **%**	39.1 **%**
1996	61.3 **%**	2.9 **%**	35.8 **%**

Figure 4: Changes in forest categories in the Czech Republic

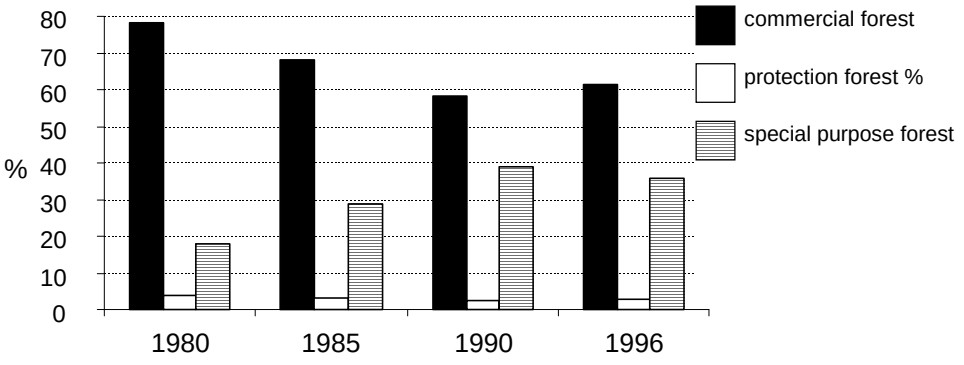


Table 9: Silvicultural systems in the Czech Republic

	Forest managed clear-cutting or shelter-wood system				Selection forest	
	high	coppice	coppice in conversion	copp. with standards	high	coppice in conversion
Year	**% of forest land area**					
1900	89.5	4.1		2.6	3.8	
1910	89.6	3.7		2.0	4.7	
1930	92.6	3.8	0.1	2.3	1.1	0.1
	% of forest stand area					
1950	96.8	0.8	2.4	**	-	-
1960	96.6	3.4		**	-	-
1970*	97.3	0.1	2.6	**	-	-
1980	98.8	1.2		**	-	-
1990	99.7	0.3		**	-	-
1996	99.9	0.1		**	-	-

Note: * Forest available for wood supply only.
** Between 1950 and 1977, the upper and lower storeys of the coppice-with-standards forest were recorded separately. Since 1978, the coppice and coppice-with-standards forests with a sufficient number of trees of good quality are included in high forests.

Table 10: Regeneration of forest in the Czech Republic

Method of regeneration:	Regeneration, ha								
	1980	**1985**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**
artificial	26,939	33,555	33,615	31,516	29,600	27,698	26,897	30,128	28,426
of which repeated	6,750	9,569	9,635	12,050	12,702	12,994	14,448	12,760	*
natural regeneration	999	594	908	557	575	697	818	1,163	1,898
Total	27,938	34,149	34,523	32,073	30,175	28,395	27,715	31,291	30,324

* **Note:** Data not recorded

Figure 5: Regeneration of forest in the Czech Republic

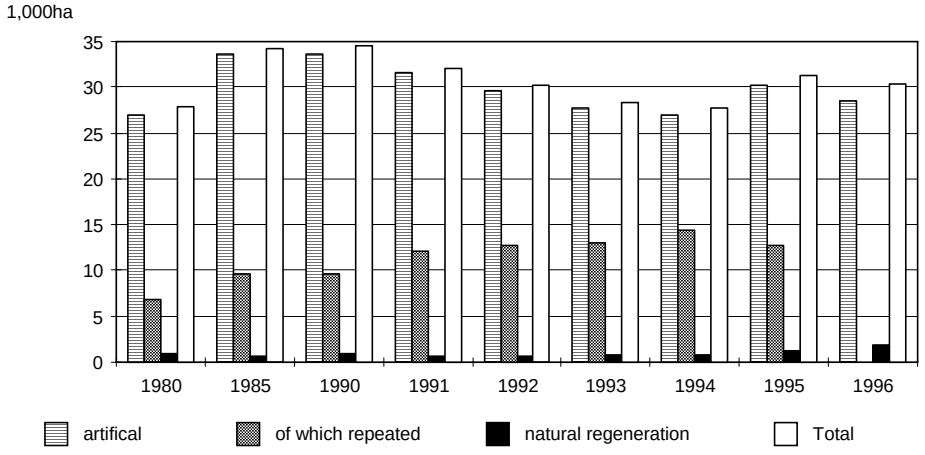


Figure 6: Area of natural regeneration in the Czech Republic

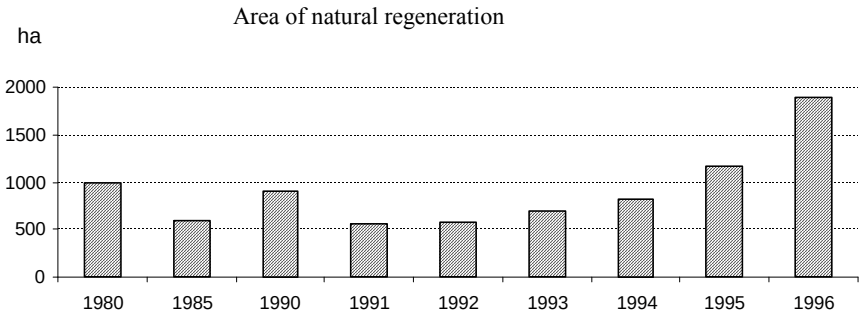


Table 11: Thinnings and cleanings

Year	Thinnings	Cleanings	Total
		1,000 ha	
1980	92.7	53.7	146.4
1985	34.9	55.2	90.1
1990	68.8	51.0	119.8
1991	93.5	52.6	146.1
1992	92.9	44.7	137.6
1993	53.2	34.2	87.4
1994	74.3	43.0	117.3
1995	111.4	44.8	156.2
1996	118.6	46.0	164.6

Figure 7: Thinnings and cleanings

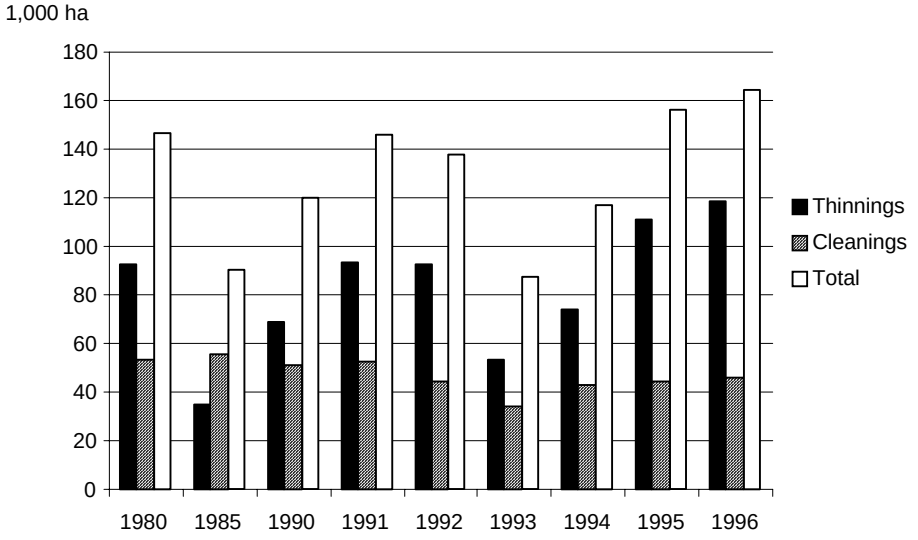


Table 12: Total annual fellings

Fellings		1985	1990	1991	1992	1993	1994	1995	1996
coniferous	**mill.**	12.82	12.17	9.51	8.70	9.69	11.16	11.31	11.26
non-conif.	**m^3**	1.09	1.16	1.24	1.15	0.72	0.79	1.06	1.32
total	**u.b.**	13.91	13.33	10.75	9.85	10.41	11.95	12.37	12.58
per capita	**m^3**	1.34	1.29	1.04	0.95	1.01	1.16	1.20	1.22
per 1 ha of for.	**u.b.**	5.29	5.07	4.09	3.75	3.96	4.54	4.70	4.78

Figure 8: Total annual fellings

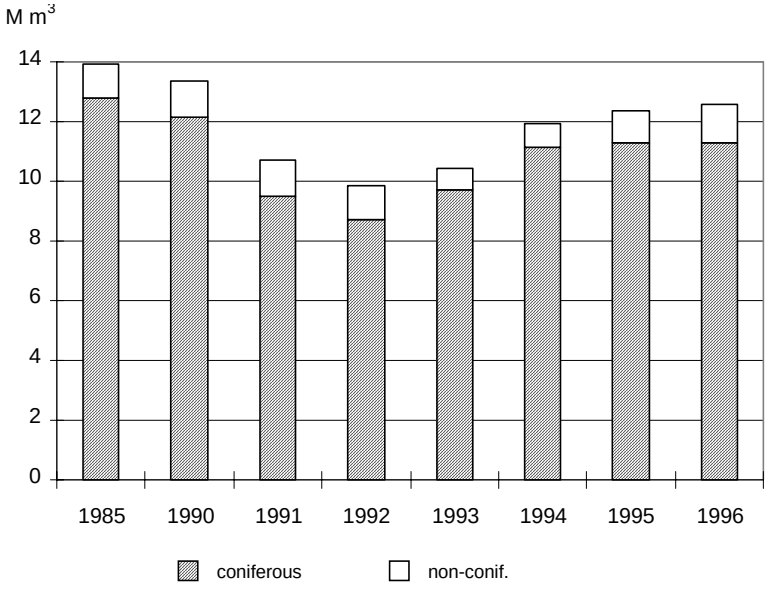


Table 13: Mean current total increments

Increment	1950*	1970	1980	1990	1996
			mill. m^3 u.b		
total current annual	9.2	14.8	17.1	17	18
			m^3 u.b. per 1 ha of the timber land		
total current annual	3.8	5.8	6.7	6.6	7.0

*** Note:** Including forests under 10 ha of size, forests not available for wood supply and afforested non-forest land.

Figure 9: Mean current total increments

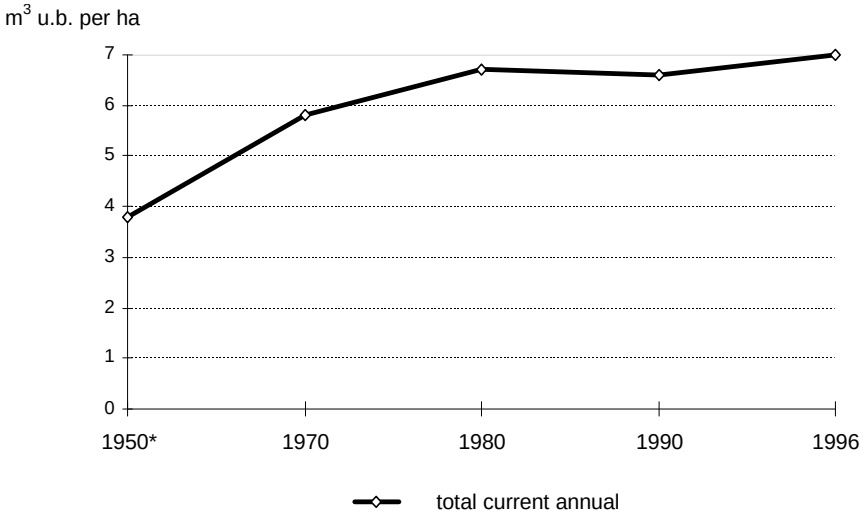
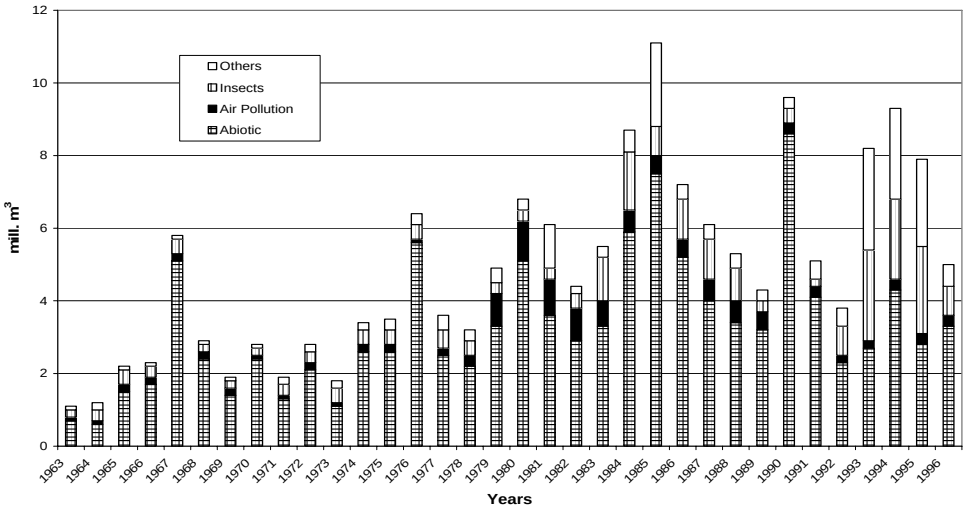


Table 14: Salvage fellings by damaging agents

Year	Abiotic	Air Pollution	Insects	Others	Total
			mill.m^3		
1963	0.7	0.1	0.2	0.1	1.1
1964	0.6	0.1	0.3	0.2	1.2
1965	1.5	0.2	0.4	0.1	2.2
1966	1.7	0.2	0.3	0.1	2.3
1967	5.1	0.2	0.4	0.1	5.8
1968	2.4	0.2	0.2	0.1	2.9
1969	1.4	0.2	0.2	0.1	1.9
1970	2.4	0.1	0.2	0.1	2.8
1971	1.3	0.1	0.3	0.2	1.9
1972	2.1	0.2	0.3	0.2	2.8
1973	1.1	0.1	0.4	0.2	1.8
1974	2.6	0.2	0.4	0.2	3.4
1975	2.6	0.2	0.4	0.3	3.5
1976	5.6	0.1	0.4	0.3	6.4
1977	2.5	0.2	0.5	0.4	3.6
1978	2.2	0.3	0.4	0.3	3.2
1979	3.3	0.9	0.3	0.4	4.9
1980	5.1	1.1	0.3	0.3	6.8
1981	3.6	1.0	0.3	1.2	6.1
1982	2.9	0.9	0.4	0.2	4.4
1983	3.3	0.7	1.2	0.3	5.5
1984	5.9	0.6	1.6	0.6	8.5
1985	7.5	0.5	0.8	2.3	11.1
1986	5.2	0.5	1.1	0.4	7.2
1987	4.0	0.6	1.1	0.4	6.1
1988	3.4	0.6	0.9	0.4	5.3
1989	3.2	0.5	0.3	0.3	4.3
1990	8.6	0.3	0.4	0.3	9.5
1991	4.1	0.3	0.2	0.5	5.1
1992	2.3	0.2	0.8	0.5	3.8
1993	2.7	0.2	2.5	2.8	8.2
1994	4.3	0.3	2.2	2.5	9.3
1995	2.8	0.3	2.4	2.4	7.9
1996	3.3	0.3	0.8	0.6	5.0

Figure 10: Salvage fellings by damaging agents



Forestry and environment

The new Forest Act No. 289/1995 Coll., in force since 1 January 1996, defines *forests as national heritage which constitutes an irreplaceable part of the environment*. The Act sets down the barriers of free dealing with forests as ownership safeguarding public interests in forests, and, at the same time, makes it possible to promote a forest owner in dealing with forest property within legal limits if public interest is involved, namely through granting services or subsidies. In the Czech Republic, important environmental functions of forests are the following: water conservancy along with soil protection, recreational along with heading benefits, and nature protection along with safeguarding the ecological stability of landscape. The forest area providing these functions substantially surpasses the area of the categories both of protective and special purpose forests. Also, 46% of the area of the present commercial forest category has analogous important environmental functions.

HISTORY OF THE ESTABLISHMENT OF NATURE RESERVES

The tradition of establishing forest nature reserves in the territory of the present Czech Republic is long. The first reserve at all even in the European context was the "Žofínský virgin forest" in the Novohradské Mts. The forest property owner, Jiří Augustin Langeval-Buquoy issued an order on August 28, 1838 that parts of the forest near the village of Žofín (35 ha) be exempted from any forest treatments. The today's fir-beech virgin forest with groups of Norway spruce trees on water-logged soils takes up 98 ha. The "Hojná voda" /Abundant Water/ reserve came into existence on the same property in the same year.

At the intercession of forest master Josef John, Duke Jan Adolf Schwarzenberg exempted from the current management the virgin forest stands composed of beech, fir and spruce

in the complex of Boubín Mt. in 1858, which were later made the reserve of "Boubínský Virgin Forest" (Kubany). The original area of 143 hectares shrank into mere 46 ha.

In 1903, the Lichtenstein family proclaimed the Norway spruce natural forest reserve of 287 ha on the Šerák and Keprník hills in the Ash Mountains (Jeseníky Mts.). A beech forest reserve of 52 ha was publicly announced by them on the top of the Javořina Mt. in 1909. The owner of the Harrachov forest estate established the "Labský důl" /Labský Hollow/ Norway spruce natural forest reserve of 60 hectares in 1904.

There were gradually new reserves in forests of the more or less natural character, and their official list was issued by the Ministry in 1933.

In the period between the two world wars, other important reserves of virgin forest character were unofficially supported at first and then gradually officially announced after 1945 and entered in the central list of areas protected by the state. After 1955, this was made on the basis of a Law on Nature Protection. The Law on Nature and Landscape Protection No. 114 of 1992 ensures the protection of natural forests on the level of so far advanced knowledge and in a more complex way than the former laws. Based on this Law, all valuable remainders of natural forests in the Czech Republic enjoy legal protection in different categories of protected areas (see the next chapter).

CLASSIFICATION AND MANAGEMENT OF FOREST PROTECTION AREAS

The Law No. 114/1992 on Nature and Landscape Protection distinguishes 6 categories of area under special protection. Their characteristics and management directives are presented here in exact wording of the Law:

A. Extensive areas, unique on a national or international scale, whose considerable part is occupied by natural or by human activities little affected ecosystems in which the plants, animals and lifeless nature are of extraordinary scientific and educational importance, can be proclaimed **national parks (NP)**. Any use of the national parks must be subordinated to the preservation and improvement of natural conditions and must be in consistence with scientific and educational objectives intended by the proclamation.

Methods and ways of protecting the national parks are discriminated on the basis of classification of national park territories into three zones of nature protection defined with regard to natural values. The strictest protection regime applies for the first zone. More detailed characteristics and regimes of the individual zones are treated by an obligatory legal regulation by which the national park is publicly announced.

B. Extensive areas with the harmonically formed landscape, the characteristic relief, the significant share of natural forest ecosystems and ecosystems of permanent grass stands, with the abundant representation of tree species and possibly with the preserved relics of historical settlement can be proclaimed **protected landscape areas (PLA)**. The commercial use of these areas is controlled by the zones of graded protection so that their natural conditions are maintained and improved, and the optimum environmental functions of these areas preserved and formed further. The recreational use is permissible as long as it does not cause any harm to natural values

of the protected landscape areas. In order to define in more detail the way of nature protection in the protected landscape areas, there are usually four -at least three- zones of graded nature protection the first of them having the most severe protection regime.

The national park and protected landscape area categories usually use a common term of the large protected areas. These two categories can be distinguished from the other particularly by the fact that they include seats, they are at least partially managed by controlled methods and that they have a recreational function also.

The other areas under special protection (national nature reserves, national natural monuments, nature reserves and natural monuments) normally use a common term of small protected areas.

Within the PLA individual zones (usually within Zone 1) the small protected areas are proclaimed the most valuable fragments of preserved ecosystems of different natural character degrees. In the case of National Parks, the most valuable parts are included in Zone 1 together with their small protected areas.

C. Small areas of exceptional natural value where the natural relief of a typical geological structure binds ecosystems that are important and unique in their character on a national or international scale can be proclaimed **national nature reserves** by the nature protection institution, which at the same time defines also the more detailed conditions of their protection. The use of national nature reserve is possible only in the case that the existing condition of their natural environment can be preserved or improved.

D. Small areas of concentrated natural values with the representation of ecosystems typical and important for the geographical region can be proclaimed **nature reserves** by the nature protection institution, which at the same time also defines the closer conditions of their protection.

E. A natural formation of small size, particularly a geological or geomorphological formation, a finding place of minerals or rare or endangered species in fragments of ecosystems, that are of national or international, scientific or aesthetic significance, even a natural formation created apart from by nature itself also by man and his activities can be proclaimed **national natural monument** by the nature protection institution which at the same time defines also the more detailed conditions of its protection. Changes or damage to the national natural monuments or their commercial use are forbidden if they could put into risk their original condition.

F. A natural formation of small size, particularly a geological or geomorphological formation, a finding place of rare minerals or endangered species in fragments of ecosystems, that are of regional environmental, scientific or aesthetic significance, even a natural formation created apart from by nature itself also by man and his activities, can be proclaimed **natural monument** by the nature protection institution which at the same time defines also the more detailed conditions of its protection.

The development of natural conditions in the small protected areas is controlled by tending plans. The plans comprise instructions to regulate natural development and human activities, especially so for practical treatments made within the parts of nature under special protection. The tending plans are approved by the nature protection institution - usually for a period of ten years, and they are used as a binding foundation

material for other kinds of planning documents, particularly for plans of forest management and area planning documentation.

To the date of December 31, 1997 there were 3 national parks in the Czech Republic whose total acreage was 1,111 km^2, i.e. 1.4% of the CR area: The National Park of Giant Mountains (Krkonoše Mts.)- 363 km^2, The National Park of Dyje River Basin (Podyjí) - 63 km^2, and The National Park of Bohemian Forest (Šumava) - 685 km^2. 24 protected landscape area with a total acreage of 10,274 km^2 were proclaimed in the Czech Republic to the same date, which occupy 13.02% of the total CR area.

Of total 1,757 small areas under special protection 218 (290 km^2) were proclaimed in categories of National Natural Monument and National Nature Reserve, and 1,539 (532.59 km^2) in categories Nature Reserve and Natural Monument. Altogether, these areas take up as much as 1.05% of the CR area.

There are 623 small areas under special protection (36% of total small areas under special protection), proclaimed primarily in order to protect the preserved forest ecosystems (forest preserves) in the Czech Republic. 89, 14, 328 and 192 forest preserves are respectively in the category of National Nature Reserves, National Natural Monuments, Nature Reserves, and Natural Monuments.

The representation of forest altitudinal vegetation zones in the forest reserves comes in the following table.

Table 15: Proportion of diverse forest stands in the forest reserves

FAVZ	**Representation in the Czech forest reserves**
Pine forests	7 %
Oak	17 %
Beech-Oak	11 %
Oak-Beech	16 %
Beech	9 %
Fir-Beech	18 %
Spruce-Beech	10 %
Beech-Spruce	6 %
Norway spruce	4 %
Dwarf pine	2 %
TOTAL	**100** %

The significance of remaining natural forests, particularly of those most valuable ones-national nature reserves and nature reserves is accentuated by the fact that they normally use to be cores of biocentres. The biocentres (either local, regional or supraregional) represent a basic skeleton (supporting) element of regional systems of ecological stability. The biocentres that would be mutually interconnected by means of biocorridors are to enable a permanent migration of biota as well as an exchange of the entire gene pool.

DEVELOPMENT OF RESEARCH IN NATURAL FORESTS

The first research plots whose purpose was to characterize the developmental processes in the natural forest were established in 1851 in the Boubín virgin forest. Forest master Josef JOHN established eight trial plots in this locality, each of 0.57545 ha (GÖPPERT 1868) and aligned on them all standing and laying trees reaching the "Derbholz" mass. However, the measurements were later never repeated.

The research of natural forest dynamics in the very proper sense of the word was launched by Prof. RNDr. Ing. Alois ZLATNÍK, DrSc., founder of Czechoslovak forest typology and teacher at the Faculty of Forestry, University of Agriculture in Brno during the 30's. In 4 localities located in the Sub-Carpathian Ukraine which at that time was a part of the Czechoslovak Republic he established 14 permanent trial plots whose size ranged between 0.60 - 6.58 ha. In these localities, breast-height diameters of trees were gauged starting from 4 cm, phytocoenological records made for areas of 20x20m, soil profiles in open bores described, soil samples analysed and developmental stages mapped (ZLATNÍK 1935, 1938). After 65 years, the measurements are being repeated on the same plots, the work being carried out by a working group from the Institute of Forest Botany, Dendrology and Typology, Faculty of Forestry and Wood Technology, Mendel University of Agriculture and Forestry in Brno - now in the territory of Ukraine.

In the 50›s, the research of forest reserves was restored by Dr.eng. Jaroslav ŘEHÁK in the National Forestry Research Institute, who established research plots in the virgin forest reserves of Boubín (4 plots), Mionší (2 plots), and Žákova hora Mt. (1 plot) - each of 0.50 to 0.75 ha. The research included records on the location of all standing and laying trees, their d.b.h., height and the kind of damage. The measurements were made in the Boubín forest reserve in 1954, 1959, 1964, 1969, 1972, 1984 and 1996; in the Mionší forest reserve in 1953, 1958 and 1963, and in the Žákova hora Mr. forest reserve in 1956, 1961, 1964, 1967 and 1971. The measurements made until the mid-sixties were made by J. ŘEHÁK himself (ŘEHÁK 1959, 1962, 1963, 1964). When the works were stopped in the national research institute, the research was continued by self-imposed enthusiasts. The repeated measurements made it possible to monitor the changes in the species composition, and development of stock and stand structure.

A similar research project was launched by Prof. eng. Miroslav VYSKOT, DrSc. at the Department of Silviculture, University of Agriculture and Forestry in Brno at the end of the 50's. In addition to two transects in the Boubín reserve, Prof. VYSKOT established research plots in three other reserves, in which students could work on their essays and dissertations during the 70's and 80's (VYSKOT 1959, 1968b, 1985). Unfortunately, the project ceased to exist at the end of the 80's.

The research of forest reserves in the Giant Mountains (Krkonoše Mts.) was started by experts from the Research Institute of Forestry and Game Management, Research Station Opočno in the 70's by establishing a network of some 15 research plots - each of 0.25 ha. The main subject of study was the tree species storey in original beech stands and natural Norway spruce mountain stands on different sites. The basic measurements made in the

period from 1976 to 1980 have then been repeated in intervals of varied lengths and currently evaluated (VACEK 1981, 1990).

The most extensive and complex research of natural forests was established and developed by eng. Eduard PRŮŠA, CSc. in the 70's. In the whole area comprising 13 reserves of which one was even 74 ha in size, all standing and laying trees up from d.b.h. of 10 cm were aligned and plotted in the map on a scale 1:1000. The most complete work in our country includes phytocoenological records on permanent plots, the description of soil profiles and soil sample analyses, detailed measurements of tree stock on stand profiles (transects), as well as detailed records on tree species regeneration and dominating kinds of undergrowth. These measurements of extraordinary importance for Czech forestry were privately funded and made in Mr. PRŮŠA's own free time without any government support (PRŮŠA 1985a, 1990).

Table 16: The list of monitored localities

Name of locality	Category of protection	Measured area (ha)	Forest altitudial vegetation zone	Basic monit.	Repeated monit.	Protected landscape area or national park
Bílá Opava	NNR	x	8.-9.	1974	1999	Jeseníky
Boubín	NNR	46.66	6.-7.	1972	1996	Šumava
Cahnov-Soutok	NNR	17.32	1.	1973	1994	-----
Diana	NR	19.78	5.-6.	(1991), 1994		-----
Hojná voda	NNM	8.86	6.	1991, (1994), 1997		-----
Jiřina	NM	1.82	1.	1978	1999	-----
Kohoutov	NNR	25.93	3.-4.	1978	1998	Křivoklátsko
Milešice	NR	8.84	6.-(7.)	1972	1996	Šumava
Mionší	NNR	5.92	5.	(1994), 1995		Beskydy
Polom	NR	19.13	5.	1973	1995	Železné hory
Ranšpurk	NNR	22.25	1.	1973	1994	-----
Razula	NNR	22.84	5.	1972	1995	Beskydy
Salajka	NNR	19.03	5.	1974	1994	Beskydy
Stožec	NM	16.21	6.	1974	1998	Šumava
Velká Pleš	NNR	10.45	1.-3.	1976	1999	Křivoklátsko
Žákova hora	NNR	17.46	6.	1974	1995	Žďárské vrchy
Žofín	NNR	74.50	6.-7.	1975	1997	-----

Note: x - investigation was carried out on a long transect and not on a continuous area
NNR - National Nature Reserve, **NNM -** National Nature Monument,
NR - Nature Reserve, **NM -** Nature Monument

PRESENT STAGE OF RESEARCH ON NATURAL FORESTS

We cannot be satisfied with the present situation in the research of virgin forest reserves in the Czech Republic. There is no government guarantee of a long-term research programme by means of a relevant research or scientific institution. The research project is ensured by two working groups:

1. Research Institute of Forestry and Game Management, Research Station Opočno (RNDr. Stanislav VACEK, CSc.) runs works on the above mentioned research plots in the Giant Mountains (Krkonoše Mts.).
2. A research team of experts from several institutions runs a long-term programme "The study of dynamics of virgin forest reserves in the Czech Republic" which is roofed by the CR Agency of Nature and Landscape Protection and so far funded from grants of the CR Ministry of Environment. The programme includes repeated measurements in the network of virgin forest reserves founded by E. PRŮŠA (see preceding chapter) with his original methodology being observed in general terms. The method of data processing and plotting in GIS has been up-dated. The system and its software enable to make digital maps of tree position, cartographical plotting of regeneration changes with time, tree stock, phytocoenoses and soil. The responsible project chief manager is Dr. eng. Tomáš VRŠKA.

REFERENCES

Results from the research of natural forests in the Czech Republic were published in 5 **books**, 29 **scientific works**, and 24 **technical articles**.

Books:

PRÙŠA, E. (1985a) Die böhmischen und mährischen Urwälder - ihre Struktur und Ökologie. Academia, Praha, 580 pp.

PRÙŠA, E. (1990) Přirozené lesy ČR (*The Natural forests of the Czech Republic*). Státní zemědělské nakladatelství, Praha, 248 pp.

VYSKOT, M., a kol. (1981) Československé pralesy (*The Virgin forests of the Czechoslovakia*). Academia, Praha, 270 pp.

ZLATNÍK, A. / ZVORYKIN, I. (1935) Studie o státních lesích na Podkarpatské Rusi (*The study about national forests in the Sub-Carpathian Ukraine*). Sborník výzkumných ústavù zemědělských ČSR, sv. 127, 206 pp.

ZLATNÍK, A. / KORSUň, F. / KOČETOV, F. / KSENEMAN, M. (1938) Prozkum přirozených lesù na Podkarpatské Rusi (*The research of natural forests in the Sub-Carpathian Ukraine*).. Sborník výzkumných ústavù zemědělských ČSR, sv. 152, 524 pp.

Scientific works:

BÍBA, M. (1978) Státní přírodní rezervace Velká hora na Karlštejnsku, vývoj, stav a výhled (*The National nature reserve Velká hora in the Karlštejn area: development, present situation and*

prospects). (Doctorand dissertation). Vědecký lesnický ústav v Kostelci nad Černými lesy, 55 pp.

CHMELAŘ, J. (1957) Studie o vývoji jedle v podmínkách přirozeného, člověkem neovlivněného lesa, jako příspěvek k řešení otázky celkového ústupu jedle (*The study of fir development in the conditions of natural forest, unaffected by man, as a contribution to the issue of general fir decline*). (Doctorand dissertation). Depon. in: knihovna Úst. les. bot., dendr. a typol. LDF MZLU Brno, 150 pp.

MÍCHAL, I. (1983) Dynamika přírodního lesa I. - VI (*Natural forest dynamics I - VI*). Živa, XXXI (LXIX) , (1983 (1-6), pp. 8-13, 48-53, 85-88, 128-133, 163-168, 233-238.

MOUCHA, P. (1978) Ekologická kritéria péče o přirozená lesní společenstva v navrhované Chráněné krajinné oblasti Křivoklátsko (*Environmental criteria of tending natural forest communities in the proposed Protected Landscape Area of Křivoklát*). (Doctorand dissertation). Vědecký lesnický ústav v Kostelci nad Černými lesy.

PIŠTA, F. (1972) Lesní společenstva šumavského pralesa (*Forest communities of the Bohemian Virgin Forest*), Lesnictví, 18 (XLV), 1972 (5), pp. 415 - 437.

PIŠTA, F. / PRÙŠA, E. (1974) Milešický prales. Lesnictví (*The Milešice Virgin Forest*), 20 (XLVII), 1974 (4), pp. 313 - 343.

PRÙŠA, E. (1985b) Státní přírodní rezervace Kohoutov, její ekologie a struktura. Lesnictví (*The National nature reserve Kohoutov: its ecology and structure*), 31 (LVIII), 1985 (11), pp. 989 - 1016.

PRÙŠA, E. (1988) Vývoj stromového patra Žofínského pralesa za období 1975 - 1987 (*Tree layer development in the Žofín virgin forest in the period 1975-1987*). Lesprojekt, Brandýs n. L., 75 pp.

PRÙŠA, E. (1989) Boubínský prales, jeho ekologie a struktura v letech 1972 - 1988 (*The Boubín Virgin Forest: its ecology and structure in the period 1972-1988*). Lesprojekt, Brandýs n. L., 75 pp.

ŘEHÁK, J. (1959) Struktura porostù Boubínského pralesa a přirozená obnova hlavních dřevin (*The structure of stands in the Boubín Virgin Forest and the natural regeneration of main tree species*). Lesnictví, 5 (XXXII), 1959 (2), pp. 119 - 138.

ŘEHÁK, J. (1962) Některé nové poznatky ze studia přirozených lesù (*Some new knowledge from the study of natural forests*). (Doctorand dissertation). VÚLHM Zbraslav-Strnady, 111 pp.

ŘEHÁK, J. (1963) Poznatky ze studia přirozených lesù rezervace Mionší a jejich využití v podrostním hospodářství (*Knowledge from the study of natural forests in the Mionší reserve, and their application in shelterwood systems*). Záv. výzkumná zpráva. VÚLHM Zbraslav-Strnady, 119 pp.

ŘEHÁK, J. (1964) Rùstové změny v přirozených lesích rezervace Boubínský prales (*Growth changes in the Boubín virgin forest reserve natural forests*). Závěrečná výzkumná zpráva. VÚLHM Zbraslav-Strnady, 72 pp.

STANĚK, T. (1989) Komparativní výzkum významných pralesovitých reliktù v ČSR (*The comparison research of important virgin forest relics in the Czechoslovak Republic*). (Doctorand dissertation). LF VŠZ Brno.

STANěK, T./ BARTáK, M. (1989) Strukturální analýza pralesa Cahnov v ekosystému jihomoravského lužního lesa (*The structural analysis of Cahnov virgin forest in the ecosystem of South Moravian floodplain forest*). Lesnictví, 35 (LXII), 1989 (6), pp. 507-520.

VACEK, S. (1981) Věková struktura autochtonní smrčiny v Krkonoších. Lesnictví (*Age structure of the autochthonous Norway spruce stand in the Giant Mountains - Krkonoše Mts*.). 27 (LIV), 1981 (3), pp. 213 - 228.

VACEK, S. (1990) Analýza autochtonních smrkových populací na Strmé stráni v Krkonoších (*The analysis of autochthonous Norway spruce populations of Strmá stráò in the Giant Mountains - Krkonoše Mts*.). Opera corcontica, 27, 1990, pp. 59 - 103.

VACEK, S. / BALCAR, Z. / JURÁSEK, A. (1984) Struktura pùvodních bučin ve východních Krkonoších (*The structure of original beech stands in the eastern Giant Mountains - Krkonoše Mts*.). Lesnictví, 30 (LVII), 1984 (9), pp. 767 - 782.

VACEK, S. / CHROUST, L. / SOUČEK, J. (1994) Produkční analýza autochtonní smrčiny (*The production analysis of autochthonous Norway spruce stand*). Lesnictví - Forestry, 40, 1994 (11), pp. 457 - 469.

VACEK, S. / CHROUST, L. / SOUČEK, J. (1996) Produkční analýza autochtonních bučin (*The production analysis of autochthonous beech stands*).Lesnictví - Forestry, 42, 1996 (2), pp. 54 - 66.

VANěK, M. (1990) 30 let vývoje boubínské pralesovité rezervace (*Thirty years of development of the Boubín Virgin Forest Reserve*). Správa CHKO Šumava, 93 pp.

VRŠKA, T. (1996a) (Pra)les Diana. (*The Diana (virgin) forest*). Lesnictví-Forestry, 42, 1996 (9), pp. 393 - 413.

VRŠKA, T. (1997a) Prales Cahnov po 21 letech. (*The Cahnov virgin forest after 21 years*). Lesnictví-Forestry ,43, 1997 (4), pp. 155-180.

VRŠKA, T. (1997b) Sledování dynamiky vývoje pralesovitých rezervací ČR na příkladě rezervací Cahnov-Soutok a Diana (*The study of dynamics of development of virgin forest reserves in the Czech Republic on the example of the Cahnov-Soutok and Diana reserves*). Doctorand dissertation, LDF MZLU Brno 1997, 153 pp.

VRŠKA, T. (1998a) Prales Salajka po 20 letech (1974-1994) (*The Salajka virgin forest after 20 years (1974-1994)*). Lesnictví-Forestry, 44, 1998 (4), in print.

VRŠKA, T. (1998b) Prales Ranšpurk po 21 letech (1973-1994) (*The Ranšpurk virgin forest after 21 years (1973-1994)*). Lesnictví-Forestry, 44, 1998, accepted for publication

VYSKOT, M. (1959) Druhová a prostorová skladba Lanžhotského pralesa a poměry přirozené obnovy (*The species and spatial composition of the Lanžhot virgin forest and the conditions of natural regeneration*). Lesnictví, 5 (XXXII), 1959 (2), pp. 157-174.

VYSKOT, M. (1968b) Porostní struktura a přirozená obnova v pralesovité rezervaci Bumbálka (*Stand structure and natural regeneration in the virgin forest reserve of Bumbálka*). Lesnický časopis, 14 (XLI), 1968 (7), pp. 607 - 620.

VYSKOT, M. (1985) Struktura a vývoj pralesovité rezervace Roštýn (*The structure and development of the virgin forest reserve of Roštýn*). Lesnictví, 31 (LVIII), 1985 (5), pp. 387 - 410.

The list of **technical articles** is irrelevant for international presentation.

NATURAL FORESTS AND FORESTS PROTECTED BY LAW IN POLAND

by Roman ZIELONY *

ABSTRACT

The protection of nature has a long tradition in Poland's forests. National Parks and Nature Reserves are particularly important in Polish forest policy of today. In the State owned forests, as much as 50% (approx. 3,353 M ha) are forests with the dominating nature protection function.

OUTLINE OF POLAND'S FOREST

Poland is located in the central part of Europe at the transient zone between the oceanic and continental climates influence. Its geographical situation, the differentiated landscape following the geological and geomorphologic processes, with 90% of lowland type landscape, the diversified soil conditions as well as, the uneven spatial distribution of its inhabitants - all these have contributed to the eventual richness of Poland's nature. An important element of Polish landscape and natural richness is the forest that covers an area of 8.7 million ha which makes 28.1% of the country's total acreage (GUS 1997). Forest occurs chiefly in the area either not useful for agriculture or - that of little demographic density. In the past, forest used to occupy as much as 90% of the total area of Poland. The deforestation processes had been initiated in the 14^{th} century and the trend continued till year 1939. The most intensive deforestation were taking part at the turn of $19^{th}/20^{th}$ centuries. The organised, rational management of forest resources has started in Polish land, similarly as in other Central European countries, at the turn of $18^{th}/19^{th}$ centuries. Large has been the impact of the normal forest model implementation on the today's state of Poland's forest. The area of forest has started growing in Poland only since the year 1945, when the forest landscape level was 20.8% (6.4 million ha). In the period 1945-1996, the area of Polish forest has increased by 2.3 million ha, and the standing volume has increased in this period of 662 hm^3 that is 173%. The present condition of forest is a combined effect of the predominant site conditions, the character of natural range of the main forest-forming woody tree species: Norway spruce, European beech, Silver fir and Scots pine; as well as the development trends of agriculture, industry and forestry.

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At present, coniferous and mixed coniferous/broad-leaved forest dominate in Poland with Scots pine and Norway spruce as the most abundantly occurring tree species covering 69% and 5.8% of total forest area, respectively. The broad-leaved species dominate 22.5% of forest area. Among them, the most important are: oaks (6%), birch (6%) and beech (4%). Considering the age structure of Polish forest, the largest portion of forest area is covered by stands 21-60 years of age, with a lot of stands growing on abandoned arable land.

The volume of annual wood cut has been equal during the last few years about 22 million m^3.

The ownership relationships and some selected parameters of Poland's forests and protected objects are presented in Tables 1-5 and Fig 1.

Table 1: Selected parameters of Poland's forests, as on 31.12.1996 (GUS 1997)

Ownership	Area in 000 ha	Total volume M. m^3	Volume per ha m^3/ha	Average age years	Mean volume increment m^3/ha/year
Public	7 282				
State Forest	6 881	1 341	197	55	3.58
National Parks	177				
Communal	77				
Other	147				
Private	1 497	176*	118*	37*	3.19*
Total	**8 779**	**1 572**	**183**		

* - with communal forest included

Table 2: Protected objects in Poland, as on 31.12.1996 (GUS 1997)

Type of nature protection objects	Quantity	Area (thous. ha)	Percentage of country's total area
National parks	22	301.0	1.0
Reserves*	1 183	128.0	0.4
Landscape parks	106	2 082.0	6.7
Area of protected landscape	309	6 612.5	21.1
Monuments of nature	30 205*		
Other**	3 512	59.6	0.2
Total		**9 183.1**	**29.4**

* - including 23010 single trees and 4537 clumps of trees

** - ecological values, documentation stations, landscape natural associations

Table 3: Polish National Parks, as on 31.12.1996 (KZPN* 1997)

No.	National Park		Creation year	Area (ha)	IUCN Category	Nature museum	Didactic center	Periodical
1.	Babia Góra	MaB	1955	1,734	II	+	-	-
2.	Bialowieża	E,MaB,WH	(1932) 1947	10,502	II	+	+	Parki narodowe i rezerwaty
3.	Biebrza	R, E	1993	59,223	-	-	-	-
4.	Bieszczady	MaB	1973	27,834	II	+	+	Roczniki Bieszczadzkie
5.	Bory Tucholskie		1996	4,789	-	-	-	-
6.	Drawa		1990	11,019	II	-	-	-
7.	Gorce		1981	6,763	II	-	-	-
8.	Góry Stolowe		1994	6,280	-	-	-	-
9.	Kampinos		1959	36,533	II	+	-	Puszcza Kampinoska
10.	Karkonosze	MaB	1959	5,573	II	+	-	-
11.	Magura		1995	19,962	-	-	-	-
12.	Narew		1996	7,350	-	-	-	-
13.	Ojców		1956	1,890	V	+	+	Pradnik
14.	Pieniny		(1932) 1954	2,346	II	-	-	Pieniny - przyroda i człowiek
15.	Polesie		1990	9,649	II	+	+	-
16.	Roztocze		1974	8,482	II	+	+	-
17.	Slowinski	MaB, R	1967	18,618	II	+	-	-
18.	Świetokrzyski		1950	7,626	II	+	-	-
19.	Tatra	MaB	(1947) 1954	21,164	II	+	+	Tatry
20.	Wielkopolski		1957	7,620	II	+	+	Morena
21.	Wigry		1989	15,122	V	-	-	-
22.	Wolin		1960	10,937	II	+	-	Klify
	The Board of Polish National Parks		1988	-	-	-	-	Parki Narodowe
	TOTAL			**301,016**		**14**	**7**	**9**

MaB - Bioshere Reserve UNESCO list
WH - World Heritage Site
R - RAMSAR convention
E - Europe's diploma
* - KZPN = The Board of Polish National Parks

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Figure 1: The protection of nature in Poland

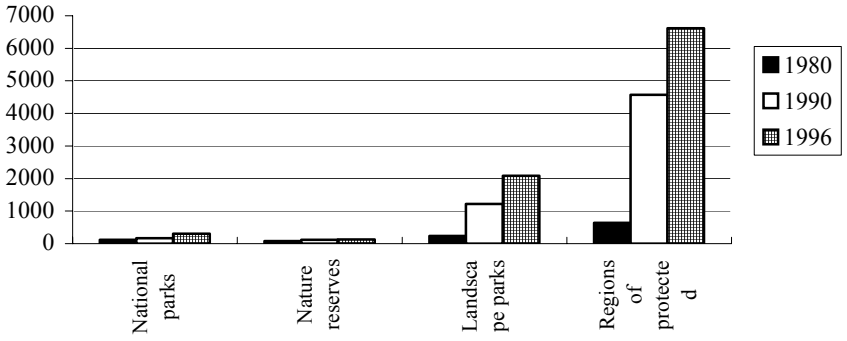


Table 4: Polish National Parks - area (ha), as on 31.12.1996 (KZPN* 1997)

No.	National Park		Area	Ownership		Area				Protection		
				State	Other	Forest	Agricultural	Water	Other	Strictly	Partly	Landscape
1.	Babia Góra	MaB	1,734	1,612	122	1,585	21	4	124	1,061	544	129
2.	Białowieża	E,MaB,WH	10,502	10,502	0	9,594	74	9	825	4,747	4,847	908
3.	Biebrza	E,R	59,223	32,139	27,084	15,425	20,225	1,026	22,547	2,569	29,054	27,600
4.	Bieszczady	MaB	27,834	27,793	41	24,695	977	43	2,119	18,426	9,408	0
5.	Bory Tucholskie		4,789	4,789	0	3,798	69	530	392	0	4,345	444
6.	Drawa		11,019	11,019	0	9,024	449	931	615	368	10,202	449
7.	Gorce		6,763	6,503	260	6,407	231	19	106	2,850	3,088	825
8.	Góry Stołowe		6,280	6,228	52	5,606	388	6	280	48	6,108	124
9.	Kampinos		36,533	31,431	5,102	27,020	6,855	156	2,502	4,862	25,749	5,922
10.	Karkonosze	MaB	5,573	5,559	14	3,829	440	24	1,280	1,718	3,794	61
11.	Magura		19,962	19,962	0	17,736	1,739	35	452	0	18,829	1,133
12.	Narew		7,350	2,045	5,305	91	719	585	5,955	0	2,045	5,305
13.	Ojców		1,890	1,342	548	1,368	170	12	340	251	1,029	610
14.	Pieniny		2,346	1,292	1,054	1,650	487	32	177	777	489	1,080
15.	Polesie		9,649	8,338	1,311	4,130	3,180	369	1,970	428	7,817	1,404
16.	Roztocze		8,482	8,386	96	7,812	268	53	349	806	7,346	330
17.	Słowiński	MaB, R	18,618	18,419	199	4,601	1,036	10,214	2,767	5,619	2,646	10,353
18.	Świętokrzyski		7,626	7,490	136	7,211	332	2	81	1,731	5,569	326
19.	Tatra	MaB	21,164	18,532	2,632	15,124	171	209	5,660	11,514	9,310	340
20.	Wielkopolski		7,620	6,791	829	4,379	2,313	447	481	259	5,470	1,891
21.	Wigry		15,122	12,472	2,650	9,190	2,266	2,933	733	385	11,814	2,923
22.	Wolin		10,937	10,930	7	4,500	123	4,501	1,813	165	10,772	0
	TOTAL	**(ha)**	**301,016**	**253,574**	**47,442**	**184,775**	**42,533**	**22,140**	**51,568**	**58,584**	**180,275**	**62,157**
		(%)	**100.0**	**84.2**	**15.8**	**61.4**	**14.1**	**7.4**	**17.1**	**19.5**	**59.9**	**20.6**

MaB - Biosphere reserve UNESCO list
WH - World Heritage Site
R - RAMSAR covention
E - Europe`s Diploma
* - KZPN = The Board of Polish National Parks

Table 5: Nature reserves in Poland, as on 31.12.1996 (GUS 1997)

Reserves' type	Total			Strict conservation		
	Number of reserves	Area (ha)		Number of reserves	Area (ha)	
		total	mean area per object		total	mean area per object
Faunistic reserves	121	32 949	272	8	1 821	228
Landscape reserves	101	35 635	352	5	473	95
Forest reserves	588	43 603	74	18	1 011	56
Peatland reserves	121	8 629	71	29	1 070	37
Floristic reserves	143	2 426	16	19	185	10
Water reserves	24	2 867	106	3	11	4
Reserves of unanimated nature	50	1 435	30	8	25	3
Steppe reserves	32	434	13	15	90	6
Reserves of halophytes	3	23	7	1	1	1
Total	**1 183**	**128 001**	**108**	**106**	**4 687**	**44**

HISTORICAL OUTLINE OF THE PROTECTION OF NATURE AND FORESTS

The history of nature protection in forests has been closely connected with the history of nature protection as such, the deforestation processes and forest management. The rudiments of nature protection go back as far as the beginnings of the State of Poland. The most important events in this respect are those legal regulations protecting either rare species or the forest belonging to the sovereign (OLACZEK et al. 1996, RADZIEJOWSKI 1996). Among them are:

- introduction of beaver protection in early 11th century, confirmed in 16th century
- introduction of punishment for cutting trees in other owner's forest in 1347
- the 1432 law protecting yew tree
- the 1443 law limiting the possibility to hunt for wild horses, moose and aurochs
- the 1868 Act on protection of marmot and chamois
- the 1925 government commission regulating the matters of nature protection
- the 1934 nature protection act.

The protection of large-area objects has started in forests (BOINSKI 1997 after WALAS 1957, CZUBINSKI et al. 1977, OLACZEK et al. 1996, RADZIEJOWSKI 1996). The ever first protected areas in Poland were:

- Ziesbuch Forest in Tuchola Coniferous Forest complex - under strict protection since 1827; at present known as 'Cisy Staropolskie Reserve' in Wierzchlas;
- 'Pamiatka Pieniacka' reserve established in 1886 in Podolye;
- a 100 ha forest reserve in the area of the today's Gorce National Park (its idea goes back to year 1916);
- a 7.5 ha reserve surrounding the Czorsztyn Castle remnants, established 1921;
- a 45.95 ha 'Reserwat' forest in Bialowieza National Park, established 1921 - the first legal attempt to protect Bialowieza Primeval Forest and, subsequently, BNP;
- two strict reserves (196 ha and 114 ha) in Swietokrzyskie Mountains, established 1922;

– a 1.5 ha 'Zamczysko' reserve established 1924; the first protected part of the today's Kampinos N P.

In the period between two world wars, nature protection in Poland had been intensively developing. Particularly fast was the increase in protected area in State Forests. In year 1923 a total of 26 forest reserves covering 8496 ha were present, with 2707 ha under strict protection. In year 1937, out of 180 reserves of 28478 ha area, 112 were located in State Forests (CZUBINSKI et al. 1977). Also, national parks had been established in that period, here forest was the chief object of protection. The historical development of the network of national parks and nature reserves in Poland as well as selected data on their present-day status are presented in Tables 6-7 and Figures 2-4.

Table 6: The development of the national parks in Poland (GUS 1997, CZUBINSKI, et al. 1977)

Year	Number	Area (ha)			
		total	forest	strictly protected area total	strictly protected area forest
1939	5	17 446			
1950	2	11 150			
1960	10	74 627	55 934		
1970	11	94 678	66 886	20 265	15 443
1980	13	118 901	82 906	30 944	21 681
1990	17	165 933	118 787	42 203	29 383
1994	19	249 205	151 886	59 950	46 294
1996	**22**	**301 056**	**183 774**	**58 580**	**45 191**

Table 7: The development of the network of reserves in Poland (GUS 1997, CZUBINSKI, et al. 1977)

Year	All reserves			Strict reserves		
	Number of objects	area (ha)		number of object	area (ha)	
		total	mean area per object		total	mean area per object
1918	39	1 469				
1937	180*	28 478				
1960	366	23 874				
1970	550	52 640				
1980	759	75 292	99	122	8 675	71
1990	1 001	116 952	117	109	7 207	66
1996	**1 183**	**128 001**	**108**	**106**	**4 687**	**44**

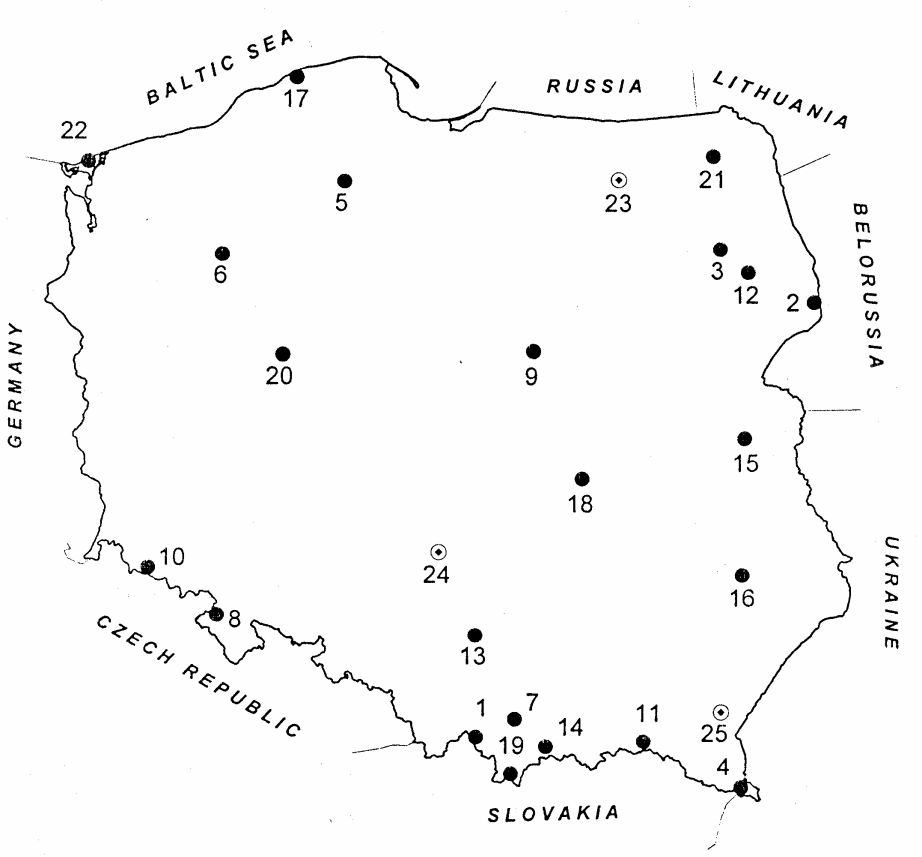
* - additionally projected 68 objects

FORMS AND CATEGORIES OF NATURE PROTECTION

According to the Nature Protection Act of 1991, different forms and categories of nature protection are defined in Poland. Out of them, the most important ones for the protection of forests are:

National park - a national park covers protected area distinctive of its particularly high scientific, natural, social, cultural and educational value, of at least 1000 ha area. All elements of nature and landscape are protected on an area of a national park. All activity in the area of a national park are nature protection-oriented, and they have absolute priority. The most substantial aim of a national park is to learn and conserve the whole of its natural systems together with the conditions of their functioning as well as reconstruction of deformed and extinct links of our domestic nature. A national park becomes established following a decree of Government.

Figure 2: National Parks in Poland



National Parks

● Existing parks			⦿ Prospective parks
1. Babia Góra	8. Góry Stolowe	15. Polesie	23. Mazury
2. Bialowieża	9. Kampinos	16. Roztocze	24. Jura
3. Biebrza	10. Karkonosze	17. Slowinski	25. Turnicki
4. Bieszczady	11. Magura	18. Świetokrzyski	
5. Bory Tucholskie	12. Narew	19. Tatra	
6. Drawa	13. Ojców	20. Wielkopolski	
7. Gorce	14. Pieniny	21. Wigry	
		22. Wolin	

Figure 3: Forest ecosystems in Poland's National Parks

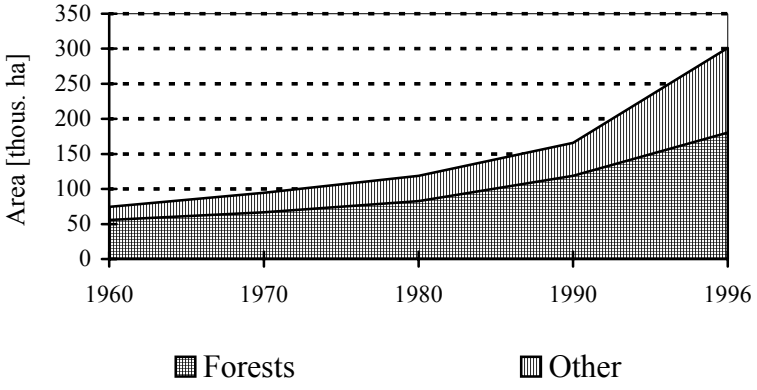
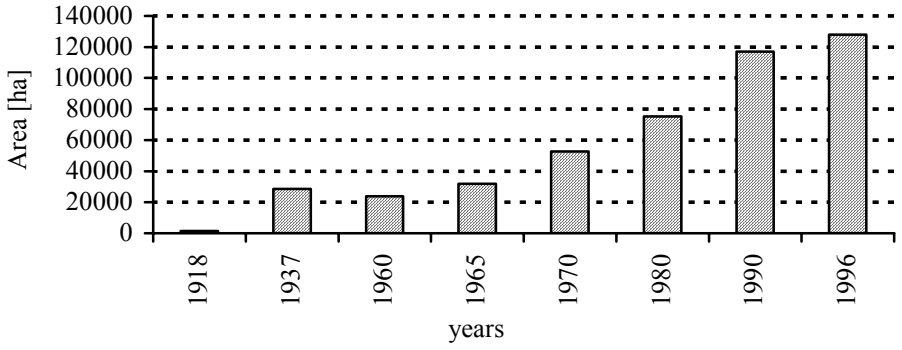


Figure 4: The area of Reserves in Poland



Landscape park - a landscape park is an area protected due to its natural, historical and cultural value; landscape parks are established with the aim to preserve, popularize and disseminate these values under conditions of rational land use management. Arable ground, forest ground and other forms of land use located within a landscape park's administrative borders are left unchanged as they are used. A landscape park is established following a decree of a province chief administrator (a voivode).

Nature reserve - is an area where protected are natural or near-natural ecosystems, target plant and animal species, elements of unanimated nature - significantly valuable because of either scientific, cultural or landscape reasons. Reserves are established following a decision of Minister.

Area of protected landscape - covers ground of distinct landscapes in different types of ecosystems. The management practices in such systems should ensure the lasting state of relative ecological balance. This form of protection is forced into existence following a decision of voivode or a resolution of the local community council.

Monuments of nature - individual objects of either living or unanimated nature or: clusters of such objects, of particular scientific, cultural, historic or landscape value, with distinct signs of their individual character, e.g. old-growth and large-size trees and shrubs of both domestic or exotic species (cf, Appendix A), wells, water-falls, rocks, valleys, erratic boulders and caves.

Protection of species - the purpose of this form of nature protection is prevent the wildlife species of plant and animals (particularly: rare or endangered species) to vanish as well as to conserve the existing specific and genetic diversity (ANONYMOUS 1995a,c). For the most endangered species, the domestic red data books have been published (GLOWACINSKI 1992, ZARZYCKI and KAZMIERCZAKOWA 1993).

Environmental values - these are worth of protection remnants of such ecosystems that are significant in the preservation of unique genetic resources and site types like, e.g. natural small area water reservoirs, clumps of trees and shrubs, peat lands, marshes, and dunes, patches of non-managed and unused vegetation, old river basins, river basin slopes.

Nature-landscape system - such systems protect extremely valuable fragments of both natural and cultural landscape, in order to preserve their aesthetic values. Besides, a distinction is made between the strict protection and partial protection in either national parks, nature reserves and in the protection of particular plant and animal species.

Strict protection - if this form of protection is employed, any man's intervention into the natural environment has to be stopped. The purpose of the strict protection is to enable the course of natural processes. In objects under strict protection man may only study and observe the nature and no intervention is allowed.

Partial protection (active protection) has been aimed onto the active participation of man in the natural processes in order to:

- conserve or reconstruct the object of protection,
- acceleration or inhibition of natural succession,
- strengthening of ecosystems.

The difference between the partial protection and the routine management activities is in the goal and the intensity of activity employed. The protection activity is only aimed at the nature, with no economic gains in mind.

Both strict protection and partial protection are being accomplished in the spatial form in national parks and nature reserves as well as in the form of species protection of plants and animals.

MANAGING NATURE PROTECTION

The problems of protection and adequate regulation of the natural environment formation, the rational utilisation of natural resources and preservation of the richness and natural heritage are in Poland of importance equal to that of the problems of economic development. This importance has found its formal expression in the fact of establishment the Ministry of Environment Protection, Natural Resources and Forestry. The management of nature protection and supervision have been subject to wide consultation with society. Within the organisational framework of the Ministry of Environment Protection, Natural Resources and Forestry there is the position of the Chief Nature Conservator, the Department of Nature Conservation and the Chief Board of National Parks. The Minister of Environment Protection, Natural Resources and Forestry has an advisory body that is the State Council of Nature Protection, including a total of 30 specialists representing different field of natural sciences. In every of the 49 provinces (voivodships) a Provincial Nature Conservator acts on behalf of the Province main administrator. A consulting and opinion-making body at the voivode's is a provincial Commission of Nature Protection - grouping 20 people - natural sciences representatives and nature protection activists. A director of a national park makes use of opinion of the park's scientific council. A landscape park director uses the opinion of the park's scientific-technical board.

NATURAL FORESTS

The term 'natural forest' is often understood and interpreted differently. In Poland, a natural forest is most often acknowledged such forest growing on permanently forest area, with its species composition and vertical structure fitting well the site's potential characteristics; besides, in order to be named 'natural' a forest cannot bear visible signs of either degradation or degeneration. This can be either a naturally established forest or forest planted by man. The area of natural forest that comply with the above-presented definition is unknown. Assuming, the above definition is met by managed forest of age over 60 years, the estimated area of natural forest would be some 2 M. ha. Another definition of natural forest is the following: 'natural forest is forest established spontaneously, without the participation of man, where preserved are at a near-primeval degree the natural biocoenotic relationships, among others, the structure and stand species composition, and the management activities employed do not cause disadvantageous changes in the ecosystems under question (WIECKO 1996). The area of natural forest understood following the last definition is much smaller - perhaps some 200 000 - 500 000 ha and these forests can be found only in non-facilitated terrain.

The participation of Poland in the works of international forestry organisations and institutions of nature protection has resulted in the actual learning of the country's acreage of natural forest as well as the principles of their determination. The organisations mentioned have done a tremendous job in the 1990-es for the definition, assessment and learning a lot of problems in the field of the sustainable development of forestry. One of such projects was the survey of present state of environmentally important natural and semi-natural forest types in selected countries of Central and Eastern Europe: Russia, Poland, the Ukraine and Hungary. In its Polish part, the project has found its final expression in a scientific seminar followed by the publication of its Proceedings' Conservation and sustainable use of forests in Poland (LONKIEWICZ 1996). In this paper, 16.7% of the country's forest area have been classified as ecologically important forest types (Table 8).

In the 1995 survey of biological diversity in State Forests a total of 744 000 ha were acknowledged natural and environmentally important forest (Table 9, Fig. 5). The importance of the object of natural forest is well visible, e.g. while analysing their presence in the Polish network ECONET: with national core areas and international core areas determined (LIRO 1995).

Table 8: Environmentally important types of forest in Poland (LONKIEWICZ 1996b)

Type of forest	Area (thous. ha)	Per cent of country's total forest area
Coastal forests	219.1	2.5
Riverside forests	346.9	4.0
Boreal forests	225.8	2.6
Broadleaved forests	475.8	5.4
Mountainous forests	194.9	2.2
Total	**1 462.5**	**16.7**

Table 9: Survey results of biological diversity in State Forests in year 1995 (LONKIEWICZ 1996a)

Type of object	State Forests		Maximum		
	number	area (ha)	RDLP**	number	area (ha)
All existing reserves	849	66 398	Bialystok	128	19 402
strict reserves	30	1 043			
Planned reserves	548	45 638	Lublin	119	8 180
Ecological values	3 798	13 952	Lublin	747	1 980
Natural forest	15 962	281 726	Olsztyn		121 848
Environmentally important forest	37 480	402 469	Bialystok	7 746	40 373
as above - wet sites	32 733	303 932	Olsztyn	4 407	
Peat lands, marshes, heathers, mountain meadows, geological objects *	19 155	60 049			
Bird nests protection zones - total	1 741		Bialystok	533	
inch black stork	761				
osprey	40				
eagle owl	43				

** - Regional Direction of State Forests * - yet non - required ecological values

NATURE PROTECTION IN FORESTS OF NATIONAL PARKS AND NATURE RESERVES

All the activities undertaken in national parks and reserves have their rationale in the plans of conservation. These documents are being prepared for a period of 20 years by the top specialists in the field of nature protection. In case of nature reserves, usually 1-3 people are employed, in case of plans for national parks, the staff covers a lot of people, grouping specialists representing different institutions.

Plans of nature protection as prepared for nature reserves contain one or two volumes and they include inventory data, a diagnosis of the natural environment state as well as a plan of future activities in the field of protection of entire nature, with particular attention paid to the main objects of protection.

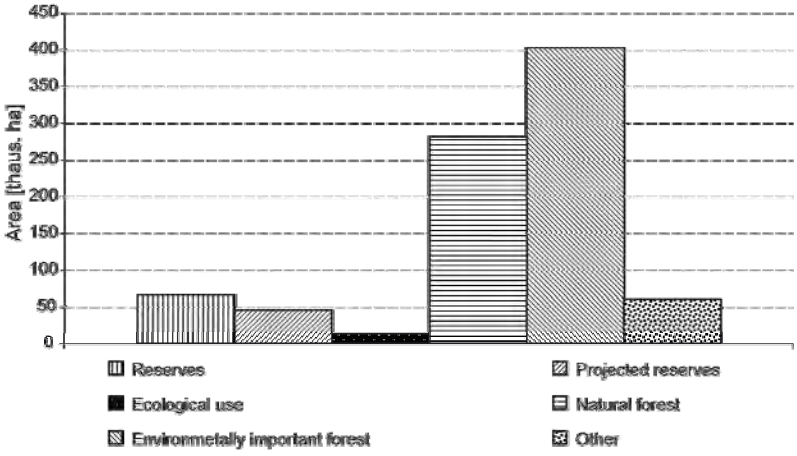
Plans of nature protection as prepared for national parks consist of a lot of different elaborations. Each of them contains inventory data, a diagnosis of the natural environment state as well as a plan of future activities in the field of protection of a determined part of the park's nature. Besides, social, historic, and economic-technical parts are, also, included in the plan. A general elaboration contains a synthesis of all the partial elaborations.

Forest ecosystems predominate in the national parks and nature reserves area. In national parks, forest formation participates from 3 to 95% of their total area (Table 4). Out of the total of 1069 nature reserves at the early 1996 year, 877 were located in the State Forests administered area (WROBEL 1997). They occupy an area equal 66.4 thousand ha, participating thus in 55% to the total area of all the reserves.

Comparing with the managed forest, the detail of description of forests located in national parks and reserves while preparing their plans of protection is far greater. The intervention activity as planned for national parks and reserves are result of protection needs and the principle of lasting occurrence only. In such objects it is a general rule that intervention is limited to small areas and its intensity is low. In terrain covered with strict

protection, no intervention is being performed. In nature reserves, while surveying, a classification system is employed, organised according to the main object of protection and type of environment (Appendix B).

Figure 5: Objects of particular high value in the state forests (State as on 31 December 1995)



NATURE CONSERVATION IN MANAGED FOREST

The functions of nature protections and those of management often overlap in many forests, regardless the ownership or prevailing system of management. Due to the specific character and their social importance, both forests and forestry are in Poland, similarly as in the rest of Europe, under a special 'supervision' of society.

a) rudiments of forest management

Forest management in Poland is being accomplished, following the regulations of the 1991 Forest Act with its later amendments of 1997, according to the following principles:

- the principle of common protection of forest,
- the principle of forest lasting,
- sustainable use of all the functions of forest,
- increasing forest resources.

Considering the extraordinary non-productive functions and natural value of forest, Poland's forests should be grouped onto:

- forest subject to special legal protection (forest in national parks and nature reserves)
- managed forest (protection forest and multiply-function forest).

The last category mentioned expresses well the importance of environment-forming and social functions of the managed forest (Tables 10 - 11). This classification system has been binding for years but it is continuously improved. On the other hand, in protection forest 9 categories are being determined, the classification based, among other criteria, on their location and/or dominating function of the entire of part of forest complex.

Table 10: Forest dominating functions in the State Forests, as on 31.12.1996, (GUS 1997)

Forest	Area (thous. ha)	Per cent of area
Protective forest	3 353	50.2
Multi-functional (commercial) forest	3 328	49.8
Total	**6 681**	**100.0**

Table 11: Categories of protection forests, as on 31.12.1996, (GUS 1997)

Category	Area (thous. ha)	Per cent of area
Soil - protection	235.9	7.0
Water - protection	1 046.9	31.2
People mass recreation	363.8	10.8
Landscape	184.3	5.5
Naturally valuable	37.5	1.2
Refuges of protected animals	55.7	1.7
City - and near city forest	386.5	11.5
Industrial pollution area	714.0	21.3
Remaining	329.3	9.8
Total	**3 353.9**	**100.0**

b) the system of nature protection and natural environment conservation in State Forests

Among the many functions to be fulfilled by forest, growing has been the role of the functions of nature protection. These last functions are being fulfilled both by forests covered by the legal forms of nature protection and those remaining forests. These functions predominate in national parks and nature reserves, while their role in the remaining forest depends largely upon the forest's category of protection and its natural richness. Considering the aims and tasks of nature protection and the idea of eco-development, first of all defined should be the term nature protection in forestry and particularly so - in the managed forest (the protection forest and multiply-function forest). I suggest the following definition: the protection of nature in the modern forestry is:

- the classic activity covering the conservation effort (preservation) as carried out by specialised formations of nature protection service and forest administration;
- taking care of non-productive functions of forest
- rational forest management that, through the activity meeting the public demand:
  - ensures the lasting of forest and uninterrupted supply with forest raw materials,
  - leads, if possible, to increase the country's forest cover,
  - takes care of the preservation of the richness of our domestic nature
  - unites the problems of forestry with those of natural environment formation (including landscape)
- understanding that the forester's activity impacts not only the forest where the intervention is carried out

- public relations between society and the role of forest and foresters
- limiting the impact of non-forest threats onto the forest formation
- formation and protection of natural environment.

The accomplished in Poland forest policy considering the demands of the sustainable development, focuses on the functions and problems of nature protection (GRZYWACZ 1994, SZUJECKI 1994). The importance of problems of nature protection in forest policy is evident in, e.g. the nation-wide assessment of forest (LONKIEWICZ 1996a) or in the introduction of the obligatory preparation of programs of nature protection at the scale of forest district (ANONYMOUS 1996b) the main purpose of which is illustration of natural richness, presentation of natural values and threats, and presentation of object of interest on the background of the region or the country; determination of hierarchy of groups of functions of particular forest complexes, definition of new objects worth protection and determination of aims and methods of their protection. The protection of nature in the biggest forest enterprise in Poland: State Forests is being accomplished in accordance with the Forest Act of 1991 (ANONYMOUS 1997a,b) and instructions of General Director of State Forests (ANONYMOUS 1994) within the framework of THE SYSTEM OF NATURE PROTECTION AND FORMATION OF NATURAL ENVIRONMENT IN STATE FORESTS, the latter has been result of realisation of selected topics of nature protection, the rational formation of the natural environment, the social expectations as well as the economic needs and possibilities of the country. This system is being accomplished through:

1. Special forms of nature protection (nature reserves, nature monuments, ecological values, documentation posts, protection of protected, endangered and rare species),
2. protection forests of general purpose (e.g. water-protecting, soil-protecting forest, game refuges),
3. protection forest of special purpose (e.g. forest in area of pollution damage, permanent experimental plots, forest surrounding health centers, forest in cities)
4. transition zone of reserves and national parks
5. multi-functional forest (economic forests).

The following functions are dominant in the above-listed groups of forests:

- exclusively protection functions: in objects from the special forms of protection. The only purpose of a forester's activity in such objects is accomplishment of the aims defined in the plans of protection (e.g. reserves) and preservation of their natural richness.
- the leading protection function and the accompanying minor importance production function - in protection forests (both of general and special purpose) as well as in the transition zones of reserves and national parks. The production of wood is in this group forests of secondary importance and it is not decisive in the principles of management activities.
- the productive-protection function - present in the multi-function forest. In this group of forest (3.3 M. ha altogether) the production function and the protection function are equally important. These forests fulfil the protection function continuously during their entire life cycle (some 100 years) while they fulfil the production function only a few times: on the occasions of thinning and final cut.

c) preservation of natural richness and biological diversity

The protection of nature has been widely considered in the activity of the largest forest enterprise in Poland: State Forests, administering the forest belonging to the public purse of area equal 6.68 M. ha. Both in the General Directorate and in Regional Directorates of State Forests there are separate organisational units dealing with the protection of nature. During the last few years, a comprehensive program of educational and promotional activity has been developed within the framework of State Forests. Its purpose has been to familiarise the wide circles of society with the problems of management and protection of forests. Particularly sound has been the effort in the ten Forest Promotional Complexes (ANONYMOUS 1995b). They cover a total area of 445 000 ha and are distributed all over the country (Fig. 6). Forest Promotional Complexes have their own scientific-social Boards where foresters, self-government representatives and scientists act jointly. The management activity in managed forest under the administration of State Forests is carried out following the plans of forests management. In these documents included are, also, chapters dealing with nature protection. Since year 1998, every such plan has to contain a program of nature protection in the forest district of interest. The ever first such program has been prepared for Kozienice Forest District, the latter comprising the Kozienice Forest Promotional Complex (ANONYMOUS 1996a,b, BULiGL 1996, ZIELONY 1995). Kozienice Forest is one of the best studied forest areas in Poland (ZIELONY 1997). Tables: 12-14 present selected data of the Program.

Based on the information presented in Tables 12-14, one can figure out that a significantly great part of the Radom Province's most valuable natural values are located in the Kozienice Forest (the Forest itself occupying some 16% of the Province administrative area). Among others, in the Forest area located is the only landscape park of the province, nearly half of the region's reserves and a significant number of nature monuments. It is just the Forest where the first ecological values of the region have been established. Particularly many natural creatures and areas are in the terrain of State Forests: Tables 13 and 14 give examples - the number and acreage of reserves and the number of nature monuments. The ten existing reserves with their area of over 900 ha have contributed to the actually high value of the index of reserve-protected area ratio: 0.78% of the total geographic area versus the region's 0.24% or the country-wide value of 0.38% (GUS 1997).

Table 12: Occurrence of selected groups of organisms present in Kozienice Forest (BULiGL 1996)

Group of organisms	All known species	Protected species	Species included in the Red data book
Lichens	204		71
Mosses	94		
Vascular plants	569	41	11
Amphibians	13	13	
Reptiles	6	6	1
Birds	225	225*	36
Mammals	59	32	10

* - some species present temporarily

Despite the rather rich factographic documentation of the natural values of Kozienice Forest, it is a positive phenomenon that the relatively small region, well known in Poland and visited by foreign visitors, has been further studied, and its forest administration managers do their best to direct such their activity as to not only prevent any degradation of the Forest but, on contrary, to enrich its resources and their diversity for the benefit of generations to come. It should be emphasised that the Program of Nature Protection of a Forest District is not a research program: it should be based mainly on the already available information or information collected in the course of works of the Plan of Forest Management.

Figure 6: Forest promotional complexes in Poland

1. Lasy Oliwsko-Darzlubskie
2. Lasy Puszczy Bukowej i Goleniowskiej
3. Bory Tucholskie
4. Lasy Puszczy Białowieskiej
5. Lasy Gostynińsko-Włocławskie
6. Bory Lubuskie
7. Lasy Rychtalskie
8. Lasy Puszczy Kozienickiej
9. Lasy Janowskie
10. Lasy Beskidu Śląskiego

Table 13: Protected objects in Kozienice Forest (BULiGL 1996)

Type of object	Number of objects		Area (ha)	
	in entire Kozienice Forest	in Forest District	in entire Kozienice Forest	in Forest District
Reserves*	10	5	903.09	343.12
Planned reserves	6	4	about 300	about 179
Landscape Park	1	1	15,098	10,772
Nature monuments	140**	87		
Ecological values	113	63	353.72	137.52
Nesting place: black stork	19	12		
lesser spotted eagle	1	1		
roller	1	1		

* - there were 24 reserves in year 1996 in the Province of 1888 ha area that is 0.24% of the Province total area

** - 191 nature monuments in the entire Kozienice Forest - in all-ownership grounds.

Table 14: Monuments of nature in Kozienice Forest (BULiGL 1996)

Community	Number of monuments		Remarks
	total	in State Forests	
Jastrzêbia	7	-	
Glowaczów	18	14	including 1 lime valley
Kozienice	18	17	
Jedlnia	2	1	
Pionki	86	81	
Pionki city	17	10	
Sieciechów	-	-	
Policzna	12		
Zwoleñ	17	14	
Gózd	2	-	
Garbatka	12	3	
Total	**191**	**140**	

SCIENTIFIC STUDY IN FOREST

The scientific study carried out in Poland covers a range of topics and the study itself has had its long tradition. Large portion of the study deal with the problems of silviculture, protection and ecology of forest. The data are gathered both in permanent and temporary observation plots or transects. A lot of forest research plots have been established in national parks and nature reserves. The oldest permanent experimental plots are, e.g. located in Bialowieza National Park (BERNADZKI et al. 1997) and in Jata forest reserve. The scientific study in forest is being conducted by the staff of branch institutes, universities and Forestry Faculties of Agricultural Universities. In the organizational framework of the Forest Research Institute, a special office: the Department of Natural

Forests with its headquarters in Bialowieza, has been operating. In Polish Academy of Sciences, the Institute of Nature Protection in Krakow has been active. A very interesting comprehensive study project has been lately carried out under the auspices of the GEF Grant on the area of the Bialowieza Primeval Forest (PASCHALIS & ZAJACZKOWSKI 1996). For a few years now, scientific study has also been carried out by the staff of national parks. The output results of many research projects are utilised while preparing the plans of protection of national parks and nature reserves.

PROGNOSIS OF NATURE PROTECTION DEVELOPMENT IN FORESTS

The prognoses of further development of nature protection in Poland include, e.g. a more explicit learning and more efficient protection of our national natural richness, covering new objects with legal protection and tutoring society in the field of nature protection and rational utilisation of our natural resources. The prognoses include, also, forests.

It is planned in Poland that another three national parks will be created within the next few years and a number of new reserves, out of which 726 objects are to be located on the area of State Forests (WROBEL 1997). A substantial increase in our knowledge is expected to be fact following the practice gained in the course of accomplishing the programs of nature protection for the managed forest.

SUMMARY

The presented in this paper, outline of nature protection problems in Poland as well as the general information on natural forest, cover exclusively selected topics of a statistical and information character. A lot of detailed data considering the nature protection in forest ecosystems can be found in publications of the Institute of Nature Protection of Polish Academy of Sciences, the Forest Research Institute and in a periodical 'National Parks and Nature Reserves' published by the country-wide Board of National Parks.

REFERENCES

ANONYMOUS (1991) The Act on Nature Protection of 16.10.1991. (In Polish).

ANONYMOUS (1994) Decree No 30 of General Director of State Forests of 19 December 1994, on forest management improvement as based on ecological principles. (In Polish).

ANONYMOUS (1995a) Minister decree from 6.01.1995 on species protection of animals. (In Polish).

ANONYMOUS (1995b) Decree No 11 of General Director of State Forests of 14 February 1995, on Forest Promotional Complexes. (In Polish).

ANONYMOUS (1995c) Minister decree from 6.04.1995 on species protection of plants. (In Polish).

ANONYMOUS (1996a) Programme of the conservation of nature and cultural values in forest districts. Proceedings of seminar hold in Pionki, November 14-15, 1995. Fund. Rozwoj SGGW.

ANONYMOUS (1996b) Instruction of drawing-up the programs of nature protection in a Forest District. (In Polish).

ANONYMOUS (1997a) The Forest Act of 28.09.1991 with 1997 amendments. (In Polish).

ANONYMOUS (1997b) Forest policy of State. (In Polish).

BERNADZKI, E. et al. (1997) The 1936 - 1993 changes in stand species composition of natural forest stands in the Bialowieza National Park (In Polish). Parki Narod.Rez. Przyr. 16.2.

BOINSKI, M. (1997) Cisy Staropolskie nature reserve in Wierzchlas (In Polish). Wyd. Tow. Mil. Borow Tucholskich. Bydgoszcz.

BULiGL (1996) Program of natural and cultural values protection in Kozienice Forest District. Unpubl. MS (In Polish). Radom.

CZUBINSKI, Z. et al. (1977) Nature reserves in Poland. PWN Warszawa-Krakow. (In Polish).

GLOWACINSKI, Z. (ed.). (1992) Polish red data book of animals. PWRiL, Warszawa . (In Polish).

GRZYWACZ, A. (ed.) (1994) Polish State Policy of complex protection of forests resources. Fund. Rozwoj SGGW. (In Polish).

GUS (1997) Forestry 1997. Statistical data and analyses.

LIRO, A. et al. (1995) The concept of country-wide ecological network ECONET-POLSKA. Fund. IUCN Poland. Warszawa (In Polish).

LONKIEWICZ, B. (ed.) (1996b) Conservation and sustainable use of forests in Poland. IUCN - Program Europy. Fund. IUCN Poland (In Polish with English Summary).

LONKIEWICZ, B. (1996a) The map of forests biological diversity. Echa Lesne.

OLACZEK, R. et al. (1996) Nature protection in Poland . IOS Warszawa. (In Polish).

PASCHALIS, P. / ZAJACZKOWSKI, S. (1996) Biodiversity protection of Bialowieza Primeval Forest . Fund. Rozwoj SGGW.

RADZIEJOWSKI, J. (ed.) (1996) Protected areas in Poland. IOS Warszawa. (In Polish).

SZUJECKI, A. (1994) Natural conditions decisive for the forest policy of the XXIst century. MS. (In Polish).

WIECKO, E. (ed.) (1996) Encyclopedic dictionary of forestry, wood science, nature protection and similar fields. Wyd. SGGW. (In Polish).

WROBEL, J. (1997) Nature protection in forests under legal protection with particular emphasis on nature reserves. In: Protection of biological diversity in forests. POLEKO Poznan. IBL Warszawa. (In Polish).

ZARZYCKI, K. / KAZMIERCZAKOWA, R (eds) (1993) Polish red data book of plants. Ins. Ochr. Przyr. PAN, Krakow. (In Polish).

ZIELONY, R. (ed.) (1995) Directions of nature protection in managed forest. Fund. Rozwoj SGGW. (In Polish).

ZIELONY, R. (ed.) (1997) Kozienice Forest - a monograph. Wyd. SGGW, Warszawa. (In Polish).

The Board of National Parks Polish 1997: National parks. National Parks in Poland. Warszawa-Bialowieza

Appendix A

Minimum dimension of domestic trees and shrub species nature monuments

No.	Species	Diameter at breast height (cm) (1,3 m above the ground level)	Circumference (cm)
1.	*Betula pendula*	70	220
2.	*Betula pubescens*	70	220
3.	*Fagus sylvatica*	100	314
4.	*Prunus avium*	30	94
5.	*Cerasus avium*	30	94
6.	*Quercus sessilis*	100	314
7.	*Quercus robur*	120	380
8.	*Crataegus sp.*	30	94
9.	*Carpinus betulus*	60	190
10.	*Pyrus communis*	50	160
11.	*Malus sylvestris*	30	94
12.	*Sorbus aucuparia*	50	160
13.	*Acer pseudoplatanus*	80	250
14.	*Fraxinus excelsior*	80	250
15.	*Abies alba*	100	314
16.	*Acer campestre*	50	160
17.	*Acer platanoides*	70	220
18.	*Corylus avellana*	30 *	94
19.	*Tilia cordata*	100	314
20.	*Tilia platyphyllos*	100	314
21.	*Larix europaea*	100	314
22.	*Larix polonica*	100	314
23.	*Populus tremula*	70	220
24.	*Pinus sylvestris*	100	314
25.	*Picea excelsa*	100	314
26.	*Rhamnus cathartica*	30	94
27.	*Ulmus scabra*	70	220
28.	*Ulmus campestris*	70	220
29.	*Ulmus effusa*	70	220
30.	*Salix alba*	100	314
31.	*Salix fragilis*	100	314
32.	*Populus alba*	120	380
33.	*Populus nigra*	120	380

* - now 20 cm is suggested

Appendix B

CLASSIFICATION SYSTEM OF RESERVES IN POLAND

1. According to main object of protection:

- Fl - floristic
- Fi - phytocoenotic
- BF - biocoenotic and physiocoenotic
- Gg - geological and soil
- Ke - ecological landscapes
- Nu - artificial plantations
- Ku - cultural

2. According to main environmental type

- L - forest*
- £ - meadows
- W - inland waters
- T - peatlands
- H - hylophytic vegetation
- Wd - dunes
- Sp - underground
- Sk - rocks
- U - plantations
- M - mixed - type

* subtypes:

- lni - lowland broadleaved forest
- lgp - highland broadleaved forest
- lmn - lowland mixed-broadleaved forest
- lmg - highland mixed-broadleaved forest
- bni - lowland coniferous forest
- bgp - highland coniferous forest
- bmn - lowland mixed-coniferous forest
- bmg - highland mixed-coniferous forest

FOREST RESERVES AND THEIR RESEARCH IN ROMANIA

by Gheorghe Florian BORLEA *

ABSTRACT

A natural forest is a very good example to illustrate the concept of sustainable development. Forest area in Romania covers 6.356,000 ha (27 % of the total land area of the country), and the proportion of natural forests still remains important. Natural forest composition model is the main goal of the present-day forest management plans. There exists a tradition in nature conservation but the legislative system for nature protection in general must be improved, and very valuable areas must be included. The concept of forest conservation has evolved from the genetic conservation of forest tree species to the conservation of biodiversity in forest ecosystems. There are only few researches recorded in natural forests here. The need of forest conservation appeared also as a reaction to the previous extensive silvicultural methods which have dramatically disturbed the forest ecosystems. Forest conservation has been also supported by the new legislation (The Forestry Code /1996), and by the activity of the 'Progresul Silvical Society'[1] members.

INTRODUCTION

Total forest area in Romania consists of 6.366,000 ha from which 6.245,000 ha is covered by forest vegetation (27% of total land area of the country). Previously, 70% of the present-day territory was covered by forest (CHIRITA 1986). Romania has very important biodiversity resources: 3,100 native species of plants, 60 native tree species, 10 groups of natural forest formations, and 150 types of forest ecosystems (DONITA, CHIRITA and STANESCU 1990).

Forest composition is varied. Conifers make up 31% (23% spruce, 5% fir-tree, and other conifers 3%), beech 31%, oak 18%, other hard broad-leaved trees 15%, and soft broad-leaved trees 5%. The average growing stock is 215 m^3/ha (36% beech), and the average growth 5.6 m^3/year/ha. The harvested wood volume was 24 - 27 million m^3 in 1951-1976, 22 M m^3 in 1987, and 14.8 M m^3 in 1997. Afforestation of inferior land areas was carried out on 1,100 ha in 1996, and on 900 ha in 1997. The realisation of natural forest composition model is the main goal of the present-day forest management plans.

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1 Association founded in 1886 in order to promote sustainable forestry.

The Romanian silviculture was born and influenced in the context of French and German silvicultural school. The first Silvicultural Code, issued in 1881, stipulated the obligation of continuity principles and the necessity of skilled forest administration and management personnel for the state owned forest property (created in 1863). Essential peculiarities of the natural relief led to the development of a specific silviculture (GIURGIU 1995):

- the excessive fragility and sensitivity of the geographical space determined the immediate modification of the environmental factors.
- the dominance of uneven relief.
- the relatively poor water resources (1700 m^3/capita).
- a very capricious climate (cyclic draughts 1894-1905, 1918-1930, 1942-1953, 1983-1993; big storms...).

The simultaneous existence of natural and artificial forests has given the possibility to make comparison. The negative impact of dramatic climate changes upon artificial forest is obvious mainly in introduced coniferous monocultures but also in the case of deforestation (clear cuttings) in mountains:

THE HISTORY OF NATURE RESERVES ESTABLISHMENT

The whole history and civilisation of the local population was continuously connected to the forest covering the main part of the land area.

Starting with 1905, naturalists and foresters were concerned about protecting the nature, and the first reference to the forest protection was made in the Constitution in 1907. In 1912, the 'Progresul Silvical Society' (professional association of foresters) proposed to the authorities, a project of National Parks like in the US of America. Due to economical reasons it was impossible to make it happen. In 1928, at the first Congress of naturalists here, Emil RACOVITA presented the Nature Monuments Law Project. In Romania adopted in 1930 at the same time with the Nature Monuments Commission Foundation.

The legislative system concerning forest conservation includes also the Forest Protection Law (1935). In 1938, Marin DRACEA, mentioned, "we didn't alternate the original structure of our vegetation through forest species dislocation, and by dramatic changes of the natural mixtures".

An important step forward for the forest conservation was made in 1935, when the first National Park - Retezat (> 11,000 ha) mainly afforested, was governed by Law.

In the period 1930-1943, 36 natural reserves were constituted (total area 15,000 ha).

After the World War II, a new Nature Protection Law was adopted and the number of natural reserves increased to 130 (75,000 ha total area). Unfortunately in 1970 the administration rules of nature reserves were modified and the Retezat National Park administration was dismissed. The result was the disturbance of the nature protection activity in the entire country. Projects and studies on National Parks System Management were issued during 1973-1978. Important studies were developed by the Geographical Institute and the Institute of Biological Research Bucharest concerning natural flora and fauna.

The criteria for the zonal function of the forests were published officially in 1957 and have been continuously improved since then. A new Silvical Code was adopted in 1962, but in 1963 the government directed (by special orders) the silviculture to clear cutting and coniferous extension out of their natural area. The economic pressure on the forest has increased at macro-level due to wood industry development and exports, and at micro-level due to population growth, and the large utilisation of wood for fuel. Starting in 1976; the specialists succeeded to add to the Law (besides some undesirable measures against sustainability) a long-term plan for forest conservation (1976-2010), as the main result of both the pressure of international organisms and the conclusion that deforestation played a very important role in the catastrophic floods of 1970-1975.

The 'Management Norms' of 1986 stipulated the term of 'special regime of conservation for the natural forests' (intensive treatments, excluding clear cuttings and maintaining the forest natural type). The multiple functions of the forests were pointed out in the 'Management Norms' of 1988.

The National System of Natural Parks and Reservations was initiated in 1990 (12 National Parks with an overall area of 340,400 ha were formed or will be formed, having more than 80% of natural forest area each).

The 'Strategy of Forestry Development' of 1995, reviewed in 1997 and in 1998, is considered to be based on the 'conservation of forest fund providing the ecological equilibrium and environment protection'. The Silvical Code of 1996 stipulates that high-forest regime will be generally adopted in order to assure the forest sustainability. The Law of Environment of 1995 stipulates the necessary regulations in order to ensure a sustainable development of natural resources.

CLASSIFICATION OF FOREST PROTECTION AREAS

Unlike the Central European countries, where the forest landscape was radically modified, Romania is favoured by the fact that in its mountain and foothill zones, natural forest still exists.

Concerning the terms used in the present paper some explanations are necessary. At the Geneva meeting (1995), a provisional list of descriptive forest indicators was prepared by the General Coordinating Committee of the Helsinki Process. The following definitions were given:

- **virgin forest** = untouched forest: an area that has never been disturbed by human intervention, with natural structure and dynamics. The soil, climate, entire flora, fauna and life process have not been disturbed or changed by logging, grazing and direct or indirect anthropogenic influences.

  In Romania the term 'quasi-virgin forest' is also used, in order to delimit former virgin forests where sporadic extraction was practised, but the typical uneven-aged structure was not affected.
- **natural forest** = a forest which has evolved as a sequence of natural succession but still showing anthropogenic influences; a forest which was developed from unmanaged pasture or from fallow land.

The present-day estimation of virgin and natural forest area in Romania can be done using:

- the 'accessibility' of a forest (or an 'isolation degree' of stands)
- 'the actual state of forest types': natural, derived, artificial or indefinite; (almost 70% of the Romanian forests still maintain their natural appearance),
- the age of stands (the existence of a normal proportion of trees aged over 120 years).

According to the last forest inventory (1985) the area of forests without accessibility (distance from the road >5km) was 126,860 ha (representing 2% of the total forest area), and 824,000 ha (13% of the total forest area) were forests with relatively bad accessibility (distance from the road between 2.1-5 km). The present-day official list of protected areas in Romania must be reviewed (it includes a number of 15 virgin and quasi-virgin forests protected as forest reserves, with the total area of 3,866 ha). A tree seed sources catalogue (*in situ* conservation) was drawn up (ENESCU 1986) and reviewed in 1997, with 2,313 seed stands (the total area 70,176 ha), excepted from cuttings; an important part of which can be included in the natural forest categories.

A short description (composition, structure, value, location) of 67 of the most valuable virgin and natural forests is presented in Table 1 (Appendix A), and in Figure 1.

The concept of the National System of Natural Parks (OARCEA 1981, STOICULESCU 1995) includes the extension of the protected areas from very small areas to large ecological units (taking into account that in the representative forest areas the disturbed forest areas are of the first generation following the virgin forest, and their natural balance was not very much disturbed. The main ideas promoted by this concept are:

- the extension of conservation in large areas,
- internal zoning;
- a maximum representativeness of autochthonous forest ecosystems.
- unitary management for the entire system of 13 National Parks.

In 1994, 13 forest areas of 397,400 ha were officially recognised as National Parks by the government, and more than 130,000 ha of integral reserves, but an administrative-managerial team doesn't exist in practice. The management of these areas is still the responsibility of the local forest administration.

The classification of natural objects (STOICULESCU and OARCEA 1989) in order to be protected by Law is:

- National Parks
  - established by law
  - proposed
- Biosphere reservations (proposed)
- Protected areas
- Natural reservations
  - mixed
  - forest
  - dendrological parks
  - botanical
  - zoological

- palaeontological
- geological
- spelaeological
- scientific
- landscape conservation
- nature monuments

The classification of protected areas inside a forest area (STOICULESCU and OARCEA 1994) (Figure 2) includes:

1. National Parks:
   – established by law (Retezat)
   – provisionally established (11 Parks - Ministry Order 7/1990)
   – planned: a) first stage 1997-2000 (Figure 2) (a)
     b) second stage after 2000 (Figure 2) (b)
2. Biosphere reservations:
   – established at national level
   – established at international level (UNESCO-1980): Pietrosul Rodnei and Rosca-Letea (Danube Delta).

The reviewed classification of National Parks and protected areas (STOICULESCU and OARCEA 1997) includes (Figure 3):

1. National Parks:
   – established by law (Retezat)
   – provisionally established (11 Parks)
2. Natural Parks - planned
3. Biosphere reservations:
   – established by law
   – established at international level (UNESCO-1980): Pietrosul Rodnei and Rosca-Letea (Danube Delta).

MOHANU, ARDELEAN and GEORGESCU (1993) described a total number of 401 natural reservations in Romania classified as:

– National Park Retezat,
– complex reservations,
– forest and flower reservations,
– fauna reservations,
– geological and geomorphological reservations;
– spelaeological reservations,
– palaeontological reservations;

The same authors present also relict, endemic and rare protected plants; individual valuable trees and endemic, relict and rare protected animals.

Figure 1: Virgin and natural forests in Romania (Romania-Forest Map; author N.Donita-1990)

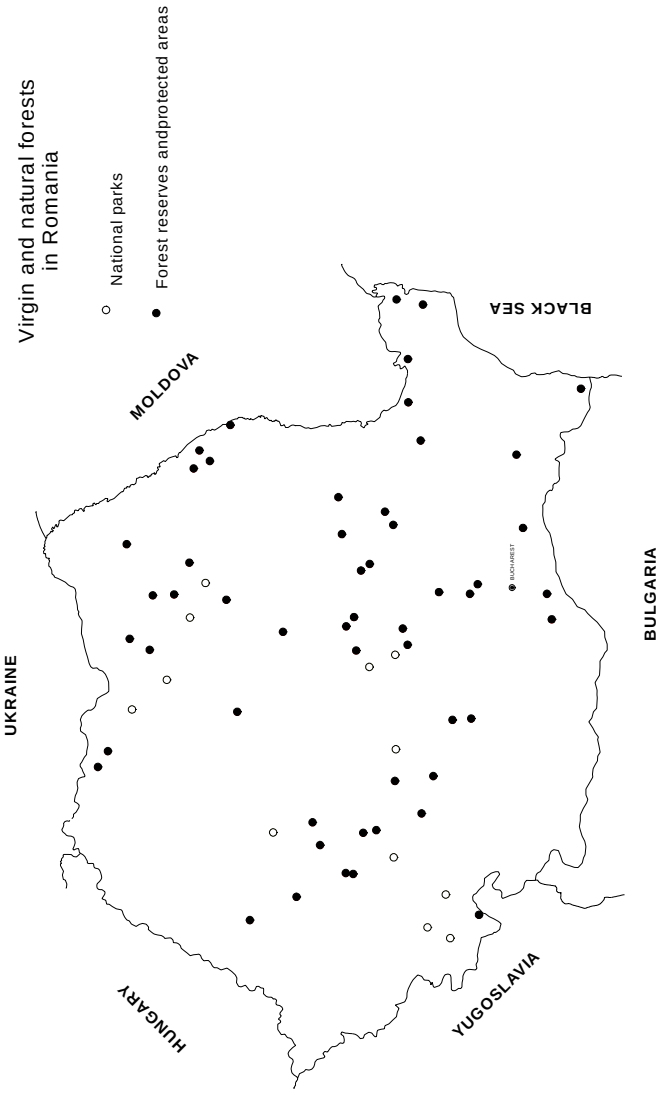


Figure 2: Protected areas inside the forest fund (STOICULESCU and OARCEA - Forest Research and Management Institute ICAS, 1994)

National Parks: I - established by law; II - provisional (established by Ministry Order 7/1990); III - planned to be established till the year 2000 and afterwards.
Biosphere Reservations: IV - established at the national and international level (since 1980).

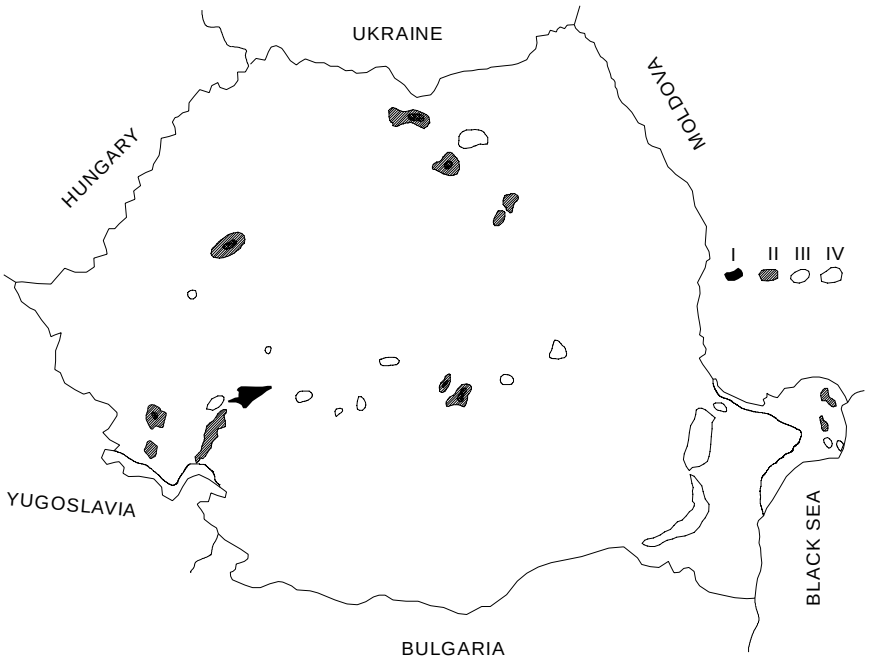


Figure 3: National parks and protected areas in Romania (STOICULESCU and OARCEA - Forest Research and Management Institute ICAS-1997)

National Parks: Established by law and by Ministry Order 7/1990.

National Parks: Planned to be established after the year 2000.

Natural Parks and Biosphere Reservations: established by law, projected in 1994, planned to be established till the year 2000, and those established at the international level in 1980.

The integral reserves area was increased to 14% of the total forest area (Figure 4) (GIURGIU 1995).

The tool used in order to promote the forest conservation and sustainability by POPESCU-ZELETIN (1957) was the 'functional zoning' of the forests. This first zonal functioning includes 2 groups:

- Group I: 'protection forest' with 5 zones (water protection, soil protection against erosion, forests of social interest, forest reserves and nature monuments) with the aim to protect the most sensitive element of each forest ecosystem.

Up till now the functional zoning was developed (GIURGIU 1995). The protection forest area was increased almost five times (Figure 5). This is explained by the protected areas extension, and by the modification of the functional zoning criteria (1986 and 1988).

Actually there are two 'functional groups' of forests (Forestry Code 1996):

- Group I: forests with special function to protect the environment: water, soil climate, strategic objectives, recreation, conservation of biodiversity in protected areas, reservations and National Parks.
- Group II: forests for biomass production and environmental protection (area of Group II is decreasing). (Figure 4)

In Figure 5 we can see the increase of Group I forest area, and the dominance of forests for soil (19%) and water protection (18%).

Concerning the protection forests (Group I) there are two situations:

- when any intervention is forbidden,
- when cuttings are permitted but the protective function remains intact (60% of the protection forests).

Ideas to improve the actual system were presented by GIURGIU (1995). A proposal for a new system of forest functional zoning into 58 categories (55 for the first group, and 3 for the second group) was also presented. The goal to include the total area of natural forests into the protected area is also stipulated. Natural forest areas for the main forest species are presented in Figure 6 (GIURGIU 1995).

Figure 4: Dynamics of production-protection forests and integral reserves in Romania

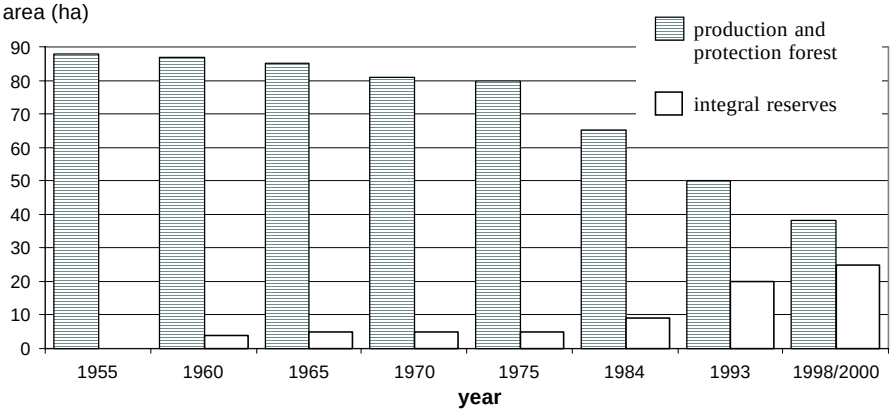


Figure 5: Dynamics of protection forests in Romania

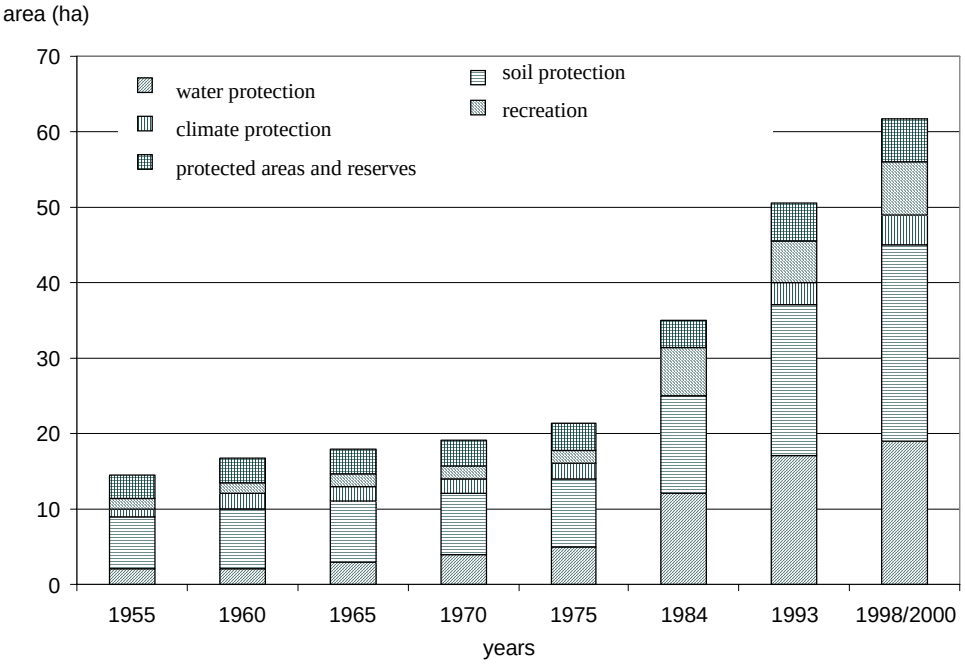
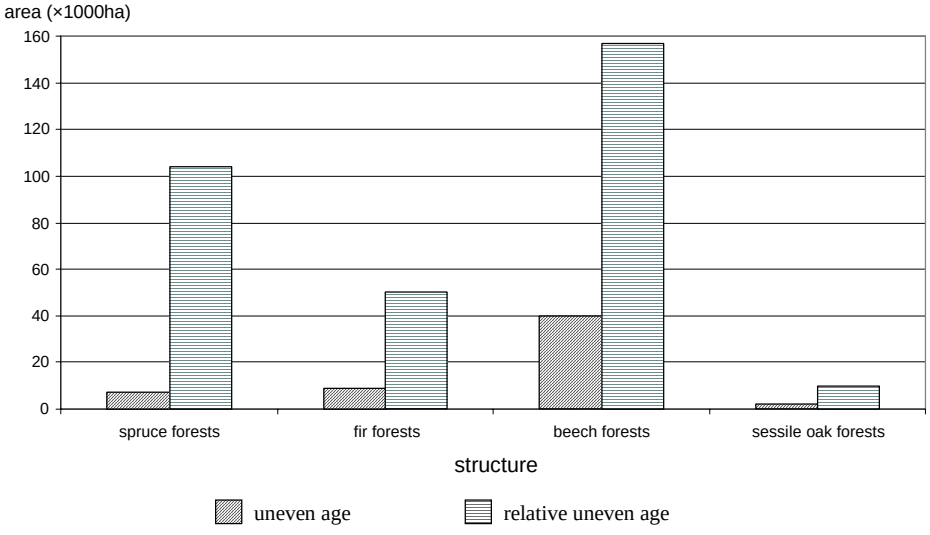


Figure 6: Area of natural forests / main forest species in Romania



THE DEVELOPMENT OF RESEARCH IN NATURAL FORESTS

From the very beginning the scientific silviculture influenced the frequency and originality of natural forests in the Romanian Carpathians (recorded by ANTORESCU 1892, FROLICH 1933, RADULESCU 1937, SABAU 1937, PRODAN 1940, DRACEA 1942). (after BORLEA, RADU and HERNEA 1997).

References on the same subject matter were made in different European forestry publications by MULLER (1929), FROLICH (1954) and MAYER (1984) (after BORLEA, RADU and HERNEA 1997). Systematic researches are recorded locally by POPESCU-ZELETIN and DISSESCU (1964) in PENTELEU and CENUSA (1986 and 1992). Recent studies recorded 37,000 ha of natural quasi-virgin forests (mainly beech, and also spruce, mixed forests, and oaks in Banat, located in the districts: Bozovici, Nera, Caransebes, Rusca-Montana, Lugoj, Lipova, Lunca Timisului, Mehadia Smejkal, Bandiu, Visoiu - 1995).

In Romania the actual area of main tree species natural forests is still important and presented in Figure 6 - GIURGIU (1995 - Forest Inventory). DONITA, CHIRITA, STANESCU (1990), described 150 forest ecosystem types in Romania.

Methods in research of natural forests in Romania

The methods used by researchers in the Romanian natural forests consist of:

- sampling plots for the most **representative** forest type of sufficient surface size from 0.2 ha (SMEJKAL et al. 1995) to 0.1 - l.0 ha (PAPAVA 1979), and presenting the structure by integral inventory of the plot with main emphasis on tree-layer structure.
- **systematic** sampling plots ('grille' type) for each structural phase (as described by LIEBUNDGUT 1959).

For the situation of spruce limit natural forests, CENUSA (1992) considers that the diameter of circular plots must be between 50 - 100 m. For beech and oak natural forests the diameter of circular plots must be 50% larger (SMEJKAL et al. 1995).

- method of **transects** with a continuous flora inventory following the altitudinal distribution of vegetation.

In Romania there are no particular methodologies in studies. Different researchers follow previous 'models' from literature.

In comparative studies of genetic variability between natural and managed forest elm-offspring population, a superior level of genetic variability was observed, both the morphological characters and the resistance to parasite attack (BORLEA 1996).

Natural spruce forests

The natural spruce forests, studied by GIURGIU (1974), show a large age variation in the small diameter categories compared to the large diameter categories; a similarity to the theoretic ideal diameter curve for virgin forest. The age-class frequency curve shows more maximum levels due to more regeneration waves. In Romania the characteristics of spruce natural forests are: 236 - 1565 trees/ha, diameter 16 - 100 cm, volume 244 - 700 m^3/ha, and height 25 - 30 m. The stability of spruce natural (virgin) forests is high. The spruce natural forest in Bucovina showed similar structural phases as described by LEIBUNDGUT (1959).

Mixed beech-coniferous natural forests

The research recorded by PAPESCU-ZELETIN and PETRESEU in 1956, and DISSESCU in 1964 (after VLAD, CHIRITA, DONITA and PETRESCU 1997) in spruce-beech-fir mixed forests shows no correlation between minimum - maximum age and diameter. Only the average age is positively correlated with diameter in range 30 - 65 cm. A beech can activate its growth even at the age of 130 - 140 years, and a fir at 100-150 years (e.g. a fir tree 465 years old had 6 cm diameter at the age of 90). The age of shrub-layer level varied between 20 - 120 years. The authors mentioned that due to 'continuous feed-back processes' this forest type maintained the initial structure. The regeneration in this type of mixture is possible only in open areas after old trees die. The 'alternation of species' in beech-fir mixtures in Semenic Mountains was described by BORLEA (1989). BANDIU (1977) explains this phenomenon as a result of differences in species radiation demands concerning light quality. The wood volume is high (600 - 1100 m^3), maximum tree-height is 50 - 60 m for fir and spruce, and 35 - 36 m for beech, and an average tree-height is 40 m for fir, and 32 - 36 m for beech. The stability is very high.

Beech natural forest

In the Semenic mountains (6,000 ha) natural beech forests still exist. Some authors (RADULESCU 1937, TARZIU 1970, PAPAVA 1977) studied natural beech in Romania, and the main conclusions are: the diameter curve is similar to the theoretical curve for selective cuttings, there is no age-diameter correlation, and only average age-diameter correlation is significant and positive. There is a positive correlation between tree-height (interval 22 - 36 m) and diameter categories (from 39 - 62 cm). The fructification variability is very large, and fructification periodicity is from 3 - 4 years to 6 - 8 years, and strongly correlated with the altitude. The growth at the age of 200 years is similar to that of 80 - 100 years (PAPAVA 1977). The volume varies in range of 322 - 1195 m^3, and the number of trees/ha is between 160 - 588. Stability is extremely high

Oak natural forests and oak-mixed natural forests

Oak natural forests were very much disturbed by anthropic activities. The oak-mixed natural forests have similar structure to that of the Bialoweza forests, with the exception of spruce (DONITA and PURCELEAN 1975, VLAD, CHIRITA, DONITA and PETRESCU 1997). The spatial structure consists of three levels: lower layer with hornbeam, intermediate layer with lime, cherry-tree, elm, sycamore maple, and superior layer with species of oak, ash, and sometimes elm or ash. The regeneration of oak is possible in these conditions (according to PASCOVSCHI 1967) due to their longevity (2 - 3 times higher than other species from this type of mixed forests).

The comparison of natural forest and managed forest

There were no systematic studies of comparing natural forests with the managed ones in Romania. Sporadically, different authors mentioned comparison of different qualitative or quantitative aspects, underlining the superiority of natural forest. There is only one exception: PAPAVA (1979) mentioned that the quality of wood is better in even-aged stands than in natural forests, and the absence of parasites is more obvious. This must be

discussed because at the same diameter class the age could be very different, and the action of parasites is a result of many interacting factors.

Concerning other qualitative aspects, especially the genetic variability, the superiority of natural forests is obvious (the genetic variability of elm in natural population is superior to that of elm in managed forest (BORLEA 1996).

THE PRESENT STATE OF RESEARCH ON NATURAL FORESTS IN ROMANIA

A very important process of reform started in the entire Romanian forestry, both in institutional organisation and property regime. The specialists' efforts are focused on the establishment of the legal status for the natural forests and natural reservations in general. Actually the research network is engaged in identifying the entire area of potential forest reserves, and in including these areas into the protected areas system (project leaders Dr. Cristian STOICULESCU ICAS Bucuresti and Dr. Zeno OARCEA). Regional researches are recorded in Bucovina (spruce natural forests - Radu CENUSA , ICAS Campulung-Moldovenesc) and have just started in Banat (beech natural forests and natural forests with elm - Gheorghe Florian BORLEA, ICAS Timiosara).

CONCLUSIONS

In Romania the theoretical concepts of forest conservation were considerably developed in the forestry legislation from the first regulation concerning forestry to the present-day legislation (Forestry Code - 1995, the Law of Environment - 1996).

The functional zoning represents the instrument used by the foresters in order to promote the conservation and sustainability of a forest. A continuous growth of the protection forest areas was recorded (from 12.7% of the total forest area in 1955, to 60% nowadays). This requires an adequate system of silvicultural intensive methods.

Social problems, as well as insufficient presentation of information to people on sustainability in forestry, can produce disturbances in the effort for forest conservation and sustainable development. In the last decades the situation of forest protection has continuously improved; this year it represents 62% of the total forest area. After 1998, when the 4th consecutive forest management plan will be completed, we expect new criteria for functional zoning.

The simultaneous existence of natural and artificial forests gave the possibility to compare the two. The negative impact of dramatic climate changes in the case of artificial forest is obvious, mainly in introduced coniferous monocultures. Deforestation (clear cuttings) in mountainous land has also totally disturbed the ecological balance.

Different authors presenting a classification of natural reserves in Romania use terms already mentioned in literature. Sometimes the general evolution of nature protection law has generated confusion in terms. The explanation could be that scientists are actually involved in trying to get as much natural areas under law protection as possible, and then clarify formal aspects. In presenting the problems of nature protected areas more accuracy is required. Important legislative changes are expected in the near future in order to clarify the status of large nature protected areas.

The present-day methods of research in natural forests must be improved. The most important quality of natural forest is its normal functionality given by the interaction of ecosystem components. The natural forest is a complete ecosystem. The research methods of a natural forest must be extended to each component of an ecosystem.

The description of virgin and natural forest types in Romania can provide scientific information and approaches, and thus can also offer 'models' for the forest of the future.

REFERENCES

BANDIU, C. (1977) Lumina ca facfor stabilizator al compozitiei ecosistemelor de amestec de brad cu fag. Padurea si spatiile verzi in prezent si perspective. Cluj-Napoca.

BORLEA, G. F. (1996) Cercetari privind rezistenta ulmlor autohtoni la grafioza - PhD thesis, University of Brasov.

CENUSA, R. (1986) Structura si stabilitara unei paduri naturale de molid din cordrul secular Slatioara, Revista Padurilor, 101, nr.4, 185-189.

CENUSA, R. (1992) Cercetari privind volumul, structura si succesiunea ecosistemelor forestiere din Nordul Carpatilor (Calimani si Giumalaau), Ph D thesis, ASAS Bucharest.

DONITA, N. / CHIRITA, C./ STANESCU, V., eds. (1990) Tipuri de ecosisteme forestiere din Romania, ICAS, seria II, Bucharest.

GIURGIU, V. et al. (1995) Zonarea functionala a padurilor din Romania, manuscript ICAS, Bucuresti.

LEIBUNDGUT, H. (1959) Uber der Zweck Metodik der Struktur-und Zuwachanalyse von Urwalden, Schw. Zeitschr. Forstw, 110, 3.

MOHANU, G. / ARDELEAN, A. / GEORGESCU. P. (1993) Rezervatii si monumente ale naturii din Romania, Editura Scaiul, Bucuresti.

OARCEA, Z. (1981) Sistemul National de Parcuri si Rezervatii, ICAS, manuscript, Bucuresti.

PASCOVSCHI, ST. (1967) Succesiunea speciilor forestiere, Ed. Ceres, Bucaresi.

PAPAVA, A. (1979) Cercetari privind fundamentarea telurilor de gospodarire pentru padurile de fag din Banat, Univ. Brasov.

SMEJKAL, G. / BANDIU, C. / VISOIU, D. (1995) Padurea seculara, Editura Mirton. Timisoara.

STOICELESCU, C. / OARCEA, Z. (1989) Natural objectives established and proposed in forest areas, ICAS, Bucharest.

STOICELESCU, C. (1998) Reffering to the forest biodiversity conservation in protected areas, Padurea Noastra, 359-360, (6-8).

TARZIU, D. (1970) Cercetari privind conditile de aplicare a tratamentului taierilor succesive in fagetele din Masibul Parang si posibilitati de ameliorare in viitor, Ph D thesis, Univ. Brasov.

VLAD, I. / CHIRITA, C. / DONITA, N. / PETRESCU, L. (1997) Silvicultura pe baze ecosistemice, Editura Academiei Romane, Bucuresti.

Appendix A

Table 1: Virgin and Natural forests in Romania

Code	Name	Location Country	Area ha	Description
	A. Virgin and natural forest complexes in National Parks			
1.	National Park Retezat	Hunedoara	11,466	Virgin and natural beech, mixed beech-fir-spruce and spruce forests, particularly in the scientific reserve (1840). Extensive areas: with *Pinus mugo*, and the largest occurrence *of Pinus cembra* in Romania. Include also alpine and sub-alpine shrubs and meadows, peaks, glacial lakes of unique landscape value. 1200 species of plants and rare high mountain fauna (chamois, bear, deer, lynx). (Genetic centre for *Hieracium* and *Ragenus*. Biosphere reserve (1979), declared as NP since 1935.
2.	National Park Rodna	Maramures	13,500	Remnants of virgin and natural spruce forest with *Pinus cembra and Pinus mugo*. Include alpine and sub-alpine pastures. Biosphere reserve (1979).
3.	National Park Domogled - Valea Cernei	Caras-Severin, Mehedinti, Gorj	13,310	Virgin beech forests in Valea Cemei and natural *Pinus nigra var banatica* in Domogled Mt. Submediterranean species on limestones in Domogled Mt *(Quercus pubescens, Q.cerris, Q.frainetto, Carpinus orientalis, Corylus colurna, Juglans regia, Fraxinus ornus, Prunus mahaleb)*. Karst phenomena.
4.	National Park Cheile Nerei - Beusnita	Caras-Severin	6,619	Beech virgin forests in Nera forest district (Cheile Nerei, Nargana, Nerganita). Xerophite vegetation *(Carpinus orientalis, Corylus colurna, Fraxinus ornus and Syringa valgare)* in Beusnita. Karst phenomena.
5.	National Park Apuseni	Bihor, Alba, Cluj	9,526	Remnants of virgin and natural spruce and beech forests in Padis and Somesul cold watersheds, as well as on the plateau Lumea Pierduta. All these forests are situated in karst area, plenty of unique geological phenomena (caves, underground glaciers, lakes, waterfalls).
6.	National Park Bucegi	Prahova, Brasov Dambovita, Arges	9,000	Virgin and natural beech and pure silver fir forests (at 900-1200 m alt.) between Sinaia and Poiana Tapului. Natural larch and larch-cembra pine stands in Piatra Arsa (1600-1800 m alt.).
7.	National Park Semenic-Cheile Carasului	Caras-Severin	8,522	Virgin and natural beech forests. Karst phenomena and gorge sub-mediterranean vegetation *(Carpinus orientalis, Fraxinus ornus, Syringa vulgaris, Cotinus coggygria)*.
8.	National Park Ceahlau	Neamt	5,424	Natural forest of beech, fir and spruce, and many endemic species. Natural occurrence of *Larix decidua var. carpatica*. Rare mugo pine and *Alnus viridis*.
9.	National Park Cozia	Valcea	6,747	Natural and virgin forests of beech, sessile oak, spruce and fir. Occurrence *of Quercus robur* at high altitude (1800 m). Many endemic species. Includes sub-alpine meadows.
10.	National Park Calimani	Suceava	8,241	Remnants of virgin and natural spruce and spruce-cembra forests. Occurrence of *Taxus baccata, Rhododendron myrtillus, Leonthopodium alpinum* and other rare, protected species.
11.	National Park Piatra Craiului	Brasov, Arges	4,024	Quasi-virgin and natural mixed (beech, fir, spruce) forests on Jurassic limestones. Specific *Acerato-Ulmetum* in gorges. Frequent occurrence of *Pinus mugo, Taxus baccata* and other endemic species.

Code	Name	Location Country	Area ha	Description
12.	National Park Cheile Bicazului-Hasmas	Harghita, Neamt	5,326	Virgin and natural spruce-fir-beech forests with *Pinus sylvestris* and *Juniperus sabina* as relicts, in limestone area with frequent karst phenomena (gorges).
	B. Virgin and natural forests in forest reserves and protected areas			
13.	Gradistea de Munte-Cioclovina	Hunedoara	1,000	Natural and seminatural beech (and spruce) forests in an area with a complex of archaeological vestiges of ancient Dacian state. System of fortresses and the spiritual capital of Dacia (Gradistea Muncelului).
14.	Portile de Fier	Mehedinti	423	Seminatural limestone vegetation, loaded along the Danube, with beech *(Fagus sylvatica, F.taurica, F.orientalis), Acer monspessulanum, Corylus colurna, Carpinus orientalis, Fraxinus ornus* and oak species *(Q.cerris, Q.pubescens, Q.virgiliana, Q.polycarpa, Q.dalechampii). Syringa vulgaris, Taxus baccata* and *Sorbus aria* in undergrowth.
15.	Ravna (Fersig)	Maramures	26	Virgin oak *(Q.robur)* forest.
16.	Rinisoara	Maramures	29	Quasi-virgin sessile oak forest
17.	Giumalau-Valea Putnei	Suceava	844	Virgin spruce forest, below the peak Giumalau.
18.	Gosmanu-Tarcau	Neamt	172	Virgin spruce-fir-beech forest.
19.	Dumbrava-Vanatorii Neamtului	Neamt	866	Old oak *(Q.robur)* natural forest.
20.	Humosu	Iasi	73	Quasi-virgin beech forest.
21.	Slatioara	Suceava	854	Virgin (spruce, fir-beech) forest at 800-1320 m alt., protected since 1904 (1921).
22.	Milea-Viforita	Buzau	149	Virgin fir (mixed with beech and spruce) forest on Mt. Penteleu. A fir cut down in 1953 was 56 m tall and 465 years old.
23.	Tisa (Penteleu)	Buzau	34	Virgin spruce forest destroyed by windfalls (1953-1961), now in regeneration phase. In the vicinity at Hategului forest the highest spruce in Romania was recorded in 1945 (62 m at 2.2 m diameter).
24.	Glodeasa	Prahova	453	Mixed quasi-virgin forest (beech and fir)
25.	Zanoaga	Dambovita	250	Virgin spruce-cembra pine forest.
26.	Tampu	Hunedoara	157	Quasi-virgin beech spruce forest
27.	Batrana	Hunedoara	117	Quasi-virgin beech forest.
28.	Gornovita (Ieroni)	Gorj	55	Virgin beech forest.
29.	Runcu-Grosi	Arad	932	Quasi-virgin and natural forest. of *Q. petraea.*
30.	Arghisel	Arad	145	Quasi-virgin and old natural beech forest.
31.	Poiana Stampei	Suceava	677	Natural *Pinus sylvestris f. turbosa* occurrence on *Sphagnum* Swamp.
32.	Bila-Lala	Suceava	234	Botanic alpine reserve with *Pinus cembra, Taxus baccata. Rhododendron myrtillus* and *Cypripedium calceolus.*

Code	Name	Location Country	Area ha	Description
33.	Tudora	Botosani	126	Remnants of old natural beech-hornbeam-sessile oak forest preserving scattered *Taxus baccata.*
34.	Uricani	Iasi	68	Natural oak *(Q.robur, Q.petraea)* forest.
35.	Harboanca-Brahasoaia	Vaslui	70	Natural oaks forest *(Q.pedunculiflora, Q.pubescens, Q.dalechampii, Q. virgiliana)* with occurrence of their natural hybrid population in sylva-steppe.
36.	Calinesti	Vaslui	365	Natural sessile oak-beech forest.
37.	Mociar	Mures	50	Remnants of old natural oak forest on heavy moist soils.
38.	Mestecanisul Reci	Covasna	34	Complex of eutrophic swamps with glacier relict *Betula nana. Pinus sylvestris* on former mobile sand dunes.
39.	Cenaru	Vrancea	309	Natural beech-fir forest with frequent natural occurrence of *Taxus baccata* undergrowth.
40.	Dalhauti	Vrancea	188	Remnants of old sessile oak-beech forest.
41.	Cristian	Brasov	372	Natural sessile oak-fir mixed forest (as azonal relict.) at 900-930 m alt.
42.	Prejmer	Brasov	252	Natural oak-swamp ecotype forest, with other rare and endemic species.
43.	Dumbrava Vadului	Brasov	395	Natural thinned forest of oak, sheltering an abundant occurrence of *Narcissus stellaris.*
44.	Spataru	Buzau	174	Natural and seminatural ash *(Fraxinus pallisae, F.angustifolia)* with oak forest, on primary saline soils.
45.	Frasinu	Buzau	156	Natural ash *(F.pallisae, F.angustifolia, F.excelsior)* forest on primary saline soils.
46.	Garboavele	Galati	450	Remnants of natural oak *(Q.pubescens, Q.pedunculiflora)* forest, surrounded by black locust plantation *of Quercus, Pyrus* and *Ulmus* natural hybrids.
47.	Viisoara	Braila	1,694	Remnants of old natural *Quercus pedunculiflora* forest, replaced by black locust plantations.
48.	Erenciuc	Tulcea	48	Pure *Alnus glutinosa* natural forest with disperse *Salix cinerea* in Danube Delta.
49.	Caraorman	Tulcea	841	Seminatural ash *(F.excelsior, F.angustifolia, F.pallisae),* oak *(Q.robur, Q.pedunculiflora)* and poplars *(P.alba, P.nigra)* forest on river-main sand dunes in Danube Delta.
50.	Letea	Tulcea	2,746	Natural and seminatural oak-ash and *Alnus glutinosa* forests on river marine sand dunes in Danube Delta, with climbing liana *(Vitis vinifera, Periploca graeca)* on trees.
51.	Valea Fagilor (Luncavita)	Tulcea	154	Relict island of natural beech *(Fagus sylvattca, F.taurica),* hornbeam and other species forest, located in a valley at Macin Mt. (Dobrogea).
52.	Hagieni	Constanta	207	Natural oak *(Q.pedunculiflora, Q.pubescens)* forest with *Carpinus orientalis.*
53.	Ciomuleasa	Calarasi	254	Natural and seminatural mixed oak *(Q.robur, Q.pedunculiflora) - Tilia tomentosa - Fraxinus pallisae, F.ornus - Prunus mahaleb* forest.

Code	Name	Location Country	Area ha	Description
54.	Caiafele si Moroiu	Calarasi	479	Old natural stands *of Salix alba, Populus alba, P.nigra* located in the Danube flood-plain, with *Vitis vinifera ssp. sylvestris* and *Periploca graeca* liana on trees.
55.	Comana	Giurgiu	439	Complex of natural oak forest *(Q.robur, Q.pedunculiflora, Q.pubescens, Q.cerris, Q.frainetto)* which include rare and threatened species *(Convallaria majalis, Paeonia peregrina, Ruscus aculeatus).*
56.	Manafu-Ghimpati	Giurgiu	83	Natural mixed oak species *(Q.cerris, Q.frainetto, Q.pedunculiflora)* forest and black locust plantations.
57.	Snagov	Ilfov	1,151	Remnants of ancient natural *Querceto-Carpineum* which covered this area far to the Danube. Sporadic occurrence of relict beech *(F.sylvatica, F.orientalis, F.taurica)* and *Quercus petraea.*
58.	Caldarusani	Ilfov	468	Old natural *Quercus robur* forest with white poplar and willow.
59.	Seaca-Optasanu	Olt	434	Old remnants of ancient *Quercus frainetto* pure massif (2,000 ha).
60.	Topana	Olt	473	Remnant of mixed *Quercus cerris-Q.frainetto* forest and of pure *Q. frainetto* natural stands.
61.	Plopeni	Prahova	254	Old remnant of natural *Quercus robur* forest and other endemic species.
62.	Latorita	Valcea	71	Old natural *Larix decidua var. carpatica* forests.
63.	Chitu-Bratcu	Gorj	1,319	Natural beech forest.
64.	Tismana-Pocruia	Gorj	220	Remnant groups of natural *Castanea sativa* dispersed in natural oak *(Quercus petraea, Q.cerris, Q.frainetto)* or beech stands.
65.	Fagetul Gradistea Muncelului	Hunedoara	35	Natural old beech forest in the territory of ancient Dacia's capital Sarmisegetaza.
66.	Bejan	Hunedoara	235	Natural occurrence of 8 native oak species (except *Q.pedunculiflora)* and genetic centre for hybrids among all these species.
67.	Vidolm	Alba	341	Old natural larch *(Larix decidua ssp. carpatica)* forest.

Appendix B

Table 2: Dendrometrical elements of virgin forests (Different authors)

Region	Composition	Height m	Diameter cm	No. of Trees/ha	Volume m^3/ha	Author
Limit Spruce Forests						
Retezat	Mo	15	23	1565	525	
Calimani	Mo Pic	13-15	18-33	1415	337	Bindiu
Calimani	Mo Pic	18-22	28-38	425	244	Donita, 1989
Calimani	Mo		16-70	390	275	Rubner, 1934
Spruce Forests						
Valea Dambovitei	Mo		21-100	431	517	Rubner, 1934 af. Antonescu
Bosnia	Mo		26-90	236	606	Rubner, 1934
Alpii calcarosi (Austria)	Mo	25		500	648	Zukrigl, 1970
Alpii de Est (Austria)	Mo	25-30			400-700	Maver, 1984
Mixed Beech-Coniferous Forests						
Carpatii Sud-Estici	Br Fa		16-100	164	364	Rubner, 1934
Parang	Br Fa	36	M 56	420	952	Tirziu, 1970
Sasso Fratino (Italy)	Br Fa	40-32		385	1162	Hofmann, 1970
Salajka (Czechoslovakia)	Br Fa			113	482	Prusa, 1970
Curcova uvala (Yugoslavia)	Br Fa	40-34	8-145	557	1113	Plavsic, 1970
Calimani	Mo Br Fa		10-100	287	568	Rubner, 1934
Campulung Muscel	Mo Br Fa	38	21-100	405	665	Rubner af. Antonescu
Parang	Mo Br Fa	33	M 54	660	1013	Tirziu, 1970
Alpii calcarosi (Austria)	Mo Br Fa	40-30	M 75		630	Zukrigl, 1970
Beech Forests						
Carpatii Sud-Estici	Fa		16-100	160	322	Rubner, 1934
Carpati	Fa				800-900	Radulescu,1937
Carpatii Meridionali	Fa				400-500	Radulescu, l937
Banat	Fa				747	Radulescu, l937
Parang (14 arb.)	Fa	28-35	M 50-76	316-588	745-927	Tirziu, 1970
Banat (14 arb. pe soluri profunde)	Fa	31-40	M 37-65	146-373	601-1195	Papava, 1977
Banat (14 arb. pe soluri scheletice)	Fa	29-33	M 34-53	180-392	553-778	Papava, 1977

Appendix C

Table 3: The age variation of spruce on diameter categories in mixed (fir-beech-spruce) virgin forests (after POPESCU-ZELETIN and PETRESCU, 1956)

Diameter cm	30	35	40	45	50	55	60	65	70	75	80
Number of trees	3	8	14	14	15	16	8	5	9	4	1
Minimum age	143	127	145	145	142	134	165	171	153	167	
Average age	147	161	166	175	177	189	189	219	191	210	175
Maximum age	155	207	219	223	225	223	232	267	237	289	

Table 4: Number of trees in mixed fir-spruce-beech forests (after POPESCU-ZELETIN and PETRESCU, 1956)

Plot	V1		V2		T1		T2	
Year	1949	1955	1949	1955	1949	1955	1949	1955
Number of trees	1600	1350	1150	800	1970	1010	1290	880

THE BROWN BEAR IN SLOVENIA - NATURAL HERITAGE OR A NUISANCE?

The problems of the conservation of large predators in the cultural landscape - the case of the brown bear in Slovenia

by Miha ADAMIČ *

ABSTRACT

Due to persecution and near extermination of the brown bear and other large predators in the 19th and in the first half of the 20th century, these were put on the Red list of threatened animals in Slovenia, and are protected yearlong since October 1993. Regardless of the legal protection of the brown bear, including moderate yearly quota harvesting system, the specie was faced with new threats, triggered off by the impacts of particular forms of human economy. In accordance with the practice in European Union, livestock support is given to people interested in sheep-breeding. Current stock of sheep in Slovenia is estimated at approximately 60,000 animals, and projected increase is expected to be at 92,000 sheep in 2003. With range expansion of the brown bear as well as the lynx and the wolf from south-central Slovenia, since their protection in 1993, the risks of predation have been transferred into the west and north-west part of the country. In extensive dinaric and alpine areas where sheep-farmers are not accustomed to the presence of the brown bear on inadequately protected pastures, the extent of damage has been increasing since 1993. In 1998 the state compensation payments for large predator damage to livestock exceeded US$ 160,000. The state supported livestock projects do not put an obligatory use of predator-safe fences and other protective tools, therefore State Agencies are in fact mutually responsible for increased predation upon insufficiently protected flocks. According to projected increase of sheep stock in Slovenia new pasture areas will have to be created in yet unaffected parts of large carnivore range. New zones of conflicts in the field of large predator conservation management will also appear in Slovenia. Although Slovenia is a small country, the way of life and the source of income for local inhabitants differ a lot. Large carnivores have been declared as a part of natural heritage, and for many inhabitants of Slovenia can also be a nuisance. The State Agencies, which are responsible for launching effective mitigation programs in the predator-affected areas, will have to take this into account.

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INTRODUCTION

Slovenia is one of the few European countries with a preserved stock of large predators, the brown bear (*Ursus arctos*), the wolf (*Canis lupus*), and the lynx (*Lynx lynx*). The last species was re-introduced in 1973, about 100 years since its extermination in the 19th century. According to older data on the history of large predators in Slovenia in the period between the mid-18th century and the end of World War I, it is evident that despite unaffected habitats in that period, all the three species were nearly exterminated. This important historical lesson is to be taken into account in current and future projects on conservation management of problematic wildlife species, which compete with humans in the utilisation of the same resources. Human aversion or acceptance might therefore be nearly as important as preserved species habitats.

The brown bear and other large predators are in today's Europe among rare (or vanishing) species, a valuable part of the natural heritage and biotic diversity. In Slovenia all the three species are protected under the Decree on the protection of rare and endangered animal species in Slovenia, adopted by the Parliament of Slovenia in October 1993. Slovenian brown bear population genotype is most suitable for the recolonization of the Alps. This might be achieved either by natural spreading of the population towards north-west or by direct human support by translocation of live-captured animals in new habitats.

Only viable populations can cope with increasing pressure, which affect not only population size and structure but also suitability of habitats. Increasing pressure upon populations is among important triggers that set off permanent changes in the patterns of species dispersion. The movements of the brown bear are, due to circulation abilities of the species, hardly to be controlled by humans. The extension of the population of brown bears out of the core area will therefore be presumably present in Slovenia in future, too. Taking into account predictions on spatial extension, the core management area of the brown bear with about 3000 sq. km, established in 1966, will be thus too small to ensure a long term persistence of a viable population, independently of the surrounding areas. The ideas and legislature on the protection of the brown bear in Slovenia, devised in the mid-60s are therefore unsuitable for current purposes. A new conservation strategy with implemented facts on population dynamics is to be designed and adopted in every day's life as soon as possible. Among the first steps to be taken are to increase the area of bear conservation.

Therefore the conservation of a viable bear population in Slovenia is not only in the national but also European interest. Only proper predictions and mitigations of conflicts among humans and the brown bear, as well as other large predators, will make the implementation of the conservation goals easier and more effective.

THE BROWN BEAR - NATURAL HERITAGE OR A NUISANCE? IT DEPENDS ON THE WAY OF LIFE AND THE PLACE OF LIVING.

Slovenia represents the north-western edge of extended Balkan-Dinaric population range of the brown bear and the wolf. The population of the brown bear is viable and highly reproductive. Natural, non-hunting mortality and yearly rates of hunter-killed bears do not exceed the yearly reproduction rates. This is among important triggers that set off continuous westward extension of the population range and penetrations of brown bears

into the Alps. Opportunistic food strategies, circulation abilities and cryptic behaviour in the vicinity of human settlements, allow the species to penetrate even into densely populated and intensively used parts of human habitats. Man-made obstacles pose no serious problems for the species to be surmounted. Recent forms of land use in the cultural landscape are poorly compatible with basic principles of conservation of viable populations of problematic wildlife species, especially those with a large distribution range and those causing severe damage to human property, provoking fear and aversion among people. It also means that what might be a valuable part of natural heritage for some could be a nuisance for others, depending on their source of income and the place of living.

Accelerated penetrations of brown bears into densely settled areas of north-western Slovenia in the post-1990 period have generated new problems to conservation management of the species. People there were unaccustomed to the presence of large predators, due to their extirpation in the early 19th century and were irritated by the occurrence of bears in their vicinity, not just because of increased predation upon livestock, but also because of the fear for their lives. This was among key reasons, stressed in several protests of local people, who claimed urgent extraction of individual bears in the outer area of the range of brown bear. But it was not the case in the core range of the bear in south-central Slovenia, where increased densities of the species occurred. Traditionally accustomed to the occurrence of bears in the surrounding forests, economic aspects of the damage caused by the brown bear were key reasons for extraction claims of the inhabitants.

Table 1: The structure of the damage caused by brown bears to human property in Notranjsko, the western part of the core management area in the period 1994 - 1998 (source: BERCE 1999)

Year	Apiaries	Livestock*	Orchards	Cereals	Silo balls	Yearly total
1994	1	-	4	1	2	8
1995	1	5	4	-	3	13
1996	5	4	10	4	1	24
1997	2	16	15	1	4	38
1998	-	24	8	2	11	45
TOTAL	9	49	41	8	21	128

* mainly sheep, but also single cases of predation upon goats, cattle and horses

Table 1 shows that the frequency of bear predation upon livestock in the period 1994 - 1998 increased ($r = 0.9413$, $n = 5$, $p < 0.05$), along with bear damage upon human property in total ($r = 0.9894$, $n = 5$, $p < 0.05$).

As regards protests of sheep-farmers, we can hardly imagine that any explanation of the conservation value of large predators might have a positive influence upon the attitude of the inhabitants in the area.

Similarly, problems of sheep predation by the brown bear increased in pre-alpine and alpine areas of Slovenia where, due to traditional forms of sheep-herding, the protection of flocks by efficient electric fences is nearly impossible (ADAMIČ / KOREN 1998).

Along with the expansion of the population area of the brown bear as well as that of the wolf in last two years, human-bear conflicts moved out of the core area into other directions. More and more reports from year to year on the penetration of brown bears in north-western Slovenia (sightings, trackings and damage reports), and an increase in damage compensations paid show possible future trends of bear-sheep interactions. The Government of Slovenia widely supports sheep farming, but it has also put the brown bear under yearlong protection in the wider area of the Alps. Since the predation upon livestock would be the key obstacle for bear recovery, the competent governmental agencies are obliged to seek optimal ways of cohabitation among conservation management of the brown bear and sheep pasturing. It is clear that bear recovery is not just a pure ecological problem, but a socio-economic one, too. The efforts to introduce safer ways of pasturing on reduced pasture surfaces inside electric fences would seriously reduce the available food for sheep and consequently reduce the size of herds. Therefore electric fencing of the pastures would be the solution only for higher productive meadows in the valleys. Controlled pasturing by sheep-guards with dogs is thus the only solution for high alpine pastures. Extraction of problem bears which would repeatedly prey on sheep in pastures at higher altitudes should also be among the tools of conservation management of the brown bear in Slovenia in future, too.

Traditional grazing of sheep and cattle in vast, unfenced alpine pastures above the timberline was the activity related to low grassland production at higher altitudes. In the mid-80s, sheep owners tried to keep sheep in fenced pastures in the valleys not far from the villages, too. But with increasing occurrence of bears in the area, even the sheep in fenced, small pastures were exposed to brown bear predation. Wire fences about 1.3-1.5 m high were no real barrier to the bears, but they kept the sheep inside and made it impossible for them to escape. But, if these fences were improved with additional electric wires, they would represent good protection against predation.

In 1994 and in 1995 one single bear killed more than 60 sheep in three different locations of alpine pastures in the vicinity of Kobarid, Drežnica and Bovec, in north-western Slovenia. Another 100 sheep were reported missing, due to attacks of the same animal. A state shooting licence for the extraction of the nuisance bear was issued in 1994, but the animal was extracted only in April 1996.

An earthquake in spring 1998 seriously affected living conditions in alpine villages and also raised new problems of the expansion of the bear range towards species historical habitats in the Alps. Since tourism, on which the economy of the area was formerly based, was rendered impossible due to the damage done to housing and the infrastructure, livestock remained the only vital source of income to the majority of people in the villages. This new economic situation made the sheep -owners extremely sensitive to the occurrence of brown bears. The Ministry for Agriculture and Forestry supported their claims, issuing special shooting licences, by which two bears have been shot in this area and another three in the neighbourhood.

CONCLUSIONS

The phenomenon of the range expansion of the brown bear and of the wolf since their full protection in 1993 is a real challenge to traditionally rigid attitudes of Europeans. Slovenia is no exception in its attitude towards large predators. Although this is a period of worldwide efforts to preserve rare animal species, rain forests and general biotic diversity, we are not yet aware that we are really capable of sharing our tiny European landscapes with large predators, as full members of these biotic communities. It is much easier for Europeans to support the survival of Indian tigers, and the survival of white sharks along the Coral reef than to imagine that the brown bear and the wolf would live in forests nearby.

Although all three species were included in the Red list of threatened mammals in Slovenia in 1993, no state-wide strategy for the preservation of key habitats was yet adopted. In Central Europe large predators are actually forest dwellers, therefore their future fate is closely related to the degree of the preservation of forest habitats. But, if the proportion of private-owned forests in Slovenia, which is high even for current European standards, is taken into account, the idea of the preservation of habitats is in fact an utopia. Since the target conservation areas in Slovenia are limited to the state-owned forest reserves, natural parks and today's wildlife reserves, any conservation interventions would thus have just a limited impact upon the welfare of large predators. Planned interspersion of patches of sheep pastures inside large blocks of sparsely settled forest landscapes in south-central Slovenia as well as the revitalisation of traditional ways of sheep herding in the Alps pose serious threats to the future welfare of all large predator species. Human-predator conflicts and rising farmers aversions against the protection of large predators in Slovenia as a consequence, will doubtless affect the conservation management strategy.

According to a study of public attitudes towards large carnivores in different parts of Slovenia (KORENJAK 1995), and taking into account increasing protests of local communities and their petitions to extract problem bears and wolves in different parts of the large predators range, it is very important to strengthen our efforts to improve the research of human dimensions in the conservation of large carnivores. The key yet unresolved question is how to condition positive attitudes of local people in the Alps and Littoral Karst to the conservation of large predators, which were in fact exterminated by their grandfathers a good hundred years ago. Since the Ministry of Slovenia for Agriculture and Forestry is responsible for compensating the damages caused by large predators and other yearlong protected wildlife species, problems of economic losses due to the predation are not relevant at all. But the emotional pressures of sheep -owners, reinforced by the fear for their own lives, triggered by the corpses of surplus killed livestock are among important reasons for the predator-aversion in exposed areas. It has to be taken into account that many good conservation projects failed due to the exclusion of local people out of the conservation processes (BATH 1994, JACOBSON / MCNUGGAT 1998)

We are fully aware that Slovenia is too small to preserve its own viable populations of brown bears and wolves (ADAMIČ 1996, ADAMIČ et al 1998). New conservation strategies, based on the knowledge of conservation biology and landscape ecology (OPPDAM 1990, PULLIAM et al 1991, WIENS 1990, HANSSON / ANGELSTAM 1991,

FRANKLIN 1993) are to be built for future preservation of biodiversity and especially for conservation of viable populations of brown bears and other large predators in Slovenia. For that purpose, the existing and planned islands of national parks and reserves inside recent predator ranges should be declared as conservation centres, functionally tied to the surrounding landscapes, forming with them uniform, large enough joint conservation areas for brown bears.

Because of evident transboundary connections between brown bears and wolves, roaming in south-central Slovenia and in Gorski Kotar in Croatia, future welfare of the species thus depends not only on their legal status in Slovenia, but also on that in Croatia. Establishment of interstate cooperation among Slovenia and Croatia for joint conservation of natural resources in border areas and the creation of Dinaric Large Predator Mega-reserve, with extensive conservation management strategy for all large predator species would be the best solution. The challenge and significance of cross boundary management plans of expanding wolf populations have been stressed by several authors, as most reasonable and efficient conservation solution for the welfare of the species (MECH 1995, NOSS et al 1996).

In the course of planned interstate cooperation, a joint large predator conservation area, comprising about 5500 km^2 of habitats on Slovene side and about 2000 km^2 of habitats in Gorski Kotar and in Čičarija in Croatia (HUBER / FRKOVIĆ 1994), might be established. The interstate project might bring together about 7000 km^2 of "Slovenian-Croatian Interstate Large predator Conservation Area". If the project is realised, there will be enough space for the conservation of viable populations of about 500 bears (projected acceptance density of average 0.7 bears / 10 km^2). Limitations on the intensity of spatial activities, affecting the suitability of habitats, will have to be implemented in the whole area. At this very point, the financial as well as the political support of the European Community will be of crucial importance. The projected population size will fulfil the criteria of long term viability. Thus its positive side effects of regional and international importance will also be warranted.

The knowledge gathered in Slovenia will be of national importance and will be used as background information for modern conservation strategy of problematic wildlife, but would also be important for other alpine countries, which support the idea of bear recovery in the Alps. Its application will help in the decision making processes in the protection of isolated populations, and also in the evaluation of planned actions on the recovery of former alpine bear populations.

REFERENCES

ADAMIČ, M. (1986) The land use changes in Slovenia and their influence on range and densities of some (game) wildlife species. Proceedings of 18th World IUFRO Congress, Div 1/2: pp. 588-600. Ljubljana 1986.

ADAMIČ, M. / KOREN, I. (1998) Možnosti povratka velikih zveri v Alpe. pp. 53-64 v J.Diaci(ured.) "Gorski gozd". 19.gozdarski študijski dnevi. Oddelek za gozdarstvo in obnovljive gozdne vire BI. Ljubljana

BATH, A.J. (1993) Public attitudes towards polar bears. An application of human dimensions in wildlife resource research. pp. 168-174 v I.D. Thompson, ur.: Forests and wildlife towards the 21th Century. Proceedings of the 21th Congress International Union of Game Biologists, Vol.1. Halifax. Nova Scotia, Canada.

BERCE, M. (1999) The report on the claims for the compensation of the damages upon human property, caused by the brown bear and other large predators in Notranjsko Wildlife Management Area in the period 1994 - 1998. Postojna 1999, 4 pp. (unpublished report)

FRANKLIN, J.F. (1993) Preserving biodiversity: species, ecosystems or landscapes. Ecological Applications 3: pp. 202-205.

HANSSON, L. / ANGELSTAM, P. (1991) Landscape ecology as a theoretical basis for nature conservation. Landscape Ecology 5: pp. 191-201.

HUBER, Đ. / FRKOVIĆ, A. (1994) Brown bear management in Croatia. Proceedings of the 21th International Congress IUGB. "Forests and wildlife towards the 21th Century", Part 1: pp. 287-292. Halifax, Canada (I.D.Thompson, editor).

JACOBSON, S.K. / MCDUFF, M.D. (1998) Training idiot savants: the lack of human dimensions in conservation biology. Conservation Biology 12(2): pp. 263-267.

KORENJAK, A. (1995) Človek in velike zveri v Avstriji in Sloveniji. Javnomnenjska raziskava o medvedu, volku in risu kot ocena možnosti varstva problematičnih živalskih vrst. Diplomska naloga: 74 pp. Univerza v Ljubljani. Oddelek za gozdarstvo Biotehniške fakultete. Ljubljana 1995

MECH, L.D. (1995) The challenge and opportunity of recovering wolf populations. Conservation Biology 9(2): pp. 270- 278.

NOSS, R.F. / QUIGLEY, H.B. / HORNOCKER, M.G. / MERRILL, T. / PAQUET, P.C. (1996) Conservation biology and carnivore conservation in Rocky Mountains. Conservation Biology 10 (4): pp. 949-963.

OPPDAM, P. (1990) Understanding the ecology of populations in fragmented landscapes. Transactions of 19th Congress IUGB, Trondheim 1989, Vol.2: pp. 373-380. NINA Trondheim 1990.

PULLIAM, H.R. / DANIELSON, B.J. (1991) Sources, sinks and habitat selection: a landscape perspective on population dynamics. American Naturalist 137, Supplement: pp. (50-66).

STAND DYNAMICS OF THE VIRGIN FOREST RAJHENAVSKI ROG (SLOVENIA) DURING THE PAST CENTURY

by Andrej BONČINA*

ABSTRACT

The paper concerns developmental features of the virgin forest Rajhenavski Rog forest stands during the past hundred years. The study is based on the first data on forests from 1893, full callipering of forest stands in the period 1957-1995, stand inventories carried out in selected permanent sample plots, and maps of horizontal structure of the virgin forest made in 1985 and in 1995. The contention about the alternation of dominant tree species, silver fir and European beech, was confirmed. The proportion of silver fir in the growing stock was the lowest in 1893 (27%) and the highest in 1967 (61%). It fell to 57% by 1995, and all indices suggest a further decrease in the future. During the period analysed, d.b.h. structure of forest stands changed as well. This shows that the virgin forest is not a static system, although the growing stock remained practically unaltered during this period (800m^3/ha). An analysis of changes in the horizontal structure of virgin forest stands over a decade shows that the proportion of the optimal stage was decreasing while the proportion of the terminal and juvenile stage was increasing. Developmental dynamics of individual stands depends on tree species composition.

INTRODUCTION

Virgin forest relicts are of many-sided significance. They are perfect for studying the natural structure of a forest and its processes. The main questions related to such a study are: How does a virgin forest function? How it is preserved although it is subject to changes? Which are the important organisational principles? Permanent sample plots and stand inventories conducted over a longer period of time give us an insight into developmental processes. Virgin forest relicts are systems which are relatively more closed and less disturbed than managed forests. Nonetheless, they too are affected by atmospheric pollution, populations of big herbivores, tourism and other factors. Areas they occupy are definitely not large enough for a 'pre-biocoenosis' of animal and plant species to be established, therefore they are better referred to as virgin forest relicts.

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In Slovenia there are approximately 200 forest reserves, including some virgin forest reserves, most of which are situated in the Kočevje region: Krokar, Virgin forest Rajhenavski Rog, Prelesnik's sinkhole, Strmec. The best known among them is the Virgin forest Rajhenavski Rog, in which most stand inventories and studies were carried out. In the first forest management plans for these forests (HUFNAGEL 1893), the virgin forest Rajhenavski Rog was neither protected nor referred to as a virgin forest. As a virgin forest it was first mentioned in 1904 (HUFNAGEL 1904) and the first stand inventory of the virgin forest with present borders (51.14 ha) was made in 1957 (DERBIŠ 1957). Later a number of inventories and studies were conducted. Full callipering was made in 1967, 1976, 1985 and 1995, phytocoenologic and pedological mapping and phytocoenologic studies were carried out (PUNCER 1980, PUNCER et al. 1974, MARINČEK et al. 1980), and studies on regeneration (VESELIČ 1980, BONČINA 1997), ornithofauna (PERUŠEK 1992), distribution of trees (CEDILNIK and KOTAR 1992, KOTAR 1993a, 1993b, BONČINA 1997), fungi (HOČEVAR et al. 1995), forest stand structure (HARTMAN 1984, 1987; MLINŠEK et al. 1980, BONČINA 1997) and biodiversity were made (BONČINA 1997).

In 1985 three permanent research plots with the total area of 1.91 hectares were set up by Mlinšek, and the first stand inventory was carried out. In the same year the patch pattern of the virgin forest was analysed and a map of developmental phases was made. Two years later a monograph on the virgin forest Rajhenavski Rog was published (HARTMAN 1987) within the framework of studies on forest reserves. In 1995 full callipering of the virgin forest was conducted and stands of the three permanent sample plots were again analysed, along with the horizontal structure of the whole virgin forest, and a map of developmental phases was made. Stand structure of different developmental stages was analysed in randomly selected plots, and diversity of plant species and regeneration of woody species were investigated.

AIM

The aim of this study was to determine developmental features of virgin forest stands. The approach was based on full callipering of the whole virgin forest carried out in the period 1957-1995, on data from 1893, on analyses of stands in permanent sample plots conducted in 1985 and 1995, and on analyses of horizontal structure of the virgin forest carried out in 1985 and 1995.

METHODS

Full callipering was carried out in 1957, 1967, 1976, 1985, and 1995. Trees were registered according to d.b.h. classes, the measurement threshold being 10 cm, in some years even 5 cm. Snags were also measured. Distinction was made between dead standing trees and dead lying trees. To calculate the growing stock, Čokl's tariff table was used, namely number 8 for conifers and number 9 for broadleaved trees (ČOKL 1992).

In permanent sample plots, all trees were measured and assessed according to the following: tree species, spatial co-ordinates of trees, diameter (mm), height (0.5 m), social status, vitality, developmental trend, size, crown coverage and shelter, etc. Methods used have been described in detail by HARTMAN (1987) and BONČINA (1997).

The patch pattern of the whole virgin forest (51.14 ha) was analysed in 1985 and 1995. Criteria for the mapping of developmental phases were similar but not quite identical, therefore changes in the patch pattern of virgin forest stands were analysed only in general. The following developmental phases were distinguished in the first analysis (HARTMAN 1987): optimal phase, optimal phase with regeneration, juvenile phase under shelter (stand re-initiation phase), juvenile phase without shelter (stand initiation phase), selection phase, initial terminal phase, and late terminal phase. In the second mapping (BONČINA 1995), we took account of research methods suggested by KORPEL (1995) and thus for each stand developmental phase and developmental stage (juvenile, optimal and terminal stage) were given. In comparison with results of the first mapping of horizontal structure, developmental phases used here are more useful. According to d.b.h. class, height structure of stands, crown shelter, and distribution of trees, we distinguished the following: stand initiation phase (juvenile phase), pole stand, young and late optimal phase, stand re-initiation phase, two-layered stand, selection phase, and gap.

RESULTS

A comparison of stand parameters

Tree species composition

Silver fir (*Abies alba*) and European beech (*Fagus sylvatica*) are the dominant tree species in the virgin forest Rajhenavski Rog. The proportion of these two species in the total growing stock is 99.5%. The remaining tree species are modestly represented. In the total area of the forest reserve encompassing 51.14 hectares we registered 20 Norway spruce trees, 89 mountain maple trees, 12 mountain elm trees and 14 lime trees. These tree species are natural elements of a Dinaric silver fir-European beech forest, but they are, in general, less competitive under conditions of a distinctly endogenous environment. The niche of these species is slightly larger gaps, which can occur on account of die-back of a group of trees from the upper position or due to the impact of abiotic factors. Disturbances that would lead to the formation of such gaps occur only rarely. Hence the proportion of tree species mentioned above is relatively low.

Over the past forty years the proportion of silver fir in the total growing stock of virgin forest stands has substantially decreased. A comparison of results of stand inventory made in 1957 and in 1967 shows a slight increase in its proportion in the total growing stock. Since 1967 the proportion of silver fir has steadily decreased. In 1967, during full callipering of the virgin forest, 176 silver fir trees with the growing stock of 513 m^3 were recorded in the area of one hectare, while in the last stand inventory only 118 silver fir trees with the growing stock of 458 m^3 were recorded. Over a period of thirty years, then, the proportion of silver fir in the total growing stock fell from 64% to 57%, and in the total number of trees from 59% to 47%.

The analysis of stand development over a relatively short period of time substantiates changes in tree species composition of virgin forest stands. The first data on stands under consideration were found in the forest management plan for the area of Rog from 1893. According to this plan, the present virgin forest was part of a larger forest compartment,

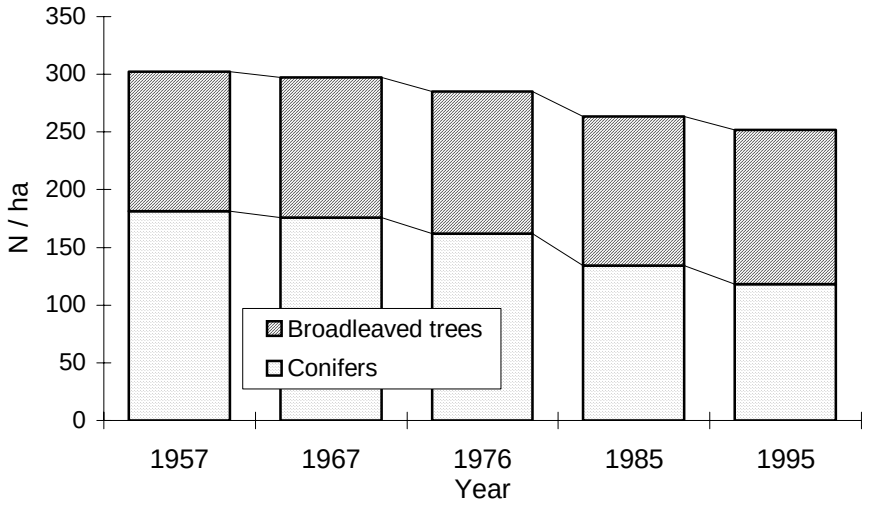
in which silver fir accounted for a mere 27.5%. Thus the present proportion of silver fir is much higher than that some hundred years ago.

The comparison must be considered with certain reservations:

- the area of the forest compartment was 89.35 hectares, thus almost twice as large as the current area of the virgin forest;
- stand parameters were determined with the use of sample methods;
- growing stock values determined are relatively low, since trees with d.b.h. of over 80 cm were not taken into account. The growing stock of the compartment, which included the present virgin forest, was 467 m^3/ha.
- anthropogenic influences on the virgin forest have not been substantiated, but they are possible due to the relative vicinity of the sawmill Rog. In the fringe area of the virgin forest a dead lying silver fir tree was found, probably some decades old, which must have been cut with a saw, judging from the shape of the front surface.

Although tree species composition, which was established a hundred years ago, is only a rough approximation, the results verify the assumption that tree species composition of the virgin forest has substantially changed over the past hundred years. A more detailed d.b.h. structure of conifers and broadleaved trees supports the contention about the alternation of tree species.

Figure 1: The ratio between broadleaved trees and conifers in the total number of trees of the virgin forest Rajhenavski Rog in the period 1957-1995



Growing stock

The growing stock of virgin forest stands has remained practically unchanged over the past forty years. Between the first full callipering in 1957 and the last, the change was insignificant. Therefore we could assume that virgin forest stands are in the state of equilibrium, which means that the increment of trees equals the quantity of dead trees. Growing stock, however, is not the most appropriate stand parameter for the description of developmental processes in virgin forest stands. Although tree species composition of virgin forest stands, d.b.h. structure and the proportion of individual developmental phases of the virgin forest changed considerably during the analysed period, the growing stock remained relatively constant in the total area, though it changed substantially in a smaller area.

Table 1: The growing stock of the virgin forest Rajhenavski Rog in the period 1957 - 1995

Year	1957	1967	1976	1985	1995
Growing stock (m^3/ha)	783	803	802	799	798

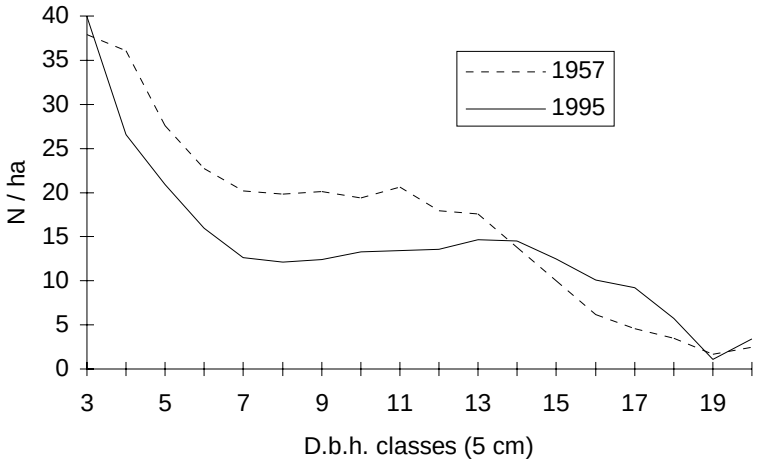
D.b.h. structure

D.b.h. structure is a stand parameter which clearly shows, along with tree species composition, developmental features of virgin forest stands. During the period 1957-1995, d.b.h. structure of stands changed substantially in the 51-hectare area of the virgin forest. Changes that relate to the life cycle of trees and stands are congruent with changes determined in the horizontal structure of virgin forest stands. The structure and functioning of virgin forest stands are also influenced by exterior factors. Silver fir decline, then, is attributed to pollution, while the efficiency of spontaneous regeneration of stands is adversely affected by big ungulate herbivores.

The most characteristic changes in d.b.h. structure of stands during the period 1957-1995 are as follows: lower density of trees, lower number of medium-size diameter trees, a slightly higher number of large diameter trees. Recently, however, the number of young, small diameter trees has risen, exclusively European beech trees.

These changes indicate that virgin forest stands are not in the state of equilibrium, at least not in such a small area as is the analysed virgin forest. Differences established for d.b.h. structure of stands suggest ageing of stands, as the study by HARTMAN (1987) has already shown, and also decaying of stands, which will be even more distinct in the future.

Figure 2: D.b.h. structure of stands in the virgin forest Rajhenavski Rog in 1957 and 1995



The analysis of d.b.h. structure of silver fir and European beech complements the insight into developmental processes of virgin forest stands. Considerable changes were found in silver fir population. Over the period of forty years the number of small diameter trees fell nearly by half. The number of medium-size diameter trees was also substantially reduced. In an area of one hectare only two silver fir trees of the second d.b.h. class were found. Such considerable changes in d.b.h. structure of silver fir (Figure 3, Table 2) cannot be attributed either to influences of abiotic factors or to endogenous processes, such as die-back of trees due to competition, or to the impact of biotic factors and the like. This change in d.b.h. structure could be at least partly the result of a phenomenon which is referred to as silver fir decline. The reasons for the occurrence of this phenomenon have not yet been satisfactorily explained.

A study on regeneration (BONČINA 1997) shows that silver fir does regenerate but it does not grow higher than 0.5 m, due to the influence of herbivores. The vitality of silver fir trees analysed in permanent sample plots (Appendix A, Table 6) is considerably lower than that of European beech. Thus we believe that silver fir decline will continue in the future. A high proportion of large diameter silver fir trees (Appendix B, Table 7) in the total growing stock seems to be sustained, but in the future it will decrease for reasons mentioned above.

In the following decades in the next century, tree species composition will be very much in favour of European beech stands. The proportion of silver fir will definitely fall. Where it will stabilise, it is uncertain. This depends largely on survival of medium-size diameter silver fir trees and regeneration and ingrowth of young silver fir trees.

To understand the alternation of the two main tree species and changes in d.b.h. structure, it is vital to gain an insight into the past development. A hundred years ago, d.b.h. structure of the compartment, which included the current virgin forest, was quite different. There were relatively few large diameter silver fir trees, but there were three

times as many small diameter trees (15-30 cm) as today and about twice as many deciduous trees (European beech) of the same diameter during the same period. Figure 3 and Table 2 show the ageing process of silver fir population in virgin forest stands. The main question is whether the resumption of silver fir ingrowth in silver fir-European beech forests can be expected.

Figure 3: D.b.h. structure of silver fir and European beech population in 1957 and in 1995

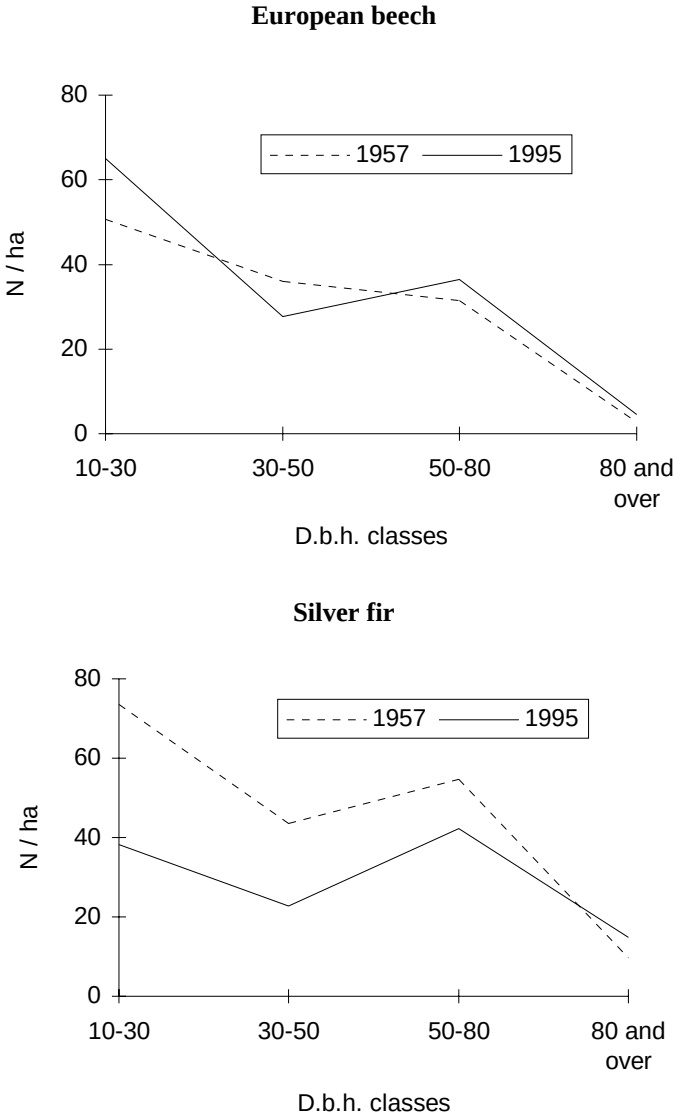


Table 2: D.b.h. structure of stands expressed in number of trees per hectare according to d.b.h. classes in 1893, 1957 and in 1995

	Conifers			Broadleaved trees		
D.b.h. classes (cm)	1893	1957	1995	1893	1957	1995
15-30	89	53	29	49	33	35
30-50	58	44	23	61	36	28
50-80	13	55	42	56	32	36
80 and over	*	10	15	*	3	5

* Data not available

A rise in the proportion of small diameter trees is the most noticeable change in d.b.h. structure of European beech population during the period 1957-1995. Also, the analysis of trees with a diameter below the measurement threshold shows that European beech has been spreading rapidly. European beech also efficiently regenerates and, in comparison to other tree species, its height growth is the most efficient and undisturbed of all (BONČINA 1997). Consequently, we believe that the number of young European beech trees will further increase in the next decades. Arguments for the alternation of tree species are supported by data on d.b.h. structure of European beech from a hundred years ago (HUFNAGEL 1893). At that time European beech was the dominant species of the virgin forest. Silver fir was in a subordinate position, prevailing in the lower position, but there were about twice as many large diameter European beech trees as today.

Horizontal structure of the virgin forest

Variability of stands may be mainly attributed to different distribution of subjects of different tree species, different height, different crown form and the like. Due to growth and die-back of trees, there are constant changes in stand structure. An element of horizontal structure or of the patch pattern of a forest (HILGARTER 1971; KORPEL 1993, 1995) can be referred to as a patch (BONČINA 1997). This element differs from its surrounding area according to selected criteria. Homogeneity within a patch is much higher than that between patches.

A patch can be a stand or part of a stand (grove, group). In such analyses of horizontal structure, two main issues are addressed, namely, determination of stands (patches) and classification of types, phases, stages, etc. (BONČINA 1997, 1998). It is characteristic of virgin forest stand structure that boundaries between individual stands are not clear-cut, only rarely are they distinct. In addition, variability of stands (patches) of the same kind is relatively high.

Conditions in which virgin forests under consideration grow are not distinguished by natural disasters, which would trigger off cyclic development of stands or even secondary succession in a large area, where stands would contain trees of a single generation. In general, die-back of an individual tree or of a group of trees sets off cyclic development in

a very small area. This is the reason why cyclic development is less distinct and less obvious in a virgin forest than in a managed forest (OTTO 1994; BONČINA 1997).

The main criterion for determining an individual patch (stands) is developmental phase. Therefore we used developmental phases to denote a stand type. In studies on virgin forests different methods are suggested for a patch pattern analysis. A virgin forest is classified into stand types, life phases, developmental phases or developmental stages. Different concepts are used but the aim is similar, if not the same, that is, to describe at one's best, under given natural conditions, diversity of forest stands and, above all, to show their development. The mapping of developmental phases of a virgin forest is easier if stands of optimal stage prevail, whereas stages of decay and juvenile stages are more demanding, since stand structure changes more rapidly. Spatial structure of a forest does not depend only on forest stand structure, but also on spatial scale employed for the analysis of a virgin forest and criteria used, which in turn depend on the intent of a study. Thus, maps of developmental phases are only an approximate description of different stands and mainly an aid for understanding the structure of stands and their developmental dynamics.

An analysis of the patch pattern of a virgin forest is based on methodology developed by LEIBUNDGUT (1959, 1982), MLINŠEK (1980), and KORPEL (1993, 1995). We divided the developmental cycle of a virgin forest stand into three stages - juvenile, optimal and decaying. Stands (or patches) at different developmental phases were classified in individual stages. The optimal stage is distinguished by a high growing stock, high crown density, and, in most cases, a uniform stand structure. The decaying stage is characterised by intensive die-back of trees in the upper layer, hence crown closure is full of gaps. The growing stock of such stands is decreasing, the quantity of dead trees is high, and stand structure is often uneven or it consists of different layers. The juvenile stage is distinguished by an increase in volume increment of a new generation of trees, whose ingrowth is intensive, and by a decrease in the number of trees of previous generations. Stands of juvenile and decaying stages are often interlinked. If the growing stock of the new generation trees is higher than that of the previous generation, the stand is classed as juvenile stage. Different stages were assessed in the field but they could have been determined objectively only with measurements and a study of the development of stands during a certain period.

Table 3: A list and the proportion of developmental stages and developmental phases in the virgin forest Rajhenavski Rog in 1995 (BONČINA 1997)

Developmental stage	Developmental phases
Juvenile stage (12%):	Stand initiation phase, two-layered stands, selection phase
Optimal stage(52%):	Optimal phase, late optimal phase
Terminal stage (36%):	Stand re-initiation phase, selection phase, two-layered stands, gaps

In the first mapping of horizontal structure of virgin forest stands, stands were classified according to developmental phases (MLINŠEK et al. 1980, HARTMAN 1987). Results of

this mapping show that optimal phase accounts for 52% of the total area, optimal phase with regeneration 17%, selection phase 3%, terminal phase 3%, juvenile phase without shelter 9%, and juvenile phase under shelter 16% of the total area (HARTMAN 1987). As early as then efforts were made to find the most appropriate "developmental phases" for the description of different kinds of stand structure. The maps of developmental phases are congruent with one another as to content, although they were made quite independently.

Table 4: A comparison of horizontal structure of the virgin forest Rajhenavski Rog in 1985 and 1995

Year 1985 (HARTMAN 1987)		Year 1995 (BONČINA 1997)	
Developmental phases	% of total area	Developmental phases	% of total area
Stand initiation phase	9	Stand initiation phase	2
Optimal phase and optimal phase with regeneration	69	Young and late optimal phase	52
Stand re-initiation phase	16	Stand re-initiation phase	19
Selection phase	3	Selection and two layered stands	26
Terminal phase	3	-	
-		Gaps	1

Despite justified objections to the mapping of virgin forest stands (BONČINA 1997; 1998; BONČINA / DIACI 1998), it is evident that (1) the structure of individual stands in the virgin forest Rajhenavski Rog differs, that (2) horizontal structure differs from that in other analysed virgin forests in Slovenia, for instance Krokar, and that (3) horizontal structure of the virgin forest Rajhenavski Rog changed over a period of ten years. For the proportion of the optimal stage was reduced by about 17%, while the proportion of selection phase and two-layered stands, which were classed as the juvenile or decaying stage, increased by as much. Changes in horizontal structure of the virgin forest established for over a relatively short period of ten years, are in keeping with changes in d.b.h. structure of a virgin forest and with an analysis of dead trees (BONČINA 1997).

When patches of horizontal structure of the virgin forest were mapped, tree species composition was given for each patch and it was established that developmental stages correlate with tree species composition. In optimal stages European beech is dominant, especially in the young optimal phase in the south part of the virgin forest, where stands are not expected to decay soon. In stands of the terminal and juvenile stage and in some stands of the late optimal phase, silver fir dominates in the growing stock. Consequently, it is expected that these stands will continue to decay and that the area of the optimal stage will further decrease in the coming decades.

Cyclic development of virgin forest stands varies. There is not only one type of development. Yet some types are more common than others and thus slightly more probable that others. Silver fir decline is the reason for considerable changes in stand

structure and in intensive developmental dynamics of the virgin forest. Stand dynamics depends on the proportion of silver fir in the growing stock of a stand, its distribution and intensity of die-back. The following examples are illustrative (BONČINA 1997):

- if a silver fir tree dies in a stand of the young optimal phase, then remaining trees, European beech in particular, fill in the vacant space with crown growth. There are fewer trees but they have larger crowns.
- if the proportion of silver fir is high and it dies uniformly in the area, two-layered stands are formed, and European beech occupies the lower position;
- if silver fir trees die one after another or in small clusters unevenly in an area, stand structure is selection,
- if the proportion of silver fir is high and trees die intensively, then regenerating stands and young uniform European beech stands are formed.

Individual stand structure is dependent on a given tree species composition. Thus the top layer of two-layered stands consists almost exclusively of silver fir and the lower layer of European beech. Similarly, selection stand structure depends on the appropriate share of silver fir or its die-back. The proportion of European beech in the growing stock will increase more and more, and therefore stand structure will change as well.

CONCLUSIONS

Findings of studies on virgin forest stands contribute to our understanding of the structure and developmental processes of forest ecosystems. At the same time they give us information which is useful for close-to-nature forest management. The following should be underlined in particular:

1. The structure of virgin forest stands is not constant, unchanging or in the state of balance. We speak about certain intervals, within which stand structure changes.
2. A comparison of d.b.h. structure shows that stands in the virgin forest Rajhenavski Rog are ageing, since the proportion of large diameter trees has increased, the density of trees has decreased and, above all, the number of medium-size diameter trees has fallen. Recently, stands have been regenerating intensively, which results in a higher number of trees of the second d.b.h. class, (5 - 10 cm).
3. The development of the dominant tree species, silver fir and European beech, is not parallel, quite the opposite. About a hundred years ago the proportion of silver fir in the total growing stock accounted for a mere 27%. The available data suggest the commencement of intensive regeneration of silver fir during that time and a bit earlier and its gradual ingrowth in the stand canopy, in which European beech dominated. The proportion of silver fir in the total growing stock was rising till 1967 when it gradually started to decrease. All indices suggest that the proportion of silver fir will decrease further in the next decades. The current state, which is just the opposite of that a hundred years ago, is distinguished by intensive ingrowth of European beech in the stand canopy, where silver fir still dominates in the growing stock.

4. Despite considerable developmental changes, which are also reflected in the altered d.b.h. structure and tree species composition, the growing stock remains practically unchanged. The average quantity of stemwood is approximately 800 m^3/ha.
5. Results of the study support the assumption about the alternation of the two main tree species, silver fir and European beech. This is undoubtedly a natural process, which may have been affected by anthropogenic factors such as anthropogenically induced changes in wildlife population, pollution and other global factors. Forest ecosystems respond to all impacts at the same time. Therefore, we cannot really appraise the extent to which the alternation of tree species is a natural or an anthropogenic process. We must be aware that a natural forest ecosystem is not a static system, which could be determined on the basis of certain tree species composition, structure and the like, but it is a dynamic and complex system. Different species, including dominant species, may use resources equivalently in stable natural conditions (WHITTAKER 1985). This observation is important for our understanding of natural structure and composition of forest stands (ecosystems). It is perfectly natural that tree species composition changes and that stands with different tree species composition and structure can grow under similar site conditions. Certain types of composition and structure of stands are thus just more probable than others, but the latter are not less natural.
6. The results of the study and their interpretation are affected by the given spatial framework, within which the study was conducted. Therefore, any excessive generalisation would be amiss. Any spatial scale represents a new quality, which interferes with our understanding of forest ecosystems. We found that the total growing stock of stands remained unchanged in the total area of the virgin forest. If the area of the virgin forest was smaller, we would certainly have found considerable changes in the growing stock of stands during the period analysed. Horizontal and d.b.h. structure of forest stands, however, is a different matter, since both of them changed substantially during the period under consideration. The area of the virgin forest (51 hectares) is obviously not large enough for such a balance to be established. And again we can assume that our conclusions about d.b.h. and horizontal structure of forest stands would have been different if the area of the virgin forest analysed had been larger. Changes in tree species composition, however, could be regarded as a phenomenon that can be observed in the whole area of Slovenia's Dinaric silver fir-European beech forests as well as in the analysed virgin forest.

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REFERENCES

BONČINA, A. (1997) Naravne strukture gozda in njihove funkcije pri sonaravnem gospodarjenju z gozdom (Natural forest structures and their functions in close-to-nature forest management), Doktorska disertacija, BF, Oddelek za gozdarstvo, Ljubljana, 210 pp.

BONČINA, A. (1998) Research of structure and biodiversity in managed and virgin fir-beech forest in Dinaric region of Slovenia. Deutscher Verband forstlicher Forschungsanstalten, Sektion forstliche Biometrie und Informatik, 11. Tagung, Freiburg (in print).

BONČINA, A. / DIACI, J. (1998). Contemporary research on regeneration pattern of Central European virgin forests with recommendation for the future research. Zbornik gozdarstva in lesarstva, 56, Ljubljana, pp. 33-53.

CEDILNIK, A. / KOTAR, M. (1992) Razmestitev dreves v sestoju. Zbornik gozdarstva in lesarstva, 40, Ljubljana, pp.15-40.

ČOKL, M. edt. (1992) Gozdarski priročnik. Tablice, 6. izdaja. Biotehniška fakulteta, Oddelek za gozdarstvo.

DERBIŠ, M. (1957) Pragozd v Kočevskem Rogu. Diplomsko delo. Biotehniška fakulteta, Oddelek za gozdarstvo, Ljubljana, 46 pp.

GAŠPERŠIČ, F. (1974) Zakonitosti naravnega pomlajevanja jelovo-bukovih gozdov na visokem krasu snežniško-javorniškega masiva. Strokovna in znanstvena dela, BTF, Inštitut za gozdno in lesno gospodarstvo, Ljubljana, 133 pp.

HARTMAN, T. (1984) Razvojna dogajanja v pragozdu Rajhenavski Rog. GozdV 42, 6, pp. 253-258.

HARTMAN, T. (1987) Pragozd Rajhenavski Rog. Strokovna in znanstvena dela, 89. BTF, Oddelek za gozdarstvo, Ljubljana, 80 pp.

HILLGARTER, F.W. (1971) Waldbauliche und ertragskundliche Untersuchungen im subalpinen Fichtenurwald Scatle/Briegels. Zürich, 80 pp.

HOČEVAR, S. / BATIČ, F. / PISKERNIK, M. / MARTINČIČ, A. (1995) Glive v pragozdovih Slovenije. 3. Dinarski gorski pragozdovi na Kočevskem in v Trnovskem gozdu. Strokovna in znanstvena dela, 117, Gozdarski inštitut Slovenije, 320 pp.

HUFNAGEL, L. (1893) Wirtschaftsplan der Betriebsklasse III. Hornwald.

HUFNAGEL, L. (1904) Wirtschaftsplan der Betriebsklasse III. Hornwald.

KORPEL, Š. (1993) Vorkommen, Charakteristik und Folge der Enwicklungsstadien, -phasen in der europäischen Urwäldern. Symposium über die Urwälder, (Saniga, M. & Korpel, Š. edts.) Forstliche Fakultät der technischen Universität Zvolen, pp. 3-10.

KORPEL, Š. (1995) Die Urwälder der Westkarpaten. Gustav Fischer Verlag, Stuttgart, 310 pp.

KOTAR, M. (1993a) Določanje načina razmestitve dreves v optimalni razvojni fazi gozda. Zbornik gozdarstva in lesarstva, 42, Ljubljana, pp. 121-153.

KOTAR, M. (1993b) Verteilungsmuster der Bäume in einer Optimalphase im Urwald. Symposium über die Urwälder, (Saniga, M. & Korpel, Š. edts.) Forstliche Fakultät der technischen Universität Zvolen, pp. 27-44.

LEIBUNDGUT, H. (1982) Europäische Urwälder der Bergstufe. Verlag Paul Haupt, Bern und Stuttgart, 306 pp.

LEIBUNDGUT, H. (1959) Über Zweck und Methodik der Struktur- und Zuwachsanalyse von Urwäldern. Schweiz. Zeitschr. f. Forstwesen, 110 Jg., Nr.3, pp. 111-124.

MARINČEK, L. / PUNCER, I. / ZUPANČIČ M. (1980) Die floristischen und strukturellen Unterschiede zwischen dem Urwald und dem Wirtscahftswald der Gesellschaft Abieti-Fagetum dinaricum.

Bericht über das internationale Symposion der Internationalen Vereinigung für Vegetationskunde in Rinteln, Vaduz, pp. 249-263.

MLINŠEK, D. et al. (1980) Gozdni rezervati v Sloveniji. Inštitut za gozdno in lesno gospodarstvo Biotehniške fakultetev Ljubljani, 414 pp.

MLINŠEK, D. (1989) Pra-gozd v naši krajini. Ljubljana, 157 pp.

OTTO, H.J. (1994) Waldökologie, pp. 391. Verlag Ulmer, Stuttgart.

PERUŠEK, M. (1992) Ptice pragozdnih ostankov Rajhenavski Rog in Pečka ter njihova odvisnost od stanja sestojev. Gozdarski vestnik 7-8, Ljubljana, pp. 322-330.

PUNCER, I. (1980) Dinarski jelovo-bukovi gozdovi na Kočevskem. SAZU. Razprave, 22, 6, 161 pp.

PUNCER, I. / WOJTERSKI, T. / ZUPANČIČ, M. (1974) Der Urwald Kočevski Rog in Slowenien. Fragmenta floristica et geobotanica, 20, 1, pp. 41-87.

VESELIČ, Ž. (1980) Analiza poškodovanosti gozdnega mladja po divjadi v pragozdnem rezervatu Rajhenavski Rog na Kočevskem. Postojna, tipkopis.

WHITTAKER, R.H. (1975) Communities and ecosystems. Macmillan Publishing Co.,Inc., New York, 385 pp.

Appendix A

Table 5: Stem wood (V-m^3/ha) and the number (N-n/ha) of dead standing and dead lying trees at different developmental phases of the virgin forest (BONČINA 1997)

Developmental phases	Life trees			Dead trees		
	V	N	Proportion of silver fir (%V)	V	N	Proportion of silver fir (%V)
Young optimal phase	1066	378	0.15	113	130	0.62
Late optimal phase	917	266	0.54	323	142	0.76
Stand re-initiation phase	942	241	0.52	474	134	0.77
Selection phase	720	259	0.53	165	89	0.40
Two-layered stand	977	289	0.99	316	104	0.58

Table 6: Vitality of trees in research plots expressed in the proportion of the growing stock (%) according to vitality classes (size sample is 1083 trees with the total growing stock of 2700 m^3 (BONČINA 1997)

VITALITY	European beech	Silver fir	Total
Very vital	1	2	2
Vital	57	35	45
Poorly vital	25	53	40
Non vital	13	10	11
Hardly alive	4	1	2

Appendix B

Table 7: D.b.h. structure of conifers and broadleaved trees in stands of the virgin forest Rajhenavski Rog in the years 1957, 1967, 1976, 1985 (HARTMAN 1987) and 1995
Basis: full callipering, values calculated per hectare

D.b.h	Year 1957		Year 1967		Year 1976		Year 1985		Year 1995	
classes	Con	Broad	Con	Broad	Con	Broad	Con	Broad	Con	Broad
2	*	*	*	*	6.1	37.8	4.3	87.0	2.0	*
3	20.2	17.7	17.8	19.7	15.0	20.8	12.4	27.4	9.3	30.6
4	22.4	13.7	21.5	14.8	20.0	17.4	12.8	15.5	10.9	15.7
5	17.6	10.0	18.0	10.2	16.3	12.4	10.9	9.6	10.0	10.9
6	13.4	9.3	11.9	8.0	10.4	6.8	8.3	7.8	8.1	7.9
7	11.7	8.5	10.4	7.7	9.5	7.2	7.9	6.8	6.0	6.6
8	10.6	9.2	9.2	8.4	8.1	7.2	6.1	6.7	5.6	6.5
9	10.6	9.5	10.0	8.7	8.3	7.6	7.2	7.5	5.5	6.9
10	10.6	8.8	9.9	9.1	8.7	7.8	7.4	7.7	5.7	7.6
11	11.5	9.1	10.5	9.0	10.1	8.1	7.3	8.4	6.1	7.3
12	11.2	6.7	10.8	6.9	10.5	8.1	8.2	8.2	6.2	7.4
13	11.2	6.4	10.7	6.0	8.5	5.4	9.7	6.9	8.0	6.7
14	9.2	4.6	9.7	5.0	10.5	5.8	9.0	6.2	8.0	6.5
15	7.1	2.9	9.4	3.4	7.1	3.6	7.6	3.9	7.7	4.8
16	4.4	1.8	5.1	1.7	5.9	1.9	7.1	3.7	6.3	3.8
17	3.4	1.2	3.9	1.1	4.5	1.3	4.0	1.3	6.5	2.7
18	2.8	0.7	3.3	0.7	3.9	0.8	2.8	0.7	4.3	1.4
19	1.3	0.4	1.5	0.4	1.7	0.4	1.3	0.2	1.0	0.1
20	2.1	0.4	2.4	0.4	3.0	0.4	4.5	0.7	3.0	0.4
Total	181.3	120.9	176.0	121.2	162.0	123.0	134.5	129.2	118.2	133.8

* Data not available

HUNDRED YEARS OF VIRGIN FOREST CONSERVATION IN SLOVENIA

by Tomaž HARTMAN *

ABSTRACT

A Virgin forest - a mighty forest cathedral - is a precious natural heritage. Nowadays, at the time of human and environmental crises, a virgin forest besides other things represents a scientific workshop of great interest. It guards some ancient but well verified messages on stability, security and survival harmony.

The primeval forests in the Kočevje region, which were established and preserved a hundred years ago (among the first ones in Europe), are the outposts of today's numerous natural reserves in Slovenia.

INTRODUCTION

»Die Abteilungen 38 u. 39 sollen als Urwald bewahrt bleiben, daher ist hier jedwede Nutzung ausgeschlossen.«

»Compartments 38 and 39 have to be preserved as a virgin forest. Any use of them is therefore excluded«.

> (From the first forest management plan: Herzogtum Gottschee, Wirtschaftsplan der Betriebsklasse I. Goettenitzer Gebirge, Gueltig vom 1. Jänner 1892.)

The above 'short' remark helped to conserve (among the first in Europe!) the precious natural heritage in the middle of vast virgin forests of the Kočevje region one hundred years ago.

The first incentive to conserve the virgin forests is attributed to Dr. Leopold Hufnagel, at that time the central administrator of Count Auersperg's estates. Dr. Hufnagel made an extensive 'economic plan' in 1892 thanks to Count Auersperg's economic rationality and the regulations passed by the forestry administration in 1886, by which all large forest estates had to be utilised according to forest management plans, securing sustained yield. As a whole, the plan was an extraordinary work since it established naturalistic selective

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management for high-karst fir-beech forests - contrary to European clear-cutting practised professionally in those days.

THE DEFINITION OF A VIRGIN FOREST

'A virgin forest is such a forest association, which is by its plant structure, composition and growth, a closed climatic development unit (climax) and has remained absolutely unaffected by any human influence. A virgin forest of such a type is a genuine virgin forest, and according to this definition it reflects the last well established gentle balance between vegetation, climate and soil.

Wherever the activity of management (pasture, temporary wood exploitation and others) can be traced, either in recent centuries or far back, then we talk of a secondary or nongenuine virgin forest. If man interfered with a virgin forest, and has cut a tree here and there, where traces of this influence can still be seen, then we talk of a forest with virgin forest character' (WRABER 1952).

So demanding is the professional definition of a virgin forest. There are only over a dozen virgin forests left in Slovenia - i.e. forests with a virgin forest character. These are small areas which have not remained completely untouched. Polluted air, acid rain, copious game, and visitors disturb the natural development. According to the above mentioned our virgin forests are in fact secondary virgin forests. Though these remote forest areas have preserved the original spirit of nature, quietly putting through its laws over millennia. In the eternal succession of birth and death, life has been bound to a solid and sound system. Nothing here is considered to be bad or good, neither useful nor harmful. Everything that exists in a virgin forest is moderately regenerating, yet constantly and safely.

It is possible that one might be disappointed by openness and accessibility of Slovenian virgin forests. Certainly these are not impassable tropical virgin forests, nevertheless they are interesting.

VIRGIN FORESTS OF THE KOČEVJE REGION

Vast forests of the Kočevje region on the ridges of the Gotenica mountain, Stojna and Rog were inaccessible virgin forests until recently. As late as one century ago this remote wilderness encountered the first cuttings, cart tracks were laid down, the Rog saw mill was built, and several kilometres of a forest railway was laid down. Traces of the first inhabitants have almost been erased by now, yet strong and vital fir and beech forests have remained. The rest of the virgin forests, which have been conserved until the present day, represents precious natural heritage.

The mountain Borovška gora, with picturesque rock faces above the Kolpa river, hides the little known **Krokar virgin forest**. The rolling karst plateau is primarily covered with beech forest.

The Strmec virgin forest is located at the southern slope of Stojna. The virgin forest fragment of a fir-beech forest is picturesque due to considerable addition of maple and spruce trees.

The famous karst sink at the foothills of Rog - known as **Prelesnikova koliševka** - boasts due to temperature inversion - a frost locality at the bottom - a primeval spruce forest and rich flora, which would otherwise be found in a cold mountain climate or far to the North.

On the eastern slope of the summit Kopa in Rog, a smaller primeval Dinaric maple-beech forest - **the Kopa virgin forest** - can be found.

The virgin forests Pečka and Rajhenavski Rog are magnificent fortresses of fir and beech; at the same time they are the best explored and most visited forest reserves in Rog.

THE VIRGIN FOREST RAJHENAVSKI ROG

The virgin forest Rajhenavski Rog is situate in the middle of Kočevski Rog, 1 km south of the former Rog saw mill, on the rolling high-karst plateau, with numerous sinkholes, at an altitude of 870-920 m above sea level; the prevailing exposition is N and S.

Cretaceous limestone forms the bedrock, the soil is brown post-Carboniferous - varying from shallow to deep at the bottom of sinkholes. The main vegetation association is Abieti-Fagetum dinaricum - a Dinaric fir and beech forest.

As to their heights, the stands are pretty uniform, of much the same height yet not even-aged; from the stand canopy, formed by a mass of beech and fir trees of 30-40 m, individual fir trees protrude, exceeding the beech by 10 m. Only few spruce trees, maples, elms and limes can be found in the stands. It is obvious that there - in the virgin forest climate and growth - only fir and beech are competitive.

As to timber quantity, fir prevails. In total there are 251 vital trees per hectare of 10 cm and above in diameter; 118 fir trees - 47 %, and 133 beech trees - 53 %. There are 788 m^3 of vital timber mass per hectare there, 449 m^3 of fir - 57 %, 339 m^3 of beech - 43 % per hectare.

There are 88 dry fir trees (212 m^3) and 21 dry beech trees (72 m^3) per hectare, which can still be measured.

The total timber supply of all trees in the virgin forest - vital and dry - amounts to 1072 m^3 per hectare.

The virgin forest of fir and beech has been growing here over millennia - since the last glacial period. A long life is another characteristic of virgin forest trees, 500-year-old giant trees are no rarity here. Trees are high and thick, reaching up to 50 m and have over 1.5 m in diameter. Undoubtedly, for this association a huge timber quantity is the major weapon in its struggle for survival. A single tree can have up to 50 tons of timber matter. It is possible to establish up to 2000 t of timber per hectare in these virgin forests. This stored energy is alleviating extreme oscillations - e.g. temperature, humidity, biomass, etc. A virgin forest creates its own internal environment.

In a virgin forest trees wither individually; young growth of beech immediately fills up stand gaps like plaster. The fir asserts itself individually among young growth of beech; it is possible to endure in shadow. The waiting that can last a century, and seems extremely long to man, represents a constituent part of life for a fir, perhaps a condition for it to grow into a strong tree.

Under the shelter of mature trees a new life emerges in a virgin forest. This shelter offers to young plants safety against snow, sleet, cold..., and represents a screen against light. In such conditions only the most vital trees can survive and thrive.

Despite monolithic appearance, a virgin forest is variegated. In small areas three developmental phases are interwoven all the time; the regeneration phase, the mature phase, and the ageing phase. Spatial distribution of developmental phases, as well as the ratio between them, change. The proportion of the mature, optimal phase- in its full strength and stability, providing the forest safety and firmness - is always prevailing.

The role of dead trees in a virgin forest is quite special. A new microcosm emerges in slowly decaying stems - a home and a rich table for numerous organisms like fungi, birds, etc. which represent an important part of the ecosystem. A dry fir tree becomes more alive (with micro-organisms) than it used to be when it was still a green vital tree.

A virgin forest environment becomes more and more important, with all the accuracy typical of the evolution processes. It is ready for natural 'unpredictabilities', yet not for human influences - polluted air, acid rain and copious game. The automatism and permanence of one of the most stable natural formations has become severely endangered.

FOREST RESERVES IN SLOVENIA

Most of the virgin forest reserves in Slovenia have been conserved in high karst plateaus where fir and beech grow. Foresters - for whom natural forests are laboratories - have spread the net of forest reserves throughout Slovenia.

The lowland forests (in Prekmurje, on the Karst) have also been left to natural development as well. Apart from the virgin forests, between the years 1970 - 1980, 170 new forest reserves have been protected, 9000 hectares in total. According to the project, which started in 1997, a total of 236 forest reserves are previewed, covering the area of 14,416 hectares. Regarding forest reserves the markings are unified. Blue colour marks the division limits. Information tables are placed in visible positions, directing one's attention to the exceptional character of the protected area. It is quite clear, no cuttings will be performed here anymore, no flowers are allowed to be picked, no fire lit, no noise made. Foresters guide the numerous visitors.

The following (Table 1) is the specification of the areas from the list of forest reserves in Slovenia, which can be called virgin forests due to the conserved character of the ecosystem and the designation 'primeval, primeval character, primeval forest':

Within the project called Forest Reserves of Slovenia, under the patronage of the Forestry Institute of Slovenia, the Forestry Department of the Biotechnical Faculty, and Prof. Dr. Dušan Mlinšek, numerous research projects are being conducted, some of them already published in professional monograph form. The long-life character of a virgin forest ecosystem requires careful and constant recording of data, slowly building up a mosaic of knowledge on the life of a virgin forest.

The net of forest reserves will become even denser; they will also be introduced 'sound cells' in the environment of other non-forest ecosystems, because the links between them and the variety of animal life have been severely injured in many places.

Table 1: The virgin forests in Slovenia

Name	Area (ha)
Bukov vrh	8.00
Ždrocle	184.26
Krokar	74.49
Strmec	15.55
Prelesnikova koliševka	3.37
Kopa virgin forest	14.05
The virgin forest Rajhenavski Rog	51.14
Pečka virgin forest	60.20
Gorjanci-Trdinov vrh v.f.	23.16
Ravna gora	15.13
Krakovo v.f.	40.50
Donačka gora v.f.	27.78
Belinovec v.f.	3.25
Šumik v.f.	19.60
Total	**540.48**

THE SIGNIFICANCE OF A VIRGIN FOREST

Due to recording cameras it is nowadays possible to see the pre-nature of the glacial North, mountain wilderness, the Amazon jungle - the primeval land one is enchanted by. Yet, are we aware that this primeval world can be found in Slovenia, right behind the next hill? Rare, endangered and therefore so precious, Slovenian virgin forest is a natural monument and heritage which is kept with respect.

It is not a place where tourists could indulge in; however, educational trails at the reserves' margins have shown virgin forests to almost one thousand visitors annually - including school youths, international expert excursions, etc. Links with the public are contributions to the green policy of Slovenia.

In the search for inner peace, or merely the peculiarity of decaying huge trees, and the life hidden therein, we are well aware that observing primeval forest is one of the keys to more sound coexistence and survival. A virgin forest is thus not only a classroom for a forester, who is becoming more and more oriented towards sustainable management, but it has become interesting to physicists, chemists, doctors, energy engineers, psychologists, etc. The understanding of interdependence between millions of organisms, climate and soil within the system, which is automatically developing and conserving itself through millennia, storing the energy, and moderately, economically yet continually regenerating it, is becoming increasingly important.

It is true that all the analyses and the findings are presented for man and through man, who is fallible.

REFERENCES

HARTMAN, T. (1992) Sto let varovanja pragozdov na Slovenskem. Dolenjski zbornik, Novo Mesto, pp. 109-116.

HARTMAN, T. (1984) Razvojna dogajanja v pragozdu Rajhenavski Rog, T. (1984) Razvojna dogajanja v pragozdu Rajhenavski Rog. GozdV 42, 6, pp. 253-258.

HARTMAN, T. (1987) Pragozd Rajhenavski Rog. Strokovna in znanstvena dela, 89. BTF, Oddelek za gozdarstvo, Ljubljana, 80 pp.

HUFNAGEL, L. (1893) Wirtschaftsplan der Betriebsklasse III. Hornwald.

MLINŠEK, D. et al. (1980) Gozdni rezervati v Sloveniji. Inštitut za gozdno in lesno gospodarstvo Biotehniške fakultete v Ljubljani, 414 pp.

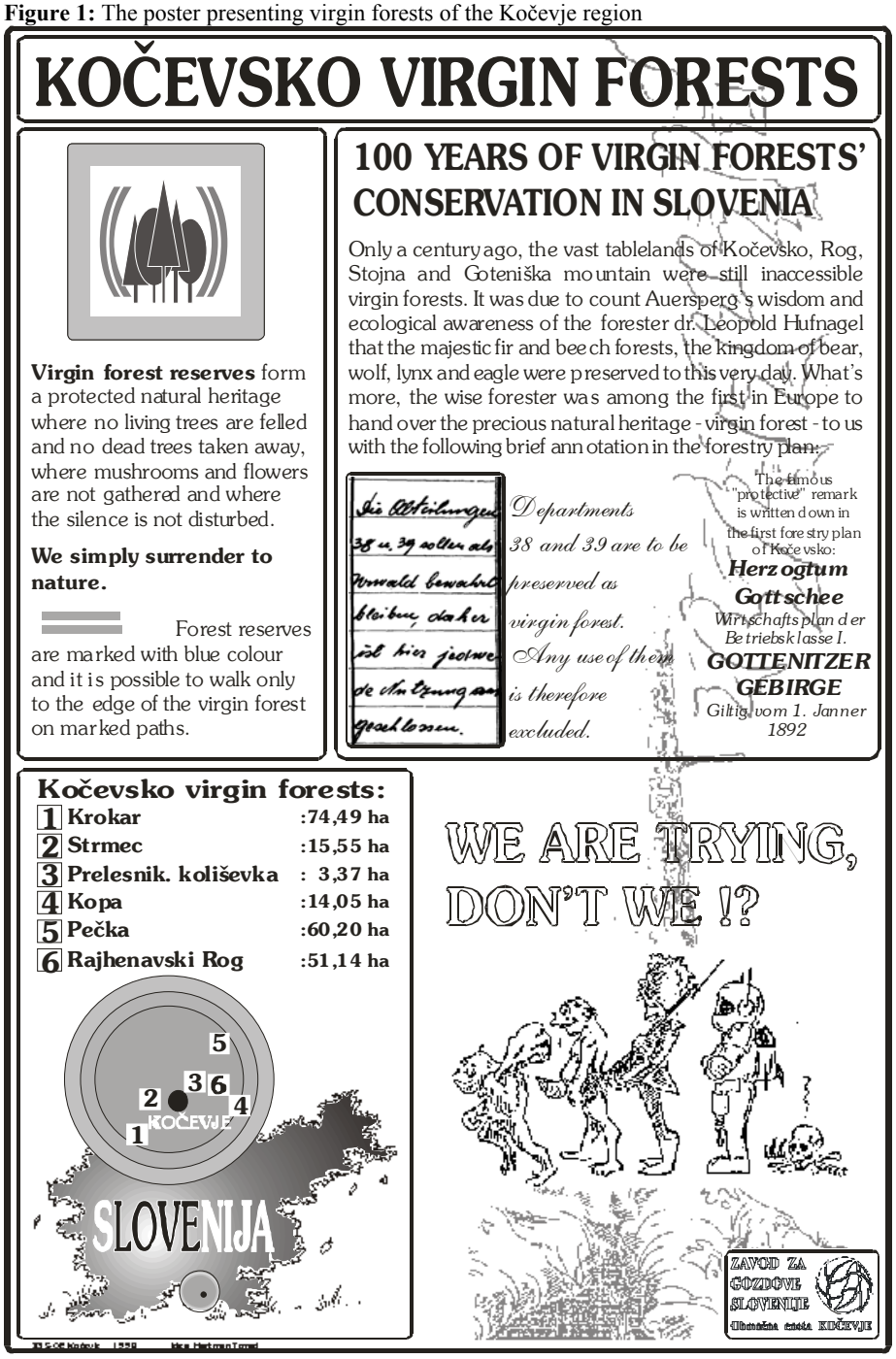
SAJOVIC, G. (ed.) (1920) Odsek za varstvo prirode in prirodnih spomenikov - spomenica. Glasnik Muzejskega društva za Slovenijo 1, Ljubljana, pp. 69-75.

ŠIVIC, A. (1924) O starih gozdovih na Dolenjskem. Šumarski list 11, Zagreb, pp. 564-567.

WRABER, M. (1952) O gozdnogospodarskem in kulturno znanstvenem pomenu pragozdnih rezervatov. Biološki vestnik 1, Ljubljana, pp. 38-66.

Appendix A

Figure 1: The poster presenting virgin forests of the Kočevje region



Appendix B

Figure 2: The poster presenting virgin forests of the Kočevje region

KOČEVSKO VIRGIN FORESTS

Virgin forest - a touch with prehistorical times, inner peace or just the singularity of majestic rotting trees - enchants us over and over again. Rare and fragile, but all the more precious for that, the intact nature is above all a natural monument and a heritage, cherished with due respect.

Virgin forest - forest never touched by axe. Undisturbed, the laws of nature have ruled primeval forests for millenia. In the eternal cycle of births and deaths life is linked up into a healthy and firm system. There is no good or evil, nor useful or harmful here. Everything that exists in virgin forest is subject to slow but continuous and safe renewal.

Today, virgin forest is a unique research workshop. An ecosystem that has been evolving over millenia all by itself, certainly deserves to be imitated. Primeval nature keeps ancient but verified information on stability, safety, as well as harmony of survival.

The majesty of virgin forests is in their giant trees growing to the height of 50 metres, measuring over 1,5 metres in diameter, carrying up to 50 tons of wood mass and living to the age of 500 years and more.

Nature in the virgin forest prepares for all "unpredictable events" with the precision characteristic of the evolutionary process, but human influence, in the form of air pollution, acid rain and excessive wildlife, has an ever more critical effect. Therefore the selfsufficiency and permanence of one of nature's strongest forms is today seriously threatened.

There are 12 virgin forests in Slovenia, **6** of them measuring **218** hectares altogether in Kočevsko region.

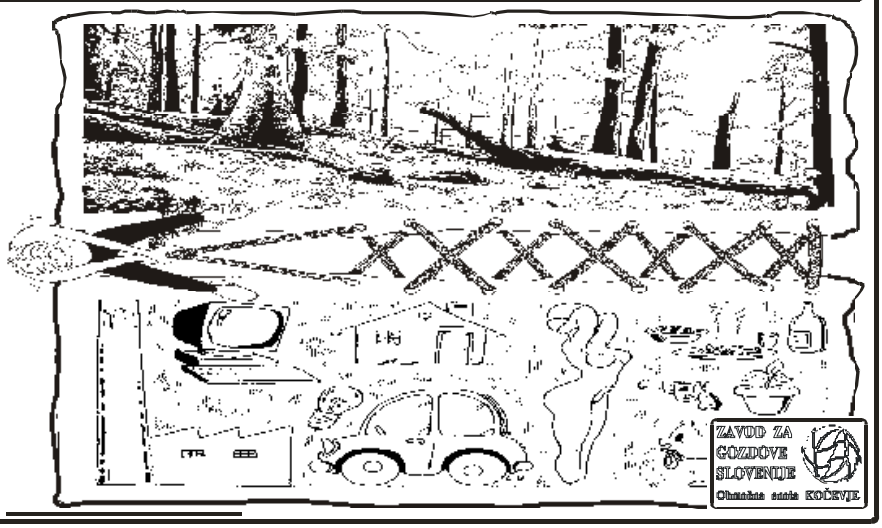
Borovška mountain with its picturesque precipitous walls above Kolpa river hides the little known **virgin forest Krokar**. The rolling karst plateau is mostly overgrown with beech forests.

The **virgin forest Strmec** lies on the southern slope of Stojna mountain. The abundance of maple and spruce trees makes the virgin forest fragment of fir and beech wood especially picturesque.

Because of thermal inversion and frosty bottom, the famous karst hollow depression at the foothills of Rog, called **Prelesnikova koliševka,** prides with primeval spruce forest and rich flora that could otherwise be found in cold mountain climate or far to the north.

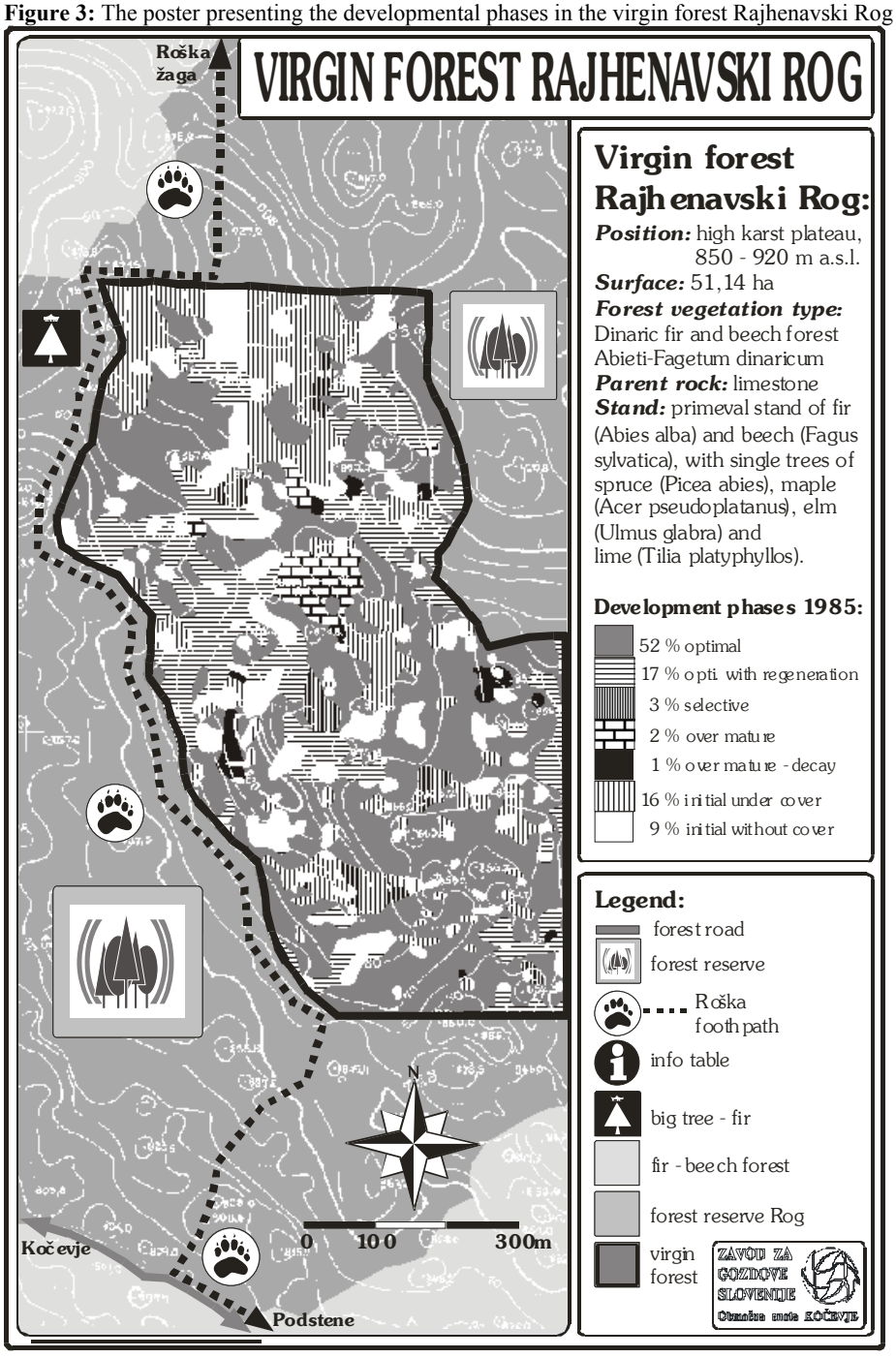
Stretching over a smaller surface, there is a primeval dinaric beech-maple forest, called the **virgin forest Kopa**, on the eastern slope of the Kopa mountain on Rog.

The **virgin forests Pečka** and **Rajhenavski Rog** are magnificient kingdoms of fir and beech trees. They are also the most explored forest reservations on Rog.



Appendix C

Figure 3: The poster presenting the developmental phases in the virgin forest Rajhenavski Rog



Appendix D

Figure 4: The poster presenting timber mass in the virgin forest Rajhenavski Rog

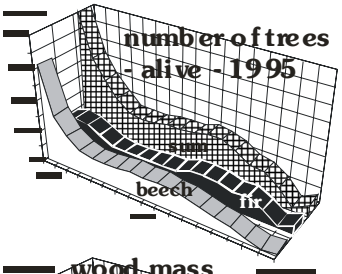
VIRGIN FOREST RAJHENAVSKI ROG

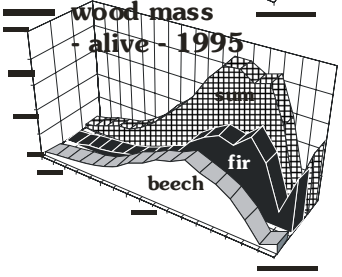
The forest environment in Rajhenavski Rog virgin forest is dominated by towering trees. It is possible that up to 2000 tons of biomass can be established in one hectare of a virgin forest. The enormous quantity of wood is unquestionably the main weapon of the fir and beech forest in its fight for survival. It represents the framework, the thick skin of life, the storage of energy which in this rocky karstic terrain can preserve the fertile soil and water, still the winds and cool the air.

As to their heights, the stands are pretty uniform, of much the same height yet not even-aged. The stand roof is formed by a mass of beech and fir trees of 30-40 metres, from which individual firs are protruding, exceeding the beech up to 10 metres. Only few spruce trees, maples, elms and limes can be found in the stands. It is obvious that there - in a virgin forest's climate and growth - only fir and beech are competitive.

Data 1995: On the total area - **51,14** hectares - there are 18493 alive and dead trees up from 10 cm in diameter. Total wood mass is 54580 m^3.

On 1 hectare:		fir		beech		sum		
		alive	dead	alive	dead	alive	dead	**sum**
number	N/ha	118	88	133	21	251	109	**360**
mass	m^3/ha	449	212	339	72	788	284	**1072**

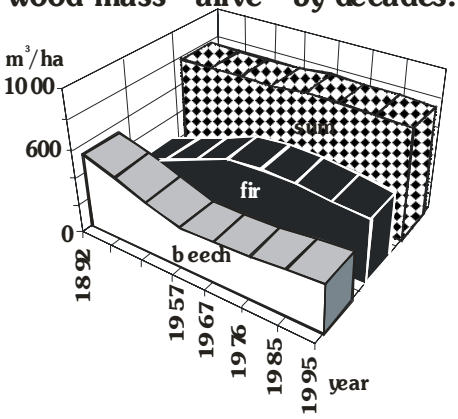




It seems that entire wood mass in the virgin forest is not changing significantly during the time although shares of beech and fir are changing.

The ecosystem keeps its energy!

wood mass - alive - by decades:



Development phases: Despite its monolithic appearance, the fir-beech virgin forest is highly variegated. Three stages of development are interwoven in small areas: renewal, maturity and aging.

Optimal phase: The majority of trees always belong to the full or optimum growth stage, which guarantees security and stability of the forest.

Initial phase: Trees in the virgin forest die individually, and beech shoots immediately fill the gaps. Slender firs grow among the young beeches, endure well in the shade. The waiting, which can last a century and seems to man extremely long, represents a constituent part of life for a fir, perhaps a condition for it to grow into a giant tree.

Terminal phase: The role of dead trees in a virgin forest is quite special. A new microcosm, a home and rich table for numerous micro-organism, fungi, birds, which represent an important part of ecosystem, emerges in slowly decaying stems. A dead fir becomes more alive than it used to be when it was still a green tree.

ZAVOD ZA GOZDOVE SLOVENIJE
Območna enota KOČEVJE

FORESTRY IN SLOVENIA AS A PROOF OF NATURE'S UNPREDICTABILITY, BIFURCATION, ETC.

by Dušan MLINŠEK *

ABSTRACT

Slovenian forestry, its most important developmental stages, and its influences on the forest: destructive trends in the distant past; revitalisation of the forests in the second part of 20th century, and threatening and dangerously irresponsible experiments dealing with reintroduction of destructive political behaviour in recent time.

INTRODUCTION - A BRIEF PRESENTATION OF SLOVENIA AND ITS BIOGEOGRAPHICAL FACTS

Slovenia is one of the very luxurious meeting points on the European continent. Let's start with the first surprise. The country is the only location where the four main European language groups meet: Germanic, Romanic, Slavic, and Finno-Ugric. At this place four different biogeographical regions meet: the Alps stretching from the west, the Dinaric Alps from the south east , the Mediterranean (sub-Mediterranean) from the south west, and the sub-Pannonian lowlands from the Far East. In this very small area (200 km by 100 km) you can find elevations from 0 m to almost 3000 m within a short distance. Here climatic zones interchange and life conditions vary at a short range. Imposing is an array of climates, ranging from Atlantic to sub-Mediterranean climate, from sub-continental to the most harsh Alpine climate. There is quite a specific difference between the climate of the Dinaric Alps and the Alpine climate. In this area the climate varies within a short distance, and in consequence, rainfall patterns alter with precipitation from 700 to 800 mm and up to 3600 mm. The country is very well known as the region of corridors, crossing from North to South and from East to West. Without going into detail you can imagine how huge the biodiversity is in this country, and how many and how different life communities are in nature, and how many things happen on the contact lines of these different ecosystems.

Looking from the other aspect, the country is not far from the Mediterranean ‘desert’ to the South, and close to steppes to the East (so called Hungarian lowlands). In both Alpine zones the Alpine length of timber line is approximately 1400 km, and the length of forest

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edge (the border zone between forest and other non forested land) is at least 40,000 km. Generally speaking, Slovenia is, in a way, the Southern border zone of European forests.

SOME INTRODUCTORY INFORMATION ABOUT THE FOREST HISTORY OF THE COUNTRY

We can imagine how diverse life was in the past centuries, specially the life of the country and its forests. To explain this, we have to subdivide the past into shorter periods, giving you some ideas concerning the most important milestones, which accompanied the life history, not only of humans but of life as an entity. The easiest way would be to list changes in forestry and of forest life in general in this part of Europe, explaining all the good and bad points, which influenced the forest ecosystems.

Let's divide the life in this country into the following periods:

- The long period before 1941
- The post World War II period (1945 - 1952)
- The golden period of Slovenia's forests (1952 - 1990), which represents almost half a century
- The period after 1991 when the unpredictability of the coming years is present.

WHEN IT COMES TO ROBBING THE NATURE AND ITS FORESTS WORLDWIDE, THERE IS NO DISAGREEMENT AMONG DIFFERENT CULTURES, DIFFERENT CIVILISATIONS AND DIFFERENT HABITS

Some facts about the original sin

There is no need to explain into detail the facts about the original sin. Humans migrated from the South, after having devastated their place of origin, savanna, looking for fertile soil. They found it in the Mediterranean forests. Using techniques they learnt in savanna (nomadic life, overgrazing, burning of organic material, and soil cultivation), they left behind the 'Mediterranean desert'. They went on to look for fertile soils in other parts of the continent using the same habits of their savanna ancestors, and caused the artificial savanna of Europe. They transformed the woody landscape into artificial landscape, demolishing the nature's fertility and permanently trying to improve it again because there were no more places left to continue this kind of robbery. Migrating across continents, practising these methods humans made some exceptions due to primeval fear. They apologised to the gods by keeping intact some groups of trees, individual trees or larger relicts of the original forest.

The worst invention, the animal muzzle, was and still is the most effective killer of the real nature - a 'trio': a cow, a goat and a sheep. This kind of attitude continued. Later on heavy industry was introduced, which needs huge quantities of energy. The European continent is one of the most energy-poor continents, and this 'king of destruction' has severely damaged the real nature; specially soil fertility was heavily impaired. A normal next step is the existing overuse of chemicals, an attempt to improve artificial fertility of soil, which has a number of negative side effects.

A specially relevant fact and a sad statement of great concern is that that we are not supposed to talk about cultural landscape in Europe any more. This landscape has become an artificial savanna, a non-cultural landscape with occasional remains.

We have to change our opinion about our ancestors completely. The ancestors who were not able to practice sustainable ways of life because human being became a foreign body in Nature. This statement needs deeper explanation.

We have to look upon new ways how to team up with our environment. How to find friendly ways of cohabitation with Nature.

SOME IMPORTANT EXCEPTIONS (FOR FORMER SLOVENIA WITHIN AUSTRO-HUNGARIAN EMPIRE)

As to the way the forests were treated in continental and Mediterranean part of Europe, Slovenia was no exception. For all these regions, similar history of forest management can be written (the theory and practice about even-aged forestry, spruce monocultures, clear-cuts, much the same silvicultural systems, etc.). But rather early we could find some exceptions in Slovenia due to its special geographical position, and these showed completely new ways of forest management. These were probably the result of excessively ruined landscape in this part of Europe, i.e. the disappearance of forests in the sub-Mediterranean part of Slovenia, the removal of forests of up to 1/3 of the original size in the most of Slovenia, overexploitation, overcutting, overgrazing in forests, litter collecting, animal fodder collecting, and pollarding in those still existing forests. The Slovenian landscape became a torrential landscape, from the Alpine to the sub-Pannonian region. It is not surprising that very early the Vienna Forestry School developed the science of 'how to protect lives against torrents and avalanches'. The history tells us about other exceptions when authorities, forestry organisations, and some individuals started to be concerned with new ways how to manage the forests in an appropriate, more or less close-to-nature way.

The example of Josef Ressel as a representative of foresters' sustainable way of thinking

Let's begin with re-naturalisation of the Karst landscape in the sub-Mediterranean region of Slovenia. The Karst area was completely ruined for a very long period. In the mid 19th century there was only 5 - 10% of shrub vegetation distributed in small spots of the Karst area. Because of these changes living conditions became very severe. Eroded rocky landscape, drought, heavy winds, extreme heat in vegetation period, overgrazing, lack of fuel, etc., have contributed to poor living conditions in this area. The land was partly abandoned. Foresters were the first to start rethinking and to look for new ways to restore life in this part of Slovenia. There are few foresters who started to re-establish the forests in this area. Already in the mid 19th century the forester - generalist Josef Ressel, mainly employed by the Austrian navy, started to plant new forests in a different way. The foresters experimented with the so called 'climax tree species' (broad-leaved tree species), and finally found a pioneer tree species (*Pinus nigra*) to fit the climate. Josef Ressel was by nature an inventor, and he became known for many of his patents (e.g. the steamer

screw), but from forester's point of view he was famous because he started to develop landscape planning already in those days; not only to re-establish the forest, but also to improve life on the Karst in its entity. Ressel was an individual beginner, and was interdisciplinary oriented. His sparkling ideas and a mass notion were needed to set this belief in motion. Today, after 1000 years of destruction and ruining of the countryside, approximately 70,000 ha of new forests - partly planted, partly naturally regenerated with a growing stock of approximately 120 t/ha - are striving very successfully in the course of re-vitalisation of the landscape in this part of Slovenia (new trends of life, new energy householding in the landscape, etc.). In parallel with Ressel's activities, other foresters self-initiatively started to follow similar ways but there was a slight difference in opinion between Ressel and these foresters, who looked at the problem less holistically. The Karst area of present-day Slovenia can be shown as an example of how to renew forests in a devastated landscape world-wide.

Hufnagel and his 'Selection Cutting System'

At the end of the 19th century Leopold Hufnagel, the well known Austrian forester, decided to change the treatment of forests belonging to big forest owners in the southern Slovenia, the forest enterprise of Auersperg family (many thousands of ha). He started with regular selection silvicultural system in the forest of Abieti-Fagetum dinaricum at the time when Austrian forests were heavily overcut, and there were no large dimension trees. At the same time in the forest management plan Hufnagel declared some virgin forests to be protected. This was the first time that virgin forests were protected as a forest area. In those days this was done mainly for hunting purposes.

Schollmayer's revolutionary turning-point and a different way of thinking in forestry

Schollmayer was the director of a huge forest property belonging to the Windischgrätz family in Postojna. He developed the so called 'Control Method of Postojna' at the beginning of the 20th century. Heavily overcut forests in this area, due to the construction of the southern railway (Vienna-Trieste), and the severely devastated Karst area in the vicinity, were the reason for his efforts. This new way in forestry meant the beginning of scientifically and practically oriented 'cognitive way' in forest management (area of 25,000 ha). This happened parallel to the introduction of the Control Method in Switzerland. There was quite a difference between the Swiss and the Postojna method. In Postojna this method was intended for a huge area of forest. At the same time some additional investigations were carried out in Postojna. This revolutionary step happened at the time when, for example, in Styria (Austria) approximately 4500 farmers and forest owners bankrupted because of completely ruined forests, and the same was happening in other parts of Europe (JOHANN 1985). Schollmayer was multidisciplinary oriented and an active forester whose basic ideas were accepted and later perfected as a general rule in Slovenia in the distant future.

A brief remark: There were some exceptions. At the same time farmers already practised the so-called 'Bauerliche Plenterung' and tried to practice sustainable forestry. This phenomenon was very important but far less successful.

THE FIRST PROHIBITION OF THE CLEAR CUT SYSTEM IN YUGOSLAVIA BETWEEN 1920 - 1941

At the time of the first Yugoslavia, Slovenian foresters had to look for work in different places of the country, mostly in Bosnia, Macedonia, and partly in Croatia. At that time the forests, like in other parts of Europe, were heavily exploited. In addition, a severe economic crisis worsened the situation. Overcutting, etc., continued and few improvements were made in forests. At that time forestry was part of the Federal Ministry of Forests and Mines, and severe disproportion between forests and devastated forests, e.g. Karst and shrub area, (out of total 9 million ha of forests, 3 million ha were heavily devastated) pressed the politicians to forbid such extensive treatment of forests as the clear-cut system. But there was little success because this prohibition was by-passed and the clear-cut system was renamed the strip-cut system.

THE NEW FOREST LAW OF FEDERAL YUGOSLAVIA AND ITS ECOLOGICALLY SOUND ROOTS BASED ON MANY FACTS - MEETING AT THE SAME TIME AND AFFECTING THE BIFURCATION POINT (TURNING FROM MECHANISTIC TO HOLISTIC WAY)

Yugoslavia was an exception in the Communist world, in which forest management was seriously taken into account. It was an experiment on how to stop exploiting the forests and to start considering forests in a close-to-nature way. The new Forest Law of Federal Yugoslavia was the basic law, which the Republics had to follow. This law imposed the rules to Republic forest laws. The federal law, in effect since 1949, strictly forbid clear-cutting in forests and proclaimed it as the most dangerous and unnatural technology applied by forest management. The clear-cut prohibition is a confirmation that this law was written in accordance with the nature protection idea. Slovenia followed the federal law very strictly because of its bad experiences, and incorporated additional nature friendly regulations into its own forest law.

Some facts causing the turning point

It is worth mentioning some facts that caused the turning point in forestry, from exploitation forestry to close-to-nature forestry:

1. Overexploited forests of 3 million hectares of shrub and Karst countryside - the good part of 9 million hectares of the total forest area in Yugoslavia.
2. The return of Slovene foresters from the southern parts of Yugoslavia after WW II, with the idea to stop the forest devastation practised especially in the southern Yugoslavia and in Slovenia as well, and with the best wishes to start a new way of forest treatment at home.
3. General opposition to the capitalistic kind of nature exploitation and to clear-cutting, which damaged Slovenian landscape very heavily in the past.
4. Already during the war the activity of the Forest Committee was the concern of the partisan movement preparing the first rules for the after-war period.
5. Development of social sciences in general.

6. The influence of the new science in its pioneer status - the holistic way of the new science on the horizon.
7. The danger of short-term economic trends and the distrust of modern technologies.
8. A permanent conflict between the FAO policies and the diverse Middle-European conceptions how to treat forests.

   Remark: The intention of FAO was to increase the quantity of biosubstance. But the Middle-European forestry is trying to improve itself by increasing the quality of wood and improving other forest functions at the same time.

Simultaneously some other measures have been taken (e.g. collecting litter and pruning of trees for litter purposes was strongly forbidden; grazing in forests was also forbidden; etc.).

THE PERIOD 1945 - 1950

Immediately after the Second World War the situation dictated additional heavy felling due to general severe economic post-war situation. Slovenia was not the only country where overcutting was practised. This was the case all over Europe. In this post war period West Germany, for example, has clear-cut 750,000 hectares of forest. The Soviet Union cut completely the old-growth in the European part of the Union. In Slovenia the overcut happened mostly along roads, damaging the forests locally. In this five-year period the felling reached more than 50% of the average annual cut. Only in some years the overcut was from 100% to 200%. Classic tools were used (no chain-saws, tractors, etc.), and the magnitude of damage was rather low with some exceptions. We must mention that public opinion was against heavy cutting and helped to shorten this period of overfelling successfully. We have to emphasize that this post World War II era was characterised by the practices mentioned before all over Europe at that time.

In the years 1947-1949 the prohibition of goat-grazing in Yugoslavia was successfully enforced. During this short period between 5 - 7 million goats were slaughtered or sold to Greece and Turkey. In this very short term goats disappeared completely except in Kosovo, and in the area around Knin in Croatia, where at that time Serbs were still living. In Slovenia at that time goats were not a serious problem any more, and their removal was rather an easy task. There is one point of great significance: this action made by former Yugoslavia immediately after the war, in spite of the difficult economic situation, was an immense contribution to the protection of nature, never seen world-wide before. After 40 years, in this once shrubby country inhabited by goats, you can nowadays find forest stands of 10 - 20 m height covering and protecting the slowly forming soils, life in general and increasing biodiversity.

1950 - 1990 THE TRANSITION PERIOD OF PRACTICE - FROM MECHANISTIC TO ORGANIC WAY OF THINKING AND ACTING IN FORESTRY

Half of the century has nearly passed and it is time to analyse the work done in Slovenian forests. Let's consider some facts with critical evaluation. After clear-cutting and similar extensive forest treatments had been forbidden, the less experienced foresters started to practice the selection cutting system (Planterung) in all forests. In a few years they

realised that this was not possible. At that time an interesting idea arose - 'the tending of forests in all circumstances has to be the basic conception - the theory and the practice of forestry in Slovenia'. It was evident that tending has to be considered as a guiding philosophy and technology at the same time. In other words, tending became more than technology. Thinning became the main activity in Slovenia due to prevailing young stands. It took a certain period of time to introduce selection thinning by supporting the best and most vital individuals instead of practising 'negative thinning' (the strict removal of badly formed, damaged or sick individuals). Thus the Slovene forester recognised today's character of human being as a foreign body in the forest rather early.

The next very important step was the recognition and respect of the Iron Law of Site. In the post war period 50 - 70% of forest sites have been phytocoenologicaly mapped at a scale of 1:10,000 (mostly with the method of Middle European Montpelier school of mapping). The work has to continue on a new level, following the fact that site and living part of matter are inseparable units.

The historical legacy and the introduction of 'The Control Method of Postojna' in all Slovenia's forests

In Slovenia forest management is based on the Control Method of Postojna for all forest categories. All forests have been measured on average 3.5 times (at ten-year intervals the growing stock of over 10 cm breast diameter is measured). Ressel, Schollmayer, Hufnagel and others foremost contributed to this trend. Additionally, silvicultural planning was elaborated scientifically and introduced as an obligatory activity for all forests. This was an important help to regard and treat each forest stand successfully in a 'cognitive way'. The abandonment of goats continued, along with the grazing prohibition for all domestic animals.

The impulses of the post World War II enthusiasm influenced all kinds of activities in forestry in general. But there was quite a different situation in other parts of Yugoslavia. In the south, Macedonia was oriented to afforest huge areas of spoiled agricultural land. Afforestation was one of the most important activity in neighbouring Serbia. But less attention was paid to tending of the existent forests. In Bosnia the conversion of coppice was the principal assignment because approximately 50% of the total forest area was coppice. In Bosnia additional significance was given to the existing high forests - in many instances with a virgin forest character. Conversion of these forests to economically valid ones, but at the same time to those of close-to-nature ones, was the second main task while improving their forests. Croatia's forest activities were directed into three directions. The first was to improve the selection cutting system in the Dinaric Alps. The second was to improve the famous lowland oak forests, and the third was to continue afforestation in the Karst coastal zone.

If we discuss the cognitive method of forest management it is very important to mention that Slovenia was divided into 14 forest management areas. This was already in the years of 1950. At the beginning the background for this division was the raw material for wood industry. But very soon this division was subordinated to new trends. It was the question of how to solve the trends and influences of 'globalisation and localisation' in the country as a very important part of cognitive approach in practising work in nature. The

localisation was stressed systematically with intention to get globalization trends under control. Within each forest management regional unit, local management units were established where 'control method' was practised. In addition the growing stock of more than 10 cm breast diameter was totally measured every 10 years. This happened 3 - 4 times over the last 40 years. The marking of trees for cutting became an organic part of silvicultural planing as a special part of cognitive treatment of Slovenia's forests.

After World War II the 'Monetary Forest Fond' was established for forest recovery. Subsequently this establishment was renamed and transformed into the fund source called 'Biological Amortisation' and each m^3 cut financed it. Certain percentage of timber price (18 - 33%) was put aside for maintenance and improvement of forests in general. In fact, this was the beginning of so-called 'ecological accounting', which has to be developed in the future and introduced in general as one of the main measures for forest improvement. Therefore it is worthwhile mentioning that by reason of 'biological amortisation' tax payable on forests by forest owners was very low.

Network of new forest reserves

In the period of 1970 to 1980 one hundred and seventy-six (176) new forest reserves were established in Slovenia, encompassing 10,000 ha. They include forest representatives of the most forest sites in the country. The main idea was to elaborate new laboratories in nature investigating the reality of forest life. The project is still alive and is the basis for the achievement explained hereafter.

Education - research - improvement of practitioner workshops - as a TRIANGLE and an effective tool in advanced forestry

The triangle with its feed-back function was introduced by the Faculty of Forestry to enhance activities in forestry, to improve forester's knowledge, and to keep them informed with up-to-date findings. At the same time first class mechanism was established to provoke feedback from education, research and improvement.... This was the way how to manage energy rationally and be informed constantly. In the past decades (since 1959) we pointed out that no sufficient attention was paid to the public. In the future the triangle has to change into tetrahedron, including the public as well.

Forestry, silviculture and its tending as a paradigm and not technology (Forestry as the Nation's culture)

The ideas presented in the above sentence tell us that forestry in Slovenia has to continue this way, and further on, it has to develop forestry in a broader sense as the culture of the country. It has to act as a teacher for other human activities, educating them how to develop and implement the 'protective role' into different man activities, and bringing them to a cultural level. - With another words - **the forest as a teacher.**

At this point I would like to mention some leading persons in forestry, who have contributed to trends and happenings brought up before. Besides some politicians, the following foresters and biologists are to be mentioned: Funkl Lojze, Košir Živko, Pipan

Rudolf, Sotošek Stanko, Anton Šivic, Tomažiè Gabrijel, Tregubov Vlado, Maks Wraber, and also some farmers and forest owners. All of the above mentioned were mostly foresters or scientists.

FLUCTUATIONS AS THE ORGANIC PART OF NATURE - AND OUR EXPERIENCE

After 1990 the forest law was changed - some important principles were kept, but 'biological amortisation' - this superb invention - was left out.

Former bad habits practised in forestry are back (revitalisation of grazing, etc.). Instead of improving the existing methods with good results, they would like to call back the past century. But we hope very much that this is the transitional period after which the sunshine of the last decades is going to shine again on the Slovenia's forests.

We learned a lot in the past period. Forestry encountered different kinds of crises and conflicts, with politicians and non-friendly science branches like agriculture. Let me list some of them. In the first decade after World War II there were fights going on between agriculture and forestry regarding the question of the borders between agricultural and forest land. Slovenia is mostly a mountainous country with rather steep slopes and for agricultural purposes farmers cut down forests on these slopes. Farmers cut down the forests due to the lack of agricultural land for more convenient farming. Under such conditions natural fertility was drastically reduced and forest vegetation started to cover these areas again. Forest pioneer vegetation is still increasing. People who do not understand basic ecology do not realise that the return of forest vegetation means the recovery of landscape. We have learned that we have to follow nature, learn from chaotic situations (note that man's aggression on nature means in fact chaos, and we have to correct our contacts with nature).

Worth mentioning is another conflict that happened in the 60's when Slovenian agriculturists and politicians tried to develop broader agriculture via additional artificial deforestation of Slovenia's landscape in different places. At the beginning the idea was to remove 170,000 hectares of forests to gain new agricultural land (around 1960). After a strong reaction from foresters this figure was reduced to 150,000 hectares and again down to 70,000 hectares. After scrutinising carefully the pros and cons this figure dropped to 14,000 hectares. All together only 7,000 hectares were deforested finally, and turned to agricultural land. But half of it (3,500 ha) was given back to forestry immediately after the clear-cut. We can imagine how serious the fight was between the foresters and the 'artificial savanna protagonists', and how speculative the opposite side behaved. One of the secret goals of the opposite side was to get timber for trading. The discussion at that time was disagreeable due to some foresters (delinquents) who took the agriculturists' side. Foresters have to anticipate such and similar nature unfriendly attacks again and again, and have to be ready to fight them. From experience they have to foresee such similar and chaotic situations, and they should deal with them. The example shows how unfriendly some science branches are concerning the protective role of environment - in this case forests.

FROM TRIANGLE TO TETRAHEDRON

Forest as an enemy

Considering the development of relations between humans and forests throughout the history we can conclude that in most cases man was an enemy to the forest. He destroyed it, establishing artificial ecosystems like foreign bodies, which oppose nature and its laws. When man is educated in different school systems his activity appears as something positive. We are compelled to recognise this mistake and reveal the truth about man and nature.

Forest as a friend - as a friend for life!

Recognising this fact man has to admit that the forest has to be accepted as his friend. We have to stop exploiting forests and develop a new philosophy in our woody country where man and forest become friends. Man has to trust the history only to a certain extent because of huge unpredictability of already severely spoiled nature. On account of this fact friendship between man and nature has to progress in a specific way based on our cognitive investigation of nature.

Inventive ideas brought by individuals need general public to proliferate

There are many examples where individuals like Schollmayer, Ressel, etc. produced original ideas through cognitive practice, spreading them for the benefit of the public. Foresters have to start teaching people about sustainability, biodiversity, iron law of locality, the importance of globalization versus localisation. These ideas, which play a very important role, have to be explained to the public objectively and ecologically and without political implications.

Extension service as the main tool in the future

The extension service has to become one of the main tools of foresters in the future as part of tetrahedron reviewed in the previous chapters. That means the extension service has to became an organic part of research, teaching, and practice as one unit based on cognitive conceptions. The new forester has to develop the new forestry on a high cultural level with responsibility. In other words, the forester has nothing to do with extension service agriculturists practised till now. Forestry as a topic has to become the organic part of educational programmes at all school levels (from primary schools to colleges producing educating teachers). In the future, considering all these facts, the foresters of the country (The Forest Service) have to add themes on real nature of forests to the regular curricula.

NEW FORESTRY AS A PROCESS

New forestry and new approaches when considering Nature

As mentioned before forests must not be considered as a kind of agricultural produce. They have to be considered as a permanent process, as part of real nature. And if so, the forestry as a human activity has to be organised as a process that perpetuates a large scale of activities.

Such forest activity has to transform the existing previously mentioned 'artificial savanna' into nature-friendly woody landscape. Forestry is obliged to bring back the forests, which are acceptable to nature. Today this is not the case. World-wide we are still far away from transforming the existing woody 'sceneries' into the really multi-functional forests. Going this way the society is obliged to abandon the existing agro-pasture system which is the major destroyer of the natural landscape. It has to be stressed: stop promoting the agro-sewage way like in Holland, in Lowlands of the Po river, etc. Stop the development of the wrong perfection of intellect when Schreber gardens become graves (by using chemicals and putting on 'make-up' to nature's dead body).

Considering all these facts we have to realise that the modern economy, which is far away from nature's economy, is responsible for all its acts when it contracts debts in Nature and makes the coming society poor. All these trends have nothing in common with democracy, because the real democracy respects not only the present man but also creative predecessors and the coming generations as well. If doing so, we will finally and slowly understand the 'responsible democracy'. All these new trends in forestry characterise this branch of human activities as the foregoer. In this area other branches have to learn how to develop in the future.

LOOKING UPON THE NEW ECOLOGICAL NICHE OF MAN AS CONCLUDING REMARKS

The preceding considerations suggest a new ecological niche of man especially in forestry, i.e. nature friendly man, who is holistically oriented, contacting nature in a cognitive way, which is beside other things the basic part of life behaviour.

In Slovenia we should be proud that already today our forests are treated in this manner and we can show other countries how the forests in Europe should look like in the future. Going this way we have been permanently learning how to be educated by forests, where the real sustainable development of man - not a greedy eater - can be studied. In other words, the dynamic science of the new forestry has to help promote the new science, which is already on the horizon: among others - a new forestry with forestry sciences as a 'non-excessive cultural process'. If not, we will not be allowed to speak about close-to-nature forestry, and we will not be able to solve the most critical landscape problems. This will be our contribution when bringing back the real forests to the continents (as the most important ecological regenerator), and at the same time an efficient counterweight and medicine for artificial landscape, from where mother-forest was banned.

Nature is solving problems of the ruined landscape by bringing back the forest ecosystems - and we have to follow this example. This has to be considered with extreme seriousness. Because the present time is howling, but the future will whisper.

SUMMARY

The history of humans from A to Z is characterised by permanent robbery of nature, of direct and indirect environment. Especially natural resources were and are still affected, and the history must be studied when dealing with damaged natural productivity of soils and devastated forests. No continent is an exception to this. A special case is the European continent, where the process of destruction started very early, and where an attempt was made to revitalise the original landscape. But this is evident only in some places and it is an exception. In some European countries this revitalisation can be registered. Slovenia is one of them.

In short, the history of Slovenia's forests and forestry is shown. Particular attention is given to the second part of this century. During the revitalisation period the forests recovered very successfully. The paper discusses some measures which are oriented towards the basics and are part of the existing forestry. The cognitive method (special relation: man - environment) has been developed as the fundamental part of forestry and also as part of Nation's culture. Due to this interesting improvement no opposition was expected after 1991 when the political regime changed. But that was exactly what happened. Thus we can solemnly claim "Do not believe the History"! The cognition has ripened - forestry must not fail. Forestry as a culture means new tasks for forestry based on the very important statement that nature is indispensable. Forestry has to further improve the alphabet of man's new relations towards nature through wisdom experienced in natural forests. That means that forestry is obliged to bring this knowledge and this relationship to other activities of man and to human behaviour in general.

REFERENCES

JOHANN, E. (1985) Geschichtliche Darstellung der Nutz- und Schutzfunktionen des Waldes in den Gebirgsregionen der ehemaligen k.k. österr.-ungar. Monarchie. In: Beiheft zur Schweizerischen Zeitschrift für Forstwesen, 74, Zürich, 75 pp.

FOREST RESERVE RESEARCH IN SWITZERLAND

by Jean-Francois MATTER *

SHORT DESCRIPTION OF THE FOREST

History of forest utilisation

As in many other European countries, the forests in Switzerland have been submitted to uncontrolled and excessive exploitation during the 18th and the first half of the 19th century: the situation prior to 1850 was disastrous, mainly in the Alps and Pre-Alps, with frequent avalanches and flood disasters. The first federal Forestry Policy Act came into force in 1876, but covered only the mountain region. Our forests were managed only in a sustainable way, when a stricter Forest Policy Act was introduced for the whole country in 1902. Its aim was to stop the depletion of the forests, to manage the remaining forest areas in a sustainable way, and to reforest wherever it was necessary to protect people and property. Since the introduction of this law, the forest area in Switzerland has increased by about 40%. A new law has been in force since 1993. It further refines prudent forest management. It also guarantees the biodiversity of the Swiss forest and its sustainable development, a policy which combines economy and ecology, as called for by the UNCED Environment Summit held in Rio de Janeiro in 1992.

Art. 1 Waldgesetz (Forest Law) (purpose):

1. This law:
   a) preserves the forest in its area and spatial distribution;
   b) protects the forest as a close-to-nature ecosystem;
   c) ensures the forest's ability to fulfil its functions, i.e. protective, social and commercial (forest functions);
   d) promotes and sustains forestry.
2. In addition, it helps protect people and important assets against avalanches, landslides, erosion and rock-fall (natural events).

The 'modern' principles of this new law are:

- Promoting a diverse composition of tree species which are compatible with each other and the environment (in accordance with natural silviculture).
- Preserving, through natural regeneration, the genetic diversity of tree species growing in the region which are typical of the site.
- Banning of the clear felling (already 1902).

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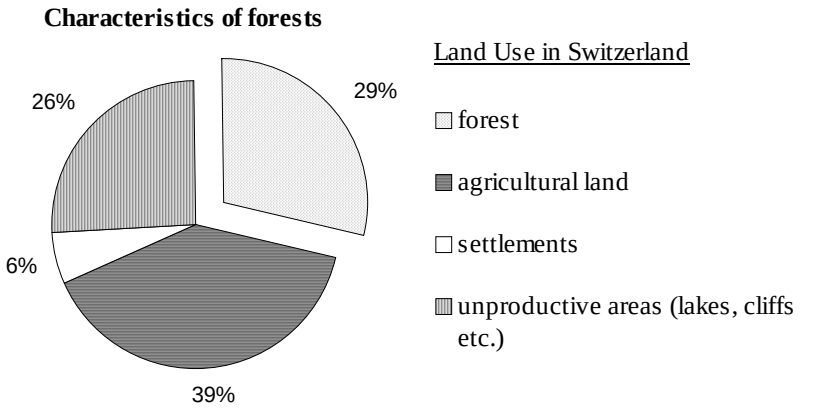
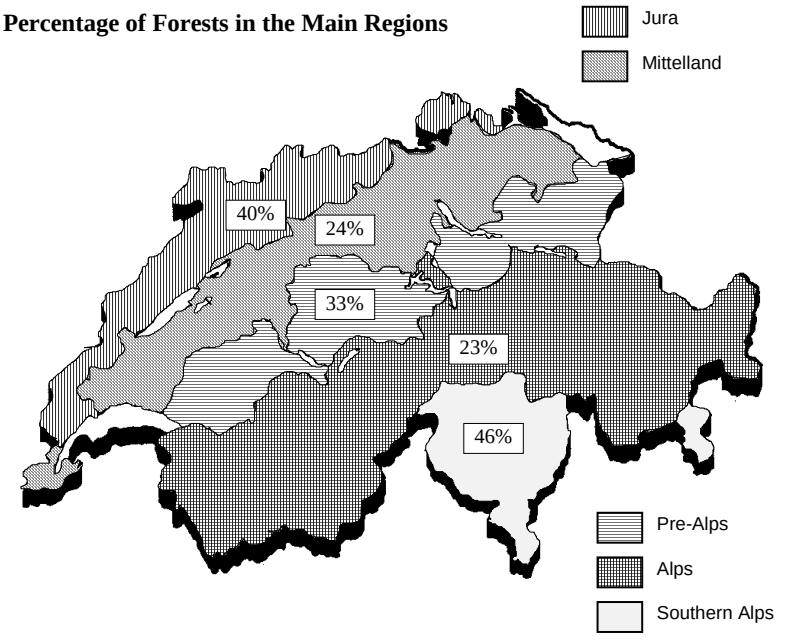
- In addition to naturally managed forests, unmanaged forests are allowed (natural forest reserves).
- Preserving or reinstating forms of forest management, i.e. coppice-with-standards and chestnut orchards, to promote diversity on the ecosystem and the landscape.





Forest area, ownership

Forested Area

Unit of estimation: total forest area

	Jura	Mittelland	Pre-Alps	Alps	Ticino	**Switzerland**
Forested area in 1000 ha	195,0	228,2	217,0	381,6	164,5	1186,3
% distribution	16,4	19,2	18,3	32,3	13,9	**100,0**
% forest in the total area	39,7	24,2	32 8	22,7	46,4	28,7
m^2 forest per capita	2100	600	2600	6300	6200	1900

Ownership

Ownership	Jura	Mittelland	Pre-Alps	Alps	Ticino	**Switzerland**
			%			
Citizens corporations	31	25	13	39	66	34
Political communities	34	19	10	26	8	21
Public corporations	1	5	20	10	2	8
Cantons	9	7	6	2	1	5
Confederation	0	1	1	1	1	1
Total of publicly owned forest	**75**	**57**	**50**	**78**	**78**	**69**
Privately owned	23	40	43	17	21	28
Corporations	2	3	7	5	1	3
Total of privately owned forest	**25**	**43**	**50**	**22**	**22**	**31**
Total forest in %	100	100	100	100	100	100
Total forest in 1000 ha	195 0	228 2	217 0	381,6	164,5	1186.3

Total volume

Species Composition (Standing Volume)

Unit of estimation: accessible forest, trees with a DBH of 12 cm or more excluding brush-wood

	Jura	Mittelland	Pre-Alps	Alps	Ticino	Switzerland
Total per 1000m^3	63574	92785	88139	97481	23148	365128
m^3/ha	328	409	417	292	176	333

Tree species

Species Composition (Standing Volume)

Unit of estimation: accessible forest, trees with a DBH of 12 cm or more excluding brush-wood

Species	Jura	Mittelland	Pre-Alps	Alps	Ticino	Switzerland
			%			
Spruce	31	43	58	63	35	49
Silver fir	22	15	22	6	6	15
Pine	4	5	1	5	2	4
Larch	0	1	0	13	15	5
Cembran pine			0	2	0	1
Other conifers	0	1	0	0	0	0
Total conifers	**57**	**65**	**81**	**89**	**58**	**74**
Beech	30	20	13	7	13	16
Maple	4	2	2	1	0	2
Ash	3	5	2	1	2	2
Oak	3	5	1	0	3	2
Chestnut				0	14	1
Other broadleaves	3	3	1	2	10	3
Total broadleaves	**43**	**35**	**19**	**11**	**42**	**26**
Total in %	**100**	**100**	**100**	**100**	**100**	**100**
Total per 1000m^3	**63574**	**92785**	**88139**	**97481**	**23148**	**365128**

Growth

Estimation #1:	8.1 Mio. m^3/year	7.4 m^3/Year/ha ('Derbholz')
Estimation #2:	6.2 Mio. m^3/year	5.4 m^3/Year/ha

Annual cuttings (1980 - 1985)

	Jura	Mittelland	Pre-Alps	Alps	Ticino	Switzerland
Total per 1000m^3	925	1721	846	662	69	4223

HISTORY OF THE ESTABLISHMENT OF NATURE RESERVES (PROTECTION AREAS)

– 1906 Motion in the Swiss Forestry Association to create natural forest reserves.

The first three reserves were created by the Association of Nature Protection:

– 1910 primeval forest reserve Scatle / Brigels (Pro Natura)
– 1914 National Park (Pro Natura)
– 1933 Aletschwald (Pro Natura)

Since 1940, creation of scientific strict forest reserves by Prof. Hans Leibundgut, former professor of silviculture: national and international promotion.

– 1947 Moos / Birmensdorf
– 1948 Swiss Working group for forest reserves (University Institutes)
– 1949 Forestry World Congress Helsinki
– 1987 39 scientific strict forest reserves with 1018 ha
– 1993 New forest law

CLASSIFICATION OF FOREST PROTECTION AREAS

The inventory is now on its way to be completed by the Federal Forest Service (1998). The first overview shows the following figures:

– 234 reserves with 13,529 ha (=0.3 % of country area or 1.1 % of forest area)
  - National Park 4,800 ha = 35
  - Mean area 234 res = 30 ha
  - 13 reserves with area > 100 ha
  - 39 strict reserves FIT
  - 80 with interventions for conservation

The new forest law foresees strict reserves as well as reserves with intervention; the contracts of protection must have a minimum duration of 50 years.

DEVELOPMENT OF RESEARCH IN NATURAL FORESTS

Method:

Preliminary studies: soil, vegetation, stand composition and structure.

Full inventory
Sampling plots with / without coordinates
Line transect

Remote sensing
Dendrochronology

PRESENT STATE OF RESEARCH ON NATURAL FORESTS

- Federal Institute of Technology, chair of silviculture (Prof. Dr. J.-Ph. Schutz): Research in natural forest is one of the five main research domains (responsible: J.-F. Matter): Management, monitoring and evaluation of the FIT reserves.
- Federal Institute of Technology, Geobotanical Institute (Prof. Dr. P.J. Edwards): Botanical observation program in the 39 FIT reserves.
- Universities of Bern, Fribourg, Neuchatel and Lausanne: punctual observation programs in some FIT reserves (Vegetation science, Zoology)
- Swiss Federal Institute for Forest, Snow and Landscape Research, Research Department Forest Monitoring, Section Forest Condition Inventory and Long-term Monitoring (Dr. J.L. Innes): Long-term Forest Ecosystem Research LFTER in FIT and new forest reserves, and in managed forest areas
- Swiss Federal Institute for Forest, Snow and Landscape Research, Research Department Landscape Ecology, Section Vegetation: Vegetation and Forest reserves (Dr. N. Kuhn): Punctual botanical observations in FIT reserves and in managed forest areas

Swiss Forest Reserves Register

No.	Name/Commune	Surface (ha)	Year	Legal status
1	ALETSCHWALD RIED-MOEREL	244.80	1933	Tenancy for 99 years through the Swiss Association of Nature Protection
2	MOOS BIRMENSDORF	.99	1948	Tenancy for 50 years through the Institute for Silviculture ETHZ
3	KRUMMENLINDEN MELLIKON	3.00	1955	A decree of Canton Forest Service 6.10.1955 / 50 years
4	PFINWALD SIDERS	6.77	1957	Tenancy for 20 years through the Canton Wallis
5	DERBORENCE CONTHEY	50.80	1957	Purchase through the Swiss Association of Nature Protection
6	ST. JEAN VILLERET	8.74	1957	A decree of government council of Berne by 27.9.1957
7	GIRSTEL STALLIKON	9.63	1957 1981	Purchase through the Institute for Silviculture ETHZ
8	BONFOL BONFOL	8.80	1961	A decree of government council of Berne by 21.8.1961
9	UMIKERSCHACHEN UMIKEN	6.40	1962	Tenancy for 50 years through the Directorate for Constructions of canton Aarau
10	UNTERWILERBERG BADEN	3.42	1962	By the decision of the Commune Ortsburger

No.	Name/Commune	Surface (ha)	Year	Legal status
11	WEIDWALD OBERERLINSBACH	5.10	1963	A decree of the community council of Aarau 22.2.1963
12	SCATLE BRIGELS	9.13	1964	Tenancy for 80 years through the Swiss Association of Nature Protection
13	REUSSINSEL + RISI MELLINGEN	4.05	1966	A decree of the Canton Forest Service 14.3.1969 / 50 years
14	BOIS DE CHENES GENOLIER	83.00	1969	Tenancy for 45 years through the Canton Waadt
15	FOLLATERES FULLY	99.82	1969	Tenancy for 50 years through the Canton Wallis and Confederation
16	KYBURG KYBURG	2.11	1970	Purchase through the Institute for Silviculture ETHZ
17	ADENBERG RAFZ	4.79	1970	Tenancy for 99 years through the Institute for Silviculture ETHZ
18	FUERSTENHALDE WEIACH	2.00	1970	Tenancy for 99 years through the Institute for Silviculture ETHZ
19	HUENTWANGENHALDE NOK-HW EGLISAU	2.50	1970	Tenancy for 50 years through the Institute for Silviculture ETHZ
20	VORM STEIN STADEL	9.96	1971 1973	Purchase through the Canton ZH Scientific adviser: Institute for Silviculture ETHZ
21	TARICHE BOIS BANAL ST.URSANNE / F.ETAT	13.29	1972	Tenancy for 50 years through the Institute for Silviculture ETHZ
22	TARICHE HAUTE COTE ST.URSANNE / F.ETAT	9.00	1972	Tenancy for 50 years through the Institute for Silviculture ETHZ
23	BOEDMERNWALD OBERALLMEINDKORP.	5.00	1972	Tenancy for 80 years through the Institute for Silviculture ETHZ
24	LEIHUBELWALD ORTSBUERGERG. GISWIL	23.79	1972	Tenancy for 99 years through the Institute for Silviculture ETHZ
25	SEELIWALD KORP. SCHWENDI	79.00	1972	Tenancy for 99 years through the Institute for Silviculture ETHZ
26	BANNHALDE POL.GDE.BUELACH	2.75	1972	Tenancy for 99 years through the Institute for Silviculture ETHZ
27	LANGGRABEN POL.GDE.BUELACH	4.34	1972	Tenancy for 99 years through the Institute for Silviculture ETHZ
28	RINSBERG POL.GDE.BUELACH	3.10	1972	Tenancy for 99 years through the Institute for Silviculture ETHZ
29	SELDENHALDE / WUTACH SCHLEITHEIM	4.50	1972	Eig. Randenvereinigung SH Scientific adviser: Institute for Silviculture ETHZ

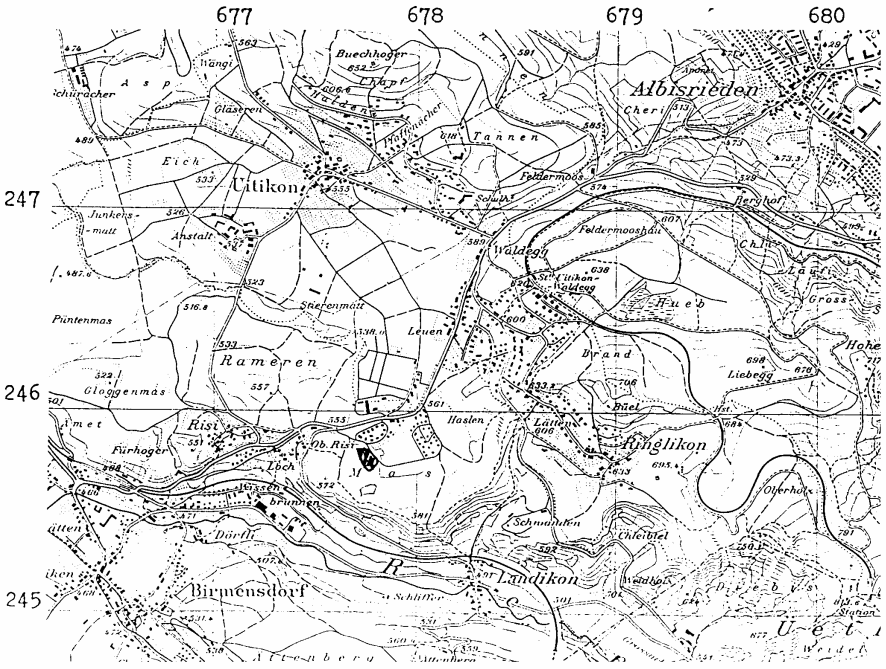
No.	Name/Commune	Surface (ha)	Year	Legal status
30	STRASSBERG BACHENBUELACH	6.31	1975	Tenancy for 99 years through the Institute for Silviculture ETHZ
31	WEIDEL STALLIKON	.60	1975	Property of the Swiss Confederation School forest of the ETHZ
32	JOOSENWALD WALENSTADT	85.36	1976.	Tenancy for 50 years through the Institute for Silviculture ETHZ
33	NATIONALPARK ZERNEZ	26.00	1977	A project of the national fonds
34	ROTTENSCHWILERMOOS ROTTENSCHW/UNTERLUNK	19.00	1977	Fondation Reusstal
35	RHEINHOELZLI FLAACH	6.39	1977	Tenancy for 50 years through the Institute for Silviculture ETHZ
36	STEIBRUCHHAU OSTERFINGEN	5.20	1979	Tenancy through the Department for Forest and Wood Research ETHZ
37	TOBELWALD GISWIL	4.53	1981	Property of the ETHZ
38	COMBE GREDE VILLERET	96.49	1982	Property of the Canton Bern
39	COMBE BIOSSE DOMBRESSON LePAQUIER	58.00	1987	State forest NE Cantonal decree ->epfz_pend.
39 FOREST RESERVES WITH THE TOTAL AREA OF 1,018.46 ha				

The editor's annotation: For printing purposes this article was transferred from the draft version presented at the meeting in Ljubljana. We regret any eventual mistakes which occurred during the printing process.

Appendix A

An example of forest reserves record in the Swiss forest reserves databank

Waldreservate der Professur für Waldbau / Departement für Wald- und Holzforschung / ETH Zürich	
Nr (No.)	2
	MOOS
Kanton (canton)	ZH
Gemeinde (commune)	BIRMENSDORF
Fläche(ha) (area)	0.99
Gründungsjahr(e) (the year of establishment)	1948
Grundeigentümer (proprietor)	HOLZKORPORATION BIRMENSDORF
Rechtsform Reservat (legal status)	PACHT 50 JAHRE / WALDBAU ETH / 11.11.47 (Tenancy 50 years / Institute for Silviculture ETH)
Waldtyp (forest type)	EHEM. MITTELWALD UND HOCHMOOR
Bemerkungen (notes)	
LK 1:25000 Nr.	1091



Appendix B

An example of forest reserves record in the Swiss forest reserves databank
(Continuation)

ZUSAMMENSTELLUNG DER AUSGEFUEHRTEN ARBEITEN
(A list of the accomplished work in the reserve (analyses, research))
****

RES.NR.: (No.) 53/125 - 13
RESERVAT: (reserve) REUSSINSEL + RISI
GEMEINDE: (commune) MELLINGEN

GRUENDUNGSJAHR: 1966 (established in the year)
EINRICHTUNGSJAHR: 1961 (equipped in the year)

JAHR (year)	KONTROLL-GANG (check-up round)	UNTERHALT (maintenance)	AUFNAHME (records)	AUSWERTUNG (analysis)	BEARBEITUNG (data processing)	PROFIL GEZ. (side view)
1961	*	*	*			*
1968	*	*				
1969	*	*	*			*
1971				*		
1973	*	*	*			
1975	*					
1976	*					
1977	*					
1979	*					
1983	*	*				
1984	*					
1988	*	*	*			
1989	*	*	*			

ANDERE ARBEITEN (additional activities)

1973	Aufnahme = Insel (recording = island)
1977	ZAUN INSEL (fence island)
1983	Freisägen des Wanderweges (pruning trees along the footpath)
1989	Vermessung (measurements)

Appendix C

An example of forest reserves record in the Swiss forest reserves databank
(Continuation)

PHYTOSOZIOLOGISCHE AUFNAHMEN DES GEOBOTANISCHEN INSTITUTES
(phytosociological mapping of geobotanical Institutes)

VEROEFFENTLICHUNGEN + DIPLOMARBEITEN
(publications + diploma works)

1958	MOOR, M.	PFLANZENGESELLSCHAFTEN SCHWEIZERISCHEN FL AUEN. MITT. SCHWEIZ. ANST. FORSTL. VERSUCHS., 34, 4
1969	HARTL, H.	VEGETATIONSKUNDLICHE NOTIZEN ZUM WALD- RESERVAT 'RISI' BEI MELLINGEN AG SCHWEIZ. ZEITSCHRIFT F. FORSTWESEN
1969	HELLER, H.	LEBENSBEDINGUNGEN UND ABFOLGE DER FLUSSAU VEGETATION IN DER SCHWEIZ. EAFV, 45, 1.
1970	KLOETZLI,F.	ZUR PFLANZENSOZIOLOGISCHE STELLUNG DER WALD VEGETATION IM RESERVAT 'RISI' SCHWEIZ. ZEITSCHRIFT F. FORSTWESEN
1972	RAPPO,H.	ANALYSE DE LA STRUCTURE DE LA RESERVE FORESTIERE DU RISI (MELLINGEN). TRAVAIL DE DIPL. INST. SYLVIC. EPFZ NR.177.

STRICT FOREST RESERVES IN EUROPE -- EFFORTS TO ENHANCE BIODIVERSITY AND STRENGHTEN RESEARCH RELATED TO NATURAL FORESTS IN EUROPE [1)]

by Jari PARVIAINEN *

ABSTRACT

Original forest structures are very rare in Europe. In 1995, COST Action E4: Forest Reserves Research Network was introduced by the COST Commission in order to promote co-ordination and enhance research in natural forests. The objectives are to create a European network of forest reserves, to collect ongoing research, to unify and standardise research methodology and to provide general access to a central data bank on forest reserves.

In order to maintain forest biodiversity in Europe, it is necessary to protect totally untouched reserves and to apply nature-oriented silviculture in production forests. Natural forests are generally accepted as being a good model on which to base nature-oriented silviculture. There are still approximately 3 mill. hectares of natural forests left in Europe (1.7% of the total forest area). The widest, continuous natural forests can be found in Finland and Sweden and in remote mountainous areas of Central and Eastern Europe.

Key elements of forest biodiversity have been identified, such as fire disturbance, dead wood component, etc., but their quantification is still very vague and speculative. The application of realistic nature-oriented silviculture requires a concerted effort to protect indigenous biodiversity, the influence of which has been underestimated in discussions on forest protection.

Due to the wide variation of human impact on forests, fragmentation, the degree of 'naturalness' of forests, vegetation zones and tree species composition, the concept of nature-oriented silviculture in the Nordic countries differs markedly from that in Central Europe. In the boreal zone the main emphasis lies on maintaining biodiversity, whereas in Central Europe the goal is to manipulate forest stand development towards the potential, original forest cover. In Central Europe, production forests are mainly artificial through alteration and cultivation practices (50-70%), whereas production forests in Finland and

1) Reprint from: Jari Parviainen et al. (eds.), Research in Forest Reserves and Natural Forests in European Countries, EFI Proceedings No. 16, 1999

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Sweden are semi-natural; here between 70 and 75% of forests result from natural regeneration.

INTRODUCTION

Forestry and silviculture have attracted unprecedented public attention in the 1990s world wide and throughout Europe. The following events have contributed to this development:

- Forest sustainability conferences and international conventions, protocols and agreements (Rio-declaration 1992, Ministerial Conferences for the Protection of Forests in Europe, in Strasbourg 1990 and Helsinki 1993, Helsinki Process, 1993, IPF-IFF United Nations Initiatives, since 1994)
- Forest-certification discussions (ITTO criteria, development of FSC, ISO-14000-norms, EMAS-environmental accreditation-systems and the introduced "country of origin-"labels)
- Climate change forecast and agreements (Kyoto 1997, Forests as sinks in carbon balance calculations)
- Low economic profitability in wood production and the use of wood as a renewable natural resource in Europe (ecobalance calculations)
- World wide campaigns promoting forest protection and those against the deforestation of tropical forests (e.g. introduced 10% – limit of WWF-International, i.e. protection areas 'hot spots')

Due to these developments, demands to change silvicultural practices and to protect the remaining remnants of natural forests in Europe have increased perceptibly. The application of traditional silviculture practice has changed and terminology has had to be reassessed. As a result of these developments and discussions, the current concept of silviculture includes, apart from wood production, an emphasis on maintaining forest biodiversity, recreational, landscape, protective and socio-economic, as well as cultural issues.

Biodiversity in forest ecosystems

The Helsinki process in 1994 defined the components of biodiversity in forest ecosystems (see Ministerial Conference on the Protection of Forests in Europe 1993, 1994 and 1996, Interim Reports on the Follow-Up of the Second Ministerial Conference 1995). With an ever-increasing amount of knowledge currently being generated these definitions seem to have been validated. Based on these definitions, endangered species are seen as indicators of change in forest ecosystems. Changes in the number and frequency of endangered species act as a warning if biodiversity becomes impoverished due to silviculture techniques. Thus, a number of endangered species have to be continuously monitored in order to asses 'forest quality'.

There are two approaches to maintaining biodiversity in forests: protection of vulnerable and rare ecosystems and sympathetic silvicultural-oriented practices being applied in production forests. For example, at a regional level, each country must implement protection measures in relation to rare and valuable forest ecosystems and a network of protection areas should be created. The density, representatives, size and the total protection areas in the network depends on the variability and types of forest stands, vegetation zones and forest condition. The general concept is that the protection network

should include, apart from old forests, other stand compartments at various stages of the development cycle.

Because total protection only secures a certain number of habitats and rare species at a very local scale, silviculture is essential for maintaining large-scale biodiversity in production forests, regionally. This includes the majority of forested areas, which in many countries means at least 80-90% of the total forest area. Silvicultural orientation in forestry practices determines the amount of forested areas, which are to be left completely outside commercial forestry activities. The hypothesis is that the closer to nature management activities are in production forests, the less there is a need for total protection of forests.

Natural forest is generally accepted as a suitable model for the realisation of nature-oriented silviculture. It is, therefore, necessary to study the various types of natural forests extant in Europe and apply results obtained to silviculture, where possible. The following summary outlines some preliminary results from the European-scale research project COST Action E4.

COST ACTION E4: FOREST RESERVES RESEARCH NETWORK

The primary aim of the COST Action E4: Forest Reserves Research Network, which was introduced by the COST Commission in 1995, is to promote the co-ordination and enhancement of research effort in natural forests in Europe. This would be achieved by the creation of a European network of forest reserves in order to gather ongoing research, to unify and standardise research methodology and to provide access to a central data bank for the exchange of research results.

COST is a framework for scientific and technical co-operation, which encourages the co-ordination of national research programmes on a European level. Within this framework financial support is given for the organisation of meetings, specific co-ordination tasks such as data bank construction and for the exchange of scientists through the Short Term Scientific Missions-programme. The research being co-ordinated is funded nationally. GOALS of the Action are to:

- compile and analyse all available information on forest reserves and ongoing research
- provide an inventory of published research reports on natural forests and forest reserves
- develop and harmonise research methodology for monitoring forest structure and ecosystem change
- promote the establishment of a permanent sampling plot system
- create a data bank for gathering information on forest reserves
- achieve a common consensus on terminology, management approach and protection status for forest reserves

The main outputs of the action will be a publication of country reports with data and definitions on forest protection and an inventory of research in natural forests and reserves, and a review of the models and methods for describing the structure of natural forests. A data bank on forest reserves, organisations, publications, research and primary results with unrestricted access for the participants will be established. This data bank on

European forest reserves will be located at the European Forest Institute, Joensuu, Finland.

Of all the "natural forests" in Europe the most relevant category to this Action are those which are strictly protected. They have been left to develop uninterfered with by man, in a state which is as original as possible. Most of these remnants are located in forest reserves and are generally protected by statute (see Figure 1).

19 European countries are involved in the project. The project is scheduled to last for four years ending in November 1999.

Detailed information was collected before the approval of this project between 1992 and 1995. The IBN-DLO Institute in the Netherlands organised the first European Forest Reserves Workshop in 1992 in Wageningen and devised a questionnaire on forest reserves (BROEKMEYER / VOS 1993).

A feasibility study on undisturbed and semi-natural forests in Europe was carried out by the European Forest Institute (EFI) in 1993, which was later accepted by the EU as a COST project. As its output, in 1994 EFI produced a series of research reviews on structure, succession and biodiversity of undisturbed and semi-natural forests and woodlands in Europe (SCHUCK, PARVIAINEN and BÜCKING 1994; PARVIAINEN, SCHUCK and BÜCKING 1995). The Action is currently structured around three working groups:

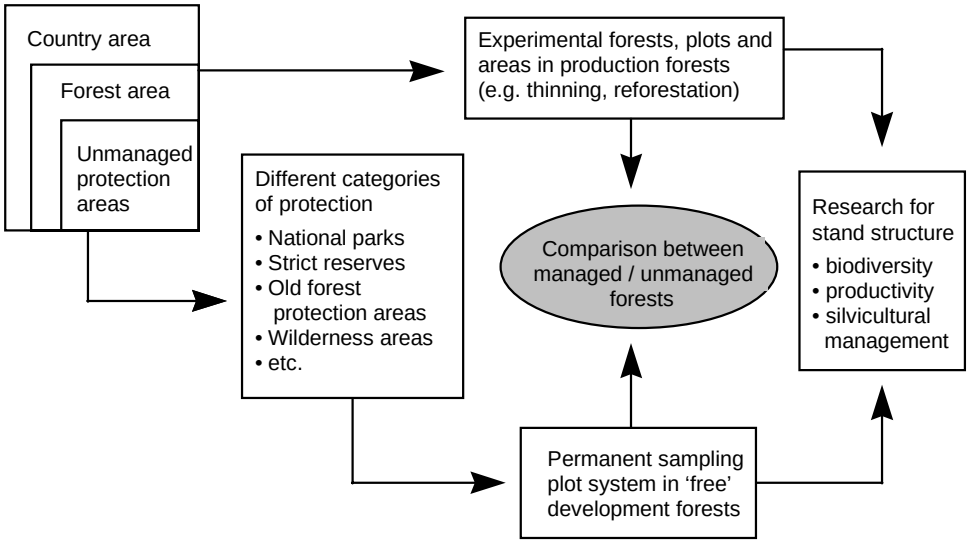
Management Committee (consisting of country delegates) Chairman: Jari Parviainen, Finland; Vicechairman: Konstantinos Kassioumis, Greece	
Working Group I Network creation Winfried Bücking, Germany	• definitions and terminology of protection areas • characteristics of existing reserves • a bibliography inventory
Working Group II Research methodology Eduard Hochbichler, Austria	• criteria for measuring forest stand,structure and regeneration • layout of the sampling plot system in forest reserves
Task Force / Working Group III Data bank Risto Päivinen, EFI, Finland	• creation of a typical on-line electronic database for forest reserves • standardisation of data collection

Prior to the end of October1998 the Action had organised the following meetings and excursions:

– 1st Management Committee Meeting in Brussels, Belgium, 4th of March, 1996

- 2nd Management Committee Meeting in Fontainebleau, France, 12/14th of September, 1996
- WG 1 meeting in Freiburg, Germany, 23/24th of January, 1997
- WG 2 meeting in Göttingen, Germany, 21-23rd of April, 1997
- 3rd Management Committee Meeting and Working Group 1 and 2 joint meeting in Finland, 30th of July-3rd of August, 1997 including a scientific excursion to forest reserves in Finnish Lapland and Russian Karelia
- 4th Management Committee and WG 1 and 2 joint meeting in Brussels, 24-25th of November, 1997
- 5th Management Committee and WG 1 and 2 joint meeting in Ljubljana, Slovenia, 26.-28th of May, 1998, including a scientific excursion
- 6th Management Committee and WG 1 and 2 joint meeting in Vienna, Austria, 15.-18th of October, 1998, including a scientific excursion

Figure 1: Forests relevant for the research in COST Action E4



The Action has also promoted research exchange under two calls of the Short Term Scientific Missions (STSM): scientists from 15 countries took part during 1997 and 1998 in a total of 20 missions.

PRIMARY RESULTS FROM THE COUNTRY REPORTS AND SOME OF THEIR POTENTIAL APPLICATIONS

Types of natural forests extant in Europe

It is difficult to provide a conclusive summary of the amount and area of natural forests in Europe because the policies and degree of forest protection varies a greatly from country to country. Apart from local climatic and edaphic conditions, reasons for these differences include traditional use of forests, their degree of originality, regional variation in continuous forest cover and concepts of protected areas, as well as permitted interventions.

During last 10-20 years in the Nordic countries, the primary goal of forest protection has been the preservation of old forest remnants. This type of forest protection maintains fauna, flora and other living organisms not subject to commercial forest operations. In contrast forests in Central Europe are protected as part of the wider landscape, as cultural entities or as specimens of 'original' nature.

In North America and Canada the reserve ideology applied in forest protection results in large, continuous areas being demarcated and left untouched. This kind of protection strategy is suitable in areas which, due to low population pressure, have not been affected by man to any great extent. Canada has been able to declare over 12% of its forests as legally protected. In addition, roughly 30% of commercial forests are essentially reserves because some of them are situated far from populated areas and have therefore, no human or industrial value.

This type of 'reservation' concept cannot be applied to the densely populated European Continent, where forests have been subjected to human influence for thousands of years. In Southern and Central Europe forests gave way to human settlements and were reduced to forest islands during the Middle Ages at the latest. Because of settlement activities such as hunting, mining, glass works and traffic, forested areas adjacent agricultural land were under constant pressure due to human activities (BÜCKING et al. 1994: ROMANE 1997).

Contrary to what is generally believed, human impact on forests in Northern Europe has also been extensive, though not as continually as in Southern and Central Europe, lasting mainly for 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 largely impacted upon by the ore mining industry (ESSEEN et al. 1997).
The principal activity which had most impact on Finnish forests was slash and burn agriculture; it was especially used 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% of the 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 forest industry.

Due to the continuous use of forests historically, there are few original, untouched virgin forests remaining in Europe. The largest virgin forests can be found in the boreal forest

zone from the European side of the Russian Federation, in the states of Komi and Archangelsk and in some parts of north-west Karelia near the Finnish border.

The European forest protection concept has been devised to be more versatile than that which exists in America. Forest protection includes different degrees and types of restrictions on forest areas with regard to their use. Forests selected on a regional basis combine to form a network. In Finland, for example, protected forest areas are located in the following areas: national parks, strict nature reserves, wilderness areas, protected peatlands, protected old forest areas, protected lake shores, herb-rich forest protection areas, ridge protection areas and protection forests of Lapland created to prevent shifting of the northern timber line. The EU/Natura 2000 -programme focuses on the protection of habitats which are especially valuable for birds and flora. In Finland, the protected forest areas with different categories amount to 15% of the total forested area (see Fig. 2, cf Table 1).

In terms of protecting mammals and birds there is a significant difference between Central European and Nordic countries where, in the latter, protected forests and production forest compartments are adjacent one another. Due to the continuous mosaic-like forest cover, large land animals, such as the bear, are able to move freely over the entire Southern Finnish region. Compressed by people, Central European forests have been fragmented into forest islands. Forests are mainly bordered by fields, settlement, roads or industrial plants. There are plenty of buffer zones, but large, continuous forest cover has disappeared. Borders between protected and production forests are generally vague in Nordic countries compared to the rest of Europe.

When comparing forest protection areas in different European countries the most interesting feature is the amount of strictly protected forests (Fig.1). They have been left to develop freely in a state which is as original as possible. The COST project, Forest Reserves Research Network, has outlined the various concepts and definitions related to protected areas and the amount of untouched forests extant in different European countries (SCHUCK et al.1994 – see Table 1 in Appendix 1). Preliminary estimates suggest that there are about 3 mill. ha of natural forests left in Europe, i.e. 1.7% of the total forest area. Their number cannot be further increased, but what is left, must to be carefully preserved and protected. The majority of these natural forest remnants are legally protected.

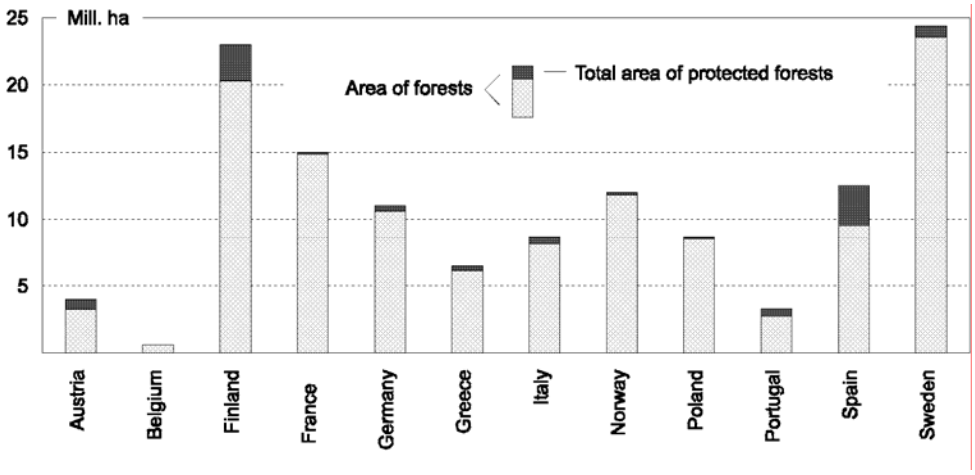
The largest continuous natural forest areas occur in Finland and Sweden, and in the mountainous regions of Central and Eastern Europe. The proportions of natural forest of the total forest area in Bulgaria, Romania, Finland, Austria, and Germany is 8%, 6%, 5.5%, 3% and 0.8% respectively. No natural forests remain in the Netherlands, whilst in Finland, there are 1.3 mill. ha of natural forest, which is circa one percent of the total forested area of Europe and nearly 43% of the European natural forest estate.

The use of 'Natural forests' in silvicultural model

It is generally accepted that natural forests are a basic model for the realisation of nature-oriented silviculture (LEIBUNDGUT 1978, 1982, 1986, 1989; SCHÜTZ 1986; SCHMIDT-VOGT 1991; THOMASIUS 1992; STURM 1993; PARVIAINEN / SEPPÄNEN 1994). It is, therefore,

necessary to analyse what types of natural forest exist in Europe and how they can be utilised as experimental areas for silviculture.

Figure 2: The area of forests and other wooded land and the total area of protected forests in selected European countries in 1998. (The different categories of protected forests outside of normal forest operations, mainly protected forest areas with rare and vulnerable ecological value, not areas for landscape management or protection from avalanches or erosion. Definitions based on national definitions. See also Table 1 in Appendix 1).



Though natural forests may be the basis for the realisation of nature-oriented silviculture, the natural forest model needs some conceptual clarification. It is necessary to distinguish between close-to-nature and nature-like silviculture (LEIBUNDGUT 1986; SCHMIDT-VOGT 1991; THOMASIUS 1992; STURM 1993; EDER 1997). The definition of close-to-nature silviculture implies that the development cycles of natural forests are mimicked and nature's own development potential and productivity are used in production forestry. In other words, management activities are guided, as far as is practical, by observed, natural forest dynamics. In nature-like silviculture, natural forest processes are transferred directly into silviculture. The latter, however, cannot always be the primary goal of sensible forest management because hazards and risks are not controlled in nature. If left entirely at the vagaries of natural forces, forestry would become economically unsustainable and would occasionally result in disasters occurring over large areas, e.g. fire, devastation by insects.

Natural forests develop in different ways throughout the various alternative vegetation zones. The development of northern, natural boreal forests is interrupted by disturbances and catastrophes, which destroy forest over large areas, thereby promoting forest regeneration. The most important disturbance factor in the boreal ecosystem is fire. Even today, millions of hectares of forest in any one year may be destroyed by fire over vast, untouched forest areas in Canada and Russian Siberia. Depending on factors such as moisture and the tree species composition, forest fires occur at intervals of between 30 and 120 years in the boreal zone (ESSEEN et. al. 1997). In peatland, on wet soils and on

islands, forest 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).

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.

Due to differences in the development cycles of natural forests, area of forest cover and differences in traditional forest uses, the concept of nature-oriented silviculture is different in the Nordic countries compared to Central Europe. In Nordic countries, in particular, 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. Silviculture is the management of coniferous forests. 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 1947; ANGELSTAM / PETTERSON 1997). Today, remaining remnants of natural forests may serve as valuable reference areas and research areas to aid in the attainment of objectives related to silvicultural management.

In Central Europe the basic principles of close-to-nature silviculture have generally been based upon 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 towards the original tree species composition for each particular site, as far as is practical (THOMASIUS 1996). Silviculture favours mixed forests dominated by deciduous trees (SCHÜTZ 1986). There is some demand for leaving strict reserves adjacent to production forests, which could serve as reference sites, thereby enhancing nature-oriented development in production forests (Der Wald hat ein Problem ... 1996; MAYER / SPELLMANN 1997).

The most relevant guiding factor in Central European silviculture has been the definition of naturalness (THOMASIUS 1996; KOCH et.al. 1997; Naturnähe Österreichischer Wälder. Bildatlas 1997; PETERKEN 1997). Generally speaking, naturalness in silviculture refers to those conditions and processes which have been affected negligently by man. The concept of hemeroby is thus defined, as applied to forestry. It implies the development of forest, uninterrupted or impeded by man, towards a natural climax state. This means potentially natural forest association where man has no longer interrupted the development and the vegetation has had time to develop up to its final state. In addition, the definition of naturalness helps to define the present quality and state of forests that exists in different countries.

The definition of naturalness is, however, not clearcut. There are many overlapping or closely related terms such as native, ancient woodland, virgin forest, old growth forest, primary forest and old forest (PETERKEN 1997). Furthermore, decisions will have to be made on how human impact will be accounted for in the definition. Account must be

taken of domestic-use of wood, the acquisition of heating and firewood or past selective felling, the results of which are still visible in the stand, and the impact of forestry practices which occurred 100 years ago. Also 'naturalness' classes will have to be defined on a proportional basis and adjusted to fit local conditions.

Austria, during the early 1990's, was the first country in Europe to carry out an inventory of the naturalness of its entire forest estate (Naturnähe Österreichischer Wälder. Bildatlas 1997). The following figures provide some examples of the naturalness of forests extant in a number of European countries:

Austria — Inventory results, published 1997, forest area 3.9 mill. ha

natural forests	3%
semi-natural forests	22%
moderately altered forests	41%
altered	27%
artificial	7%
total	100%

Germany — Alteration of tree species composition in the Black Forest (BÜCKING et. al., 1994)

	Prior to change	
	at time Ch.b.	today
spruce	3%	45%
beech	53%	19%
conifers	23%	65%
broadleaves	77%	35%
exotic tree species (douglas fir, red oak in whole Germany)	-	4%

Great Britain — (PETERKEN 1997)

67% plantations with exotic tree species (sitka, spruce and others)
83% of all ancient woods extend to no more than 20 ha

Finland — (PARVIAINEN / SEPPÄNEN 1994)

regenerated trough planting or by sowing	5.2 M ha	23%
natural regeneration	17.8 M ha	77%
in total	23.0 M ha	100%
absence of exotic tree species		

Sweden — (ESSEEN et. al., 1997, Statistik Δrbok för skog, 1996)

regenerated by planting	6.5 M ha	28%
natural regeneration	17.1 M ha	72%
in total	23.6 M ha	100%
exotic tree species, plantings with P. Contorta	0.5 M ha	2%

From current and historical data and records on forest structure, it is clear that Central European production forests are mainly altered or cultivated, whereas in Nordic countries, they are semi-natural. Even though about a quarter of forests have been established by sowing or planting in Finland and in Sweden, many resemble primary forest after fire succession due to the presence of natural seedlings in the regeneration areas, and the development of to be more or less mixed forests. Stand development is primarily influenced by management of these seedlings, especially thinning.

The need to elucidate biodiversity factors

The most important silvicultural development in the 1990s has been the focus on biodiversity factors in management. Research on forest biodiversity has expanded rapidly in recent years. In spite of this, quantification of, for example, how much dead wood to leave or how many key-biotopes should be left in forests to preserve threatened species, has not as yet been clarified. Decaying and hollow trees are important for the maintenance of biodiversity in both deciduous and coniferous forests because they support thousands of species, especially insects and decay fungi. In northern boreal forests, it has been calculated that about 35% of all threatened species are dependent on dead wood (ANNILA 1998). To put biodiversity into perspective, when all species in the Nordic countries are considered (c. 25 000), only 3,6% of the threatened category occur in forests. According to OECD- statistics (1991), 38% of mammals, 33% of birds, and 16% of vascular plants are threatened in Western and Middle European countries. The respective numbers for Finland are 11%, 6%, and 6%.

In Nordic countries it is estimated that not more than 2/3 of the known, threatened species can be preserved by silvicultural practices (ANNILA 1998). Little is known of up to 1/3 of these, some of which are extremely rare. Such species are most likely to have been rare even before the commencement of intensive forest production. There have been only occasional observations made of these species. In contrast, studies show that the number of threatened species in temperate zone forests varies according to the development stage of the forest and tree species composition. Both species number and diversity vary, depending on the age of the forest.

According to recent Finnish studies on threatened species, 90% survive adequately in production forests. The majority of the remaining species have always been rare and only appear in specific sites that differ markedly from the neighbouring ecosystems. These habitat types, which are known as key biotopes, are hardwood stands, herb-rich forests, grassland forests, ridges, rocks and gorges. These key biotopes are not considered for silvicultural purposes and are left untouched in order to preserve rare species. According to ‘quality’ analyses of silvicultural methods implemented in private forests, the key biotopes cover approximately 6% of the total forest area of Southern Finland (NIEMELÄ / ARNKIL 1997). Coincidentally, this figure is very similar to an estimate of key biotopes in German forests, i.e. 6-8% of the total forest area (Naturschutz im Wald 1997).

The recommended share of dead wood in production forests obviously depends on the composition of tree species and the stand-structure. A general recommendation is to leave

2-3% dead wood of the total growing stock, which in Nordic countries amounts to about 5-8m3 per hectare (PARVIAINEN / SEPPÄNEN 1994; WOLLSCHLÄGER 1996). A similar percentage has also been estimated for central European forests. In the temperate zone, however, a figure of 2-3% means double the amount of dead wood per hectare must be left compared to the boreal forest zone (Naturschutz im Wald 1997). An alternative method is to estimate the share of dead wood in each stand relative to a corresponding natural forest stand and to leave 10-12% of the volume of dead wood normally found in the latter (KORPEL 1997). Research is inconclusive as to what proportions of the total dead timber should be fallen and standing. Most common estimates suggest that the bulk of dead wood should be fallen, decaying wood.

Recommendations of the amount of fallen, decaying wood vary from 60 to 80% of the total dead wood component.

From the point of view of preserving living organisms and enhancing biodiversity, open areas should also be created in forests. If regeneration in high forests was replaced entirely by selection forests, open areas and their attendant living organisms, would disappear. In Finland, there are dozens of such species. Correspondingly, one of the drawbacks of fire prevention in modern silviculture is the extinction of living organisms, which are dependent on charcoal wood. There are about 40 such species in the Nordic countries. This is why the modern silvicultural guidelines recommend controlled burning in production forests in order to ensure adequate micro-habitats on a small scale for those organisms which are dependent on fire and charcoal wood (ANNILA 1998).

Additional costs to modern silviculture as a result of managing biodiversity

To date, no detailed economical calculations as to how much additional expenses will be incurred due to the incorporation of biodiversity aspects in silvicultural management, and whether wood production is reduced significantly. In practice, if the deadwood component is made up poor quality timber, useless for logging, it will not cause unreasonable additional costs to maintain the required deadwood volume. Practical guidelines favour fallen dead wood, because manual logging can be dangerous if standing dead trees fall during forest operations. However, if mechanical harvesting is applied, this danger can be averted.

According to a report on private forests in Finland, volumes would decrease by 5 to 7% if key biotopes are left, in addition to the required proportion of dead/decaying wood (NIEMELÄ / ARNKIL 1997). Preliminary calculations for Southern Finland suggest that the application of such techniques in modern silviculture would cause a reduction of about 10-12%, at most, in wood production, over the long term (JÄRVELÄINEN et al. 1997).

Similarly, here are no precise, published estimates in Middle Europe or Germany on the differences between ecological- and wood production-oriented silviculture. The city of Lübeck forests are a rare and important example of the implementation of ecological silviculture, which began in 1994. In Germany, a so-called Naturland-certificate may be awarded if ecological silviculture is applied. The requirements are: no clear cutting, no exotic tree species, no chemicals, selective felling only is allowed, 10% of the forest areas

must be set aside as reference areas, i.e. strict reserve areas, and the dead wood component must amount to 10% of the total tree volume.

The forest area around the city of Lübeck is an optimal site for European beech (*Fagus sylvatica*). During previous commercial forest activities, exotic tree species – especially Norway spruce, but also red oak and Douglas fir – were planted in the region. The long-term plan now is to develop the forest into beech dominated stands and to remove Norway spruce stands in favour of mixed forests. Other exotic tree species, such as Douglas fir, will not be maintained.

In January 1998, an independent evaluator (BORCHERS) published a report on the forests of the city of Lübeck, which assessed the economic implications as a result of current forest management. According to this report, the reduction in the level of silviculture and the establishment of reference areas created losses in wood production and increased the expenses related to silvicultural management amounting to between 80 and 240 DM /year/ ha. In conclusion, BORCHERS stated that this kind of forest management is only possible in forest parks, where there are no silviculture-related expenses. Thus, this type of silvicultural model is really only applicable in forests which are owned by cities or communities like Lübeck, where the additional costs can be covered by tax revenues. In private forests such silvicultural practices are unprofitable. However, the silvicultural model applied in the city of Lübeck does sets guidelines for ecological silviculture and quantifies the economic losses resulting from its implementation, which is of considerable benefit to the forest community generally.

CONCLUSIONS: NO UNIFORM SILVICULTURAL MODEL EXISTS

There is no uniform silvicultural model in Europe. In order to maintain biodiversity, different silvicultural and regeneration methods are required. Which methods to choose depends on the following parameters; climate, soil and tree species characteristics. At present, the main trend in European forestry is toward nature-oriented silviculture. The basic elements of nature-oriented silviculture are known for each forest zone, but the quantification of the properties that dictate how 'natural' silviculture is, have not been studied sufficiently and are not well understood. Quantification is required of such aspects as the amount of deadwood and the key biotopes that should be left. There is general agreement that by leaving deadwood and micro-biotopes in production forests a proportion of threatened species may be conserved. Nature-oriented silviculture serves both as large-scale protection of biodiversity and timber production, but thus far, the significance of the former remains underestimated in the general debate on forest protection. The feasibility of nature-oriented silviculture must always be evaluated on economic grounds. Experience shows that sustainable forest management has been most successful when forestry is profitable.

In order to preserve natural species diversity there must be open areas created in forests. If silvicultural orientation favours selection forests only, those species that live at the edge of forests and in open areas would become increasingly rare. It is necessary to carry out prescribed, controlled burning during regeneration procedures in Nordic countries, in order to conserve those species that are dependent on wood charcoal.

Research on biodiversity factors should be further consolidated and enhanced. There is an increasing need for an inter- and multi-disciplinary approach in order to link silvicultural management to zoological and botanical disciplines. Old, comparative, permanent experimental plots are important, because by re-analysing them, new data on untouched forests, and to varying degrees, managed forests, may be obtained, even in the short term. By increasing knowledge relevant to the implementation of nature-oriented silviculture, it will be possible to offset the continuing clamour for changes in silvicultural management.

Though nature-oriented silviculture in Europe must be defined carefully as knowledge increases, it can be concluded that the greatest threat to the quality of forests and their sustainability in Europe are external factors that emanate outside the forest, as opposed to underdeveloped silvicultural method. Air pollution poses an increasing threat to Central European forests. Carbon dioxide emissions and greenhouse gases, resulting in possible global warming are threats to forests, especially in peripheral areas in the north and on mountain slopes. It is necessary to reduce and monitor emissions on an international scale. Silvicultural procedures cannot eliminate for these effects. However, these effects can be offset, to some degree, by altering silvicultural operations.

In Europe, a serious problem is the underutilisation of forest growth. Annual fellings are only 65-77% of the annual growth. In order to maintain forests' resistance to outside factors, wood usage in Central Europe as well as in the Nordic countries should be increased. If forests are not managed and thinned, they become old and dense and consequently, there is an increasing amount of dead and drawn trees. The most serious practical problem is the thinning of young forests. If this procedure is neglected, the optimal, natural production capacity of forests may be lost.

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REFERENCES

ANGELSTAM, P. (1997) Landscape analysis as a tool for the scientific management of biodiversity. Ecological Bulletins 46: 140-170. Copenhagen

ANGELSTAM, P. / PETTERSON, B. (1997) Principles of present Swedish forest biodiversity management. Ecological Bulletins 46: 191-203. Copenhagen

ANNILA, E. (1998) Forest management and threatened species. Proceeding. Nordic symposium "New stand types in boreal forestry – ecological features and silvicultural consequences. February 10-11.1998, Vaasa.

BORCHERS, J. (1997) Kosten und Nutzen einer "Naturland" - Zertifizierung, 1997, Wiesbaden

BROEKMEYER, M.E.A. / VOS, W. (1993) Forest reserves in Europe: A review in Broekmeyer, M.E.A., Vos, W. and Koop, H. (eds.), 1993. European forest reserves. Proceedings of the European forest reserves workshop. PUDOC-DLO, Wageningen. p. 306.

BÜCKING, W. (1997) Naturwald, Naturwaldreservate, Wildnis in Deutschland und Europa (Natural Forests, Strict Forest Reserves, Wilderness Areas in Germany and in Europe) "Forst und Holz" Nr. 18:515-522

BÜCKING, W. / OTT, W. / PUTTMANN, O. (1994) Geheimnis Wald. DWR- Verlag. 192 p.

'Der Wald hat ein Problem – Wir haben eine Lösung' (1996) AFZ/der Wald 19:1066

EDER, W. (1997) Naturnahe, nachhaltige Forstwirtschaft in Zentraleuropa. (Sustainable Close-to-nature Forestry in Central Europe) "Forst und Holz" Nr. 20 .pp. 587-592

ESSEEN, P-A. / EHNSTRÖM, B. / ERICSON, L. / SJÖBERG, K. (1997) Boreal forests. Ecological Bulletins 46: 16-47. Copenhagen

Forest Report by the Federal Government (1997) Bundesministerium für Ernährung, Landwirtschaft und Forsten. Bonn. 54 p.

FRAMSTAD E. (1996) Biodiversity and sustainable Forestry in Norway – criteria and indicators. Sustainable Forest Management, TemaNord 1996:578. Copenhagen. pp. 89-94

FRIVOLD, L. H. (1996) Considerations about sustainable silviculture in Norway. Sustainable Forest Management, TemaNord 1996:578. Copenhagen. pp. 158-166

GEMMEL, P. (1996) Silviculture for sustainable forestry. Sustainable Forest Management, TemaNord 1996:578. Copenhagen. pp. 167-174

Interim Report on the Follow-Up of the Second Ministerial Conference, Ministerial Conference on the Protection of Forests in Europe, 16-17, June 1993 in Helsinki. (1993) Ministry of Agriculture and Forestry. Helsinki. 255 p.

JÄRVELÄINEN, V-P./ TIKKANEN, L. / TORVELAINEN, J. (1997) Metsien monimuotoisuuden turvaamisen taloudelliset vaikutukset. Summary: Economic effects of Preserving Forest Biodiversity in Finland. Helsingin yliopisto, taloustieteen laitos. Julkaisuja nro.15. Yksityismetsätalous. 96 p.

KEENAN, R. J. / KIMMINS, J. P. (Hamish) (1993) The ecological effects of clear-cutting. Environ. Rev. 1: 121-144.

KNUDSEN, J. E. (1996) Silvicultural methods and sustainability. Sustainable Forest Management, TemaNord 1996:578. pp. 184-194

KOCH, G. / KIRCHMEIER, H. / REITER, K. / GRABHERR, G. (1997) Wie natürlich ist Österreichs Wald? Ergebnisse und Trends. Österreichische Forstzeitung 1/1997: 5-8.

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" Nr. 21:619-624.

KOUKI, J. (ed.). (1994) Biodiversity in the Fennoscandian boreal forests: natural variation and its management. Annales Zoologici Fennici 31.1.

KUULUVAINEN, T. (1994) Gap disturbance, ground microtopography and the regeneration dynamics of boreal coniferous forests in Finland: a review. In Kouki, J. (ed.). Biodiversity in the Fennoscandian boreal forests: natural variation and its management. Annales Zoologici Fennici 31 (1): 35-51

LAWESSON, J. E. / BERTHELSEN, J. P. (1996) Biodiversity and sustainable forest management in Denmark. Sustainable Forest Management, TemaNord 1996:578. Copenhagen. pp. 95-102

LEHTONEN, H. (1997) Forest fire history in North Karelia: ecological approach. University of Joensuu. Faculty of Forestry, Research Notes 59. 23 p.

LEIBUNDGUT, H. (1978) Über die Dynamik europäischer Urwälder. Allg. Forstz. 33, 686-690

LEIBUNDGUT, H. (1982) Europäische Urwälder der Bergstufe. Bern, Stuttgart: Haupt.

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.

MEYER, P. / 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, 16-17 June 1993. (1993) Documents. Helsinki. The Ministry of Agriculture and Forestry, 56 p.

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. Helsinki. 20 p.

Ministerial Conference on the Protection of Forests in Europe, Progress report. (1996) Ministry of Agriculture, Rural Development and Fisheries, Lissabon. 62 p.

Naturnähe Österreichischer Wälder. Bildatlas (1997) Bundesministerium für Land- und Forstwirtschaft. Wien. 39 p.

Naturnahe Waldwirtschaft in Nordhein-Westfalen. (1997) Ministerium für Umwelt, Raumordnung und Landwirtschaft. 50 p.

“Naturschutz im Wald” Generationenvertrag für Mensch und Natur. (1997) Deutscher Forstverein e. V., Niedenstein. 38 p.

NIEMELÄ, H. / ARNKIL, R. (1997) Metsäluonnon hoito hakkuissa ja metsänuudistamisessa. Tapio, moniste.

PARVIAINEN, J. (1996) Silviculture, management, techniques and sustainability. Sustainable Forest Management, TemaNord 1996:578. Copenhagen. pp. 140-146

PARVIAINEN, J. / SEPPÄNEN, P. (1994) Metsien ekologinen kestävyys ja metsänkasvatusvaihtoehdot. Metsäntutkimuslaitoksen tiedonantoja 511. Vantaa. 110 p.

PARVIAINEN, J. / SCHUCK, A. / BÜCKING, W. (1994) Forestry research on structure, succession and biodiversity of undisturbed and semi-natural forests and woodlands in Europe. In Paulenka, J. and Paule, L. (eds.). Conservation of Forests in Central Europe. Proceedings of the WWF Workshop held in Zwolen, July 7.-9.1994. Autora Publishers. pp. 23-30

PARVIAINEN, J. / SCHUCK, A. / BÜCKING, W. (1995) A Pan-European system for measuring biodiversity succession and structure of undisturbed forests and for improving biodiversity-oriented silviculture. In Bamsey, C.R. (ed.). Proceedings: Innovative Silviculture Systems in Boreal Forests, A symposium held in Edmonton, Alberta, Canada, October 2-8.1994. Edmonton. Pp. 77-82

PARVIAINEN, J. / BÜCKING, W. (1997) Strict forest reserves in Europe. Effort to enchange biodiversity and strengthen the research of natural forest in Europe “Concepts of naturalness”. Programme and Abstracts of the Conference: Naturalness and European Forests in Strasbourg, France. 26.-29.10.1997. p. 112

PARVIAINEN, J. / PÄIVINEN, R. / UUTTERA, J. / VARMOLA, M. (1998) The State of the art of forestry related research in natural forests in Finland. Manuscript for COST Action E4 Country Reports. COST Commission and European Forest Institute.

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

ROMANE, F. (1997) Some remarks on spontaneous forest succession in the Mediterranean Region. Invited paper.COST Action E4: Forest Reserves Research Network meeting in Pallas-Ounastunturi, Finland 30.-31.7.1997.Manuscript for COST Action European Forest Institute. Joensuu

SCHMIDT-VOGT, H. (1991) Naturnahe Fichtenwirtschaft. Heft 31. Wilhelm-Münker-Stiftung. 55 p.

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 p.

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. Zeitschrift für Ökologie und Naturschutz Nr. 2. Gustav Fischer-Verlag. pp.181-192

THOMASIUS, H. (1992) Prinzipien eines ökologisch orientierten Waldbaus. Forstw.Clb. 111,Verlag Paul Parey, Hamburg und Berlin. pp. 141-155

THOMASIUS, H. (1996) Geschichte, Anliegen und Wege des Waldumbaus in Sachsen. Schriftenreihe der Sächsischen Landesanstalt für Forsten, Waldumbau. Graupa. pp. 11-52

TOIVONEN, H. (1996) Preserving biodiversity in Finnish forests- some botanical aspects.Sustainable Forest Management, TemaNord 1996:578. Copenhagen. pp. 78-88

Unser Wald. Natur und Wirtschaftsfaktor zugleich. (1998) Bundesministerium für Ernährung, Landwirtschaft und Forsten. 51 p.

WOLLSCHLÄGER, L. (1996) Totholzforschung in borealen Wäldern am Beispiel einer Fallstudie im Urwald Multiharju (National Park Seitseminen, Finland). Albert-Ludwigs-Universität, Freiburg. 69 p.

Appendix 1

SUMMARY OF THE COST E4 COUNTRY REPORTS

PROTECTION OF FORESTS AND STRICT FOREST RESERVES

The first forest reserves in Europe were established as early as the beginning of the 19th century. On the other hand, agriculture has been the predominant form of land use and natural forests, more often than not, have survived only in sites unsuitable for cultivation or where logging is unprofitable. This has also affected the ecological representatives of the resultant protected areas. Improving the representatives of forest reserves has been the primary aim of forest protection in recent times.

Many of the countries engaged in the COST E4 Action have undertaken detailed programmes aimed at the protection of natural forest ecosystems. In addition, nature conservation legislation has recently been reformed in many countries and new forest reserves have been created. These countries include Austria, Belgium, Finland, Denmark, Germany, Hungary, Ireland, the Netherlands, Norway, Russia, Slovenia and Sweden. In general, it can be stated that the need to conserve natural forest ecotypes has been recognised and has lead to the establishment of forest and nature reserves in all of the participating COST E4 Action countries.

Due to past, diverse land use pressures, natural forests area has decreased extensively in all European countries. However, few detailed nation-wide inventories on the naturalness of forests have been made. In several countries serious efforts have been made to increase forest area. In the majority of countries, forests have been altered significantly. Thus, European countries differ widely in relation to forest protection policy and its implementation.

Short summary by countries

Austria carried out an inventory of ‘forest naturalness’ in the 1990's. The Natural Forest Reserves Programme was initiated in 1995 and contributes to the implementation of an overall strategy of maintaining and improving forest biodiversity. The objective is to provide at least one Natural Forest Reserve for each natural forest community in the ecoregions. In addition to forest reserves, nearly one fifth of the total forest estate is classified as ‘protection forest’. These forests, which include protective, recreational or general economical functions, will be preserved through limited forest utilisation and specific silvicultural management operations.

In Belgium the Law on Nature Protection enacted in 1973 promotes nature protection throughout the country. The three regions of Belgium, i.e. Brussels, Flanders and Wallonia, have their own separate administration and legislation for forestry and nature protection, and only in Flanders does there exist a specific Forest Decree. The Flemish Forest Decree, passed in 1990, has lead to the establishment of strict and specially managed forest reserves. In all three regions, forests are also protected in official nature reserves.

In Denmark both forest and protected forest areas have increased rapidly during the 1990s. The Danish National Strategy for Natural Forests, published in 1994, outlines a medium-term strategy up to the year 2040. One of the goals is to preserve the remaining natural forests, in addition to traditional management systems. Protected forests should, by 2040, account for 10% of the total forest area. A network of strict forest reserves was established in 1994.

In Finland large areas of forests are strictly protected under different categories of protected areas. The areas that are afforded legal protection are, as a rule, left untouched. The Revised Nature Conservation Act came into force in 1997. The basic network of reserves has been complemented by programmes aimed at the conservation of specific habitat types, i.e. 290 000 ha of old growth forests, herb rich forests, peatlands etc. The implementation of the EU NATURA 2000 programme will include previously unprotected forest areas. In addition, in a similar area of forest, restricted wood production occurs. Such areas include areas near the northern timber line and forests managed for recreation.

About 1% of the forests in **France** are subject to various statutory nature conservation measures. These include Bio-reserves, which are areas of distinct ecological interest. Bio-reserves in forests are divided into special and strict forest reserves. It is planned that the network of Bio-reserves would reach a total area of at least 30,000 ha by the end of the century.

In Germany unmanaged, protected forests can be found in the network of strict Natural Forest Reserves, established for nature conservancy and scientific purposes, and in unmanaged areas of National Parks and the Biosphere reserves. Initially, the goal was to preserve the complete range of forest communities, but lately the need for larger areas has been recognised. Policy and management of protection areas varies widely in the 16German states.

In Greece a law introduced in 1971 added new categories of protected areas. The law includes forestry legislation that addresses faunal, floral and habitat protection. The categories important for forest protection are the strictly protected core areas and peripheral zones of National Parks and Aesthetic Forests. In the protected Natural Monuments category there are also valuable forest areas.

In Hungary, legally protected forests occur in National Parks, Landscape Protection Areas, Nature Reserves or Forest Reserves. The Hungarian Forest Reserve Network was established in 1991. The reserves are forest areas set aside to monitor natural dynamics of forest ecosystems and thus, any intervention is prohibited. The areas are located within existing nature reserves.

Ireland is at present launching two new categories of conservation areas: National Heritage Areas and Specific Areas for Conservation. These areas include all Nature Reserves and National Parks, as well as important semi-natural forests, which lie outside Parks and Reserves. These areas are situated both on state-owned and private lands. The total area of woodland within all these areas has not yet been fully quantified.

In Italy during the 1970's two lists of the most important biotopes were published. These lists have formed the basis for the subsequent establishment of a large network of Parks,

and State and Regional reserves. Most of the areas include a strict reserve core where access is only allowed for scientific purposes.

In the Netherlands forests, where nature conservation is the main management goal, cover 30% of the total forest area, and only a fraction of these are Strict Forest Reserves. In many cases these areas are also managed for recreation, landscape or low level wood production. The Dutch Forest Reserves Programme was initiated in 1983, with the principal aim being scientific research. Although the areas are strictly protected, planted forests can also be included. Each forest reserve represents a specific site and forest type.

Norway has large National Parks, mainly in the alpine regions. The first reserves consisted of either wilderness or typical biotypes. In the last decade, focus has increased on the conservation of biodiversity; e.g. productive forest areas in the lowlands, and special threatened areas in newly created ecosystems, e.g. scrub development. There are separate action plans designed to create a network of forest reserves for both broad-leaved, deciduous forests and coniferous forests. An additional plan aims to protect 120 km2 of productive coniferous forests before year 2000.

Environmental legislation in **Portugal** has been reformed recently and contain new protection categories, in addition to the existing National parks and Nature reserves. Protected areas may contain special zones called 'Strict Nature Reserves', where human activities are restricted to scientific studies only. Semi-natural forest sites have also been included in the EU NATURA 2000 Network.

The **Russian** network of reserves and other protection categories has been developed since the beginning of 20th century. A priority is to increase the area of forest reserves in the near future. In addition, a large area of forests belong to a special category, which is managed for specific purposes, such as pre-tundra forests, protected riverine zones, research and educational forests.

Protected forests in **Slovakia** can be divided into protective forests with conservation and ecological functions, and special purpose forests, which are situated in watershed and emission areas. In addition to all other categories of protected areas, there are strictly protected forest reserves, many of which are part of National Parks, Biosphere reserves and protected landscapes.

In Slovenia the expansion of forest reserve network to increase the representatives of forest biotypes began in the 1970's. During the 1990s the area covered by the network has reached 1% of the total forest area. These reserves are strictly protected, with the principal aims being nature conservation and research. In addition to reserves, forests are also protected in protective forests, forests with subordinate productive functions, and in ecocells.

In Spain many protected areas have been created during the last 15 years. The Natural Parks are the most important category of protected areas, however, they do not fully represent the range of natural forests in Spain. Stronger protection is afforded in small Nature Reserves, especially where they occur as special zones in National Parks and Natural Parks. Because these areas often have their own separate administration, there is no integrated information available about the total protected forest area.

Sweden is currently revising the National Park system, where more emphasis will be put on regions outside the previously protected arctic-alpine mountain region. Natural forests

were intensively studied during the first nation-wide inventory of valuable forests in between 1972 and 1985. Most of the forests identified in the inventory were protected by 1992 and a new programme is being implemented to systematically protect valuable forests. Generally, forest reserves, as well as other legally protected areas, are left to develop freely.

In the United Kingdom, a new law enacted during the 1980s, afforded greater protection to conservation areas. Woodland is protected via a variety of mechanisms including the designation as Sites of Specific Scientific Interest (SSSI), ownership/management by conservation organisations, and local or national bodies sympathetic to nature conservation. SSSIs have been selected to represent the range of British woodland types and to conserve rare species. Many of these areas are managed as coppice, high forest, wood-pasture or minimum intervention areas according to the characteristics of the site and the management of the immediate, surrounding area. Nature conservation agencies aim to establish a series of minimum intervention sites, where no silvicultural treatments will be permitted.

RESEARCH IN FOREST RESERVES AND NATURAL FORESTS

Most countries participating in the COST E4 Action are determined to establish a representative network of strict forest reserves. These areas are scientifically important, particularly in countries where natural forests represent only a small proportion of the total forest area. Forest reserves are important for research on natural forest dynamics, especially in Central-European countries. In Scandinavia, natural forests outside reserves have been, and still are, very valuable for research.

Traditional basic research on vegetation and structure of natural ecosystems has increased, particularly during the 1990s, with greater emphasis on silvicultural techniques, as a result of the current focus on sustainable forest management and the preservation of biodiversity in managed forests. Knowledge on the dynamics of natural forests is very relevant to current and future forest management. Due to the demand for more ecologically-oriented silviculture, many countries have launched research programmes focusing on biodiversity and/or ecological research in forest reserves.

Short summary by countries

In Austria, research to date on natural forests has focused mainly on the survey, documentation and evaluation of forest structure-related data. The main activities on natural forests at present, are linked to the Natural Forest Reserves Programme. A network of observation plots has been established in forest reserves.

In Belgium forest research initially focused on productivity and the potential of exotic species. A more ecologically-oriented research programme has developed since the 1980s. Current research topics include, ecology of old forest plant species, evaluation of endangered species, methodology for the quantification of biodiversity and basic inventories of forest reserves.

In Denmark a basic research and a long term monitoring programme in natural forests have been formulated. Although forest dynamics have not previously been studied widely, pollen analysis has been used to study vegetation dynamics. Studies in natural

forests are considered important in the process of developing nature-based forest management, especially as a result of extensive reforestation programmes.

In Finland natural forests have been studied since the 1920s when, at that time, basic knowledge of natural forests dynamics was gathered. Up to the 1990‘s there has been little research activity specifically on natural forests, although results of forest management studies have often been compared to undisturbed forests. In recent years several research programmes concerned with natural forests have been established focusing on fire ecology, forest dynamics and structures of natural forests. The most important permanent plot network in natural forests was established in 1993 by Metla including more than 250 different natural forests.

Strict forest reserves have been established in **France** to study and observe forest dynamics and environments, untouched by man. In each region, a scientific committee controls the inventory and scientific programme within the reserves.

In Germany, most research activities have focused on vegetation studies: stand type, stand structure, vegetation mapping and plant inventories. Recently, faunistic studies have been initiated. In addition, an initiative to implement a monitoring programme in unmanaged beech ecosystems has been suggested. Research often focuses on the dynamics of natural forest reserves for the benefit of silviculture in production forests. Ongoing research includes standard surveys of permanent plots or core areas in forest reserves.

In Greece the Forest Research Institute of Athens established a large number of experimental plots throughout the country in the 1960s. The control plots on unmanaged areas provide data on natural forest development. Recently, the creation of a network of plots in forest reserves has been discussed. At present, a number of studies are focusing on silvicultural research in natural forests.

Traditional forest research in **Hungary** has focused on either floristic, faunistic or succession in managed oak woods. Presently, a network of forest reserves in natural forests is being established for research purposes. A standard monitoring scheme is being planned for these areas, and systematic research has already been ongoing in some reserves since the 1980s.

A number of research projects concerning various aspects of oakwood ecology were initiated in **Ireland** during the 1970s. In general, there is a paucity of published stand structure data for Irish woodlands. Presently, a comprehensive programme of monitoring and scientific research is being undertaken in a semi-natural oakwood, which serves as the flagship site of a proposed Irish Ecological Monitoring Network. Palynological and soil research techniques have also been traditionally employed to study the development of natural forests.

The **Italian** Forest Research Institute established a research programme on forest areas of peculiar interest in 1952. Of the network of permanent plots some still remain. The aim was to study the evolutive trends of the main forest ecosystems. Recently, new research areas have been established within several Natural Parks. Phytosociological methods are being used to classify forest ecosystems in order to characterise their dynamics. In addition, the impact of recreation on the protected areas is being assessed

Research-related goals of the Forest Reserve Programme in **the Netherlands** are inventory and analysis of spontaneous forest processes. For these purposes, permanent plots have been established. The information gathered is also important for the implementation of the Dutch National Long-term Forestry Plans, which aim at more natural forest-oriented management.

Few research projects have been carried out in **Norway**, in nature reserves, though considerable research has been done in natural and managed forests outside of reserves. This work has focused on forest history, utilisation and disturbance of forests, forests structure and dynamics, fragmentation, multiple use of forests etc. Natural forests will be the focus of research, – for example a current, large research project on biodiversity, – although no project is specifically targeted on forests reserves.

There is no special research programme focused on protected areas in **Portugal**. The most common studies have dealt with vegetation dynamics. Since fire is a major cause for concern in Portugal, issues related to fire prevention and vegetation recovery after fire have been studied in protected areas. In addition, faunistic studies of endangered species have been carried out.

Almost all forest research in the **Russian** taiga zone has been carried out in natural forests subject to various forms of disturbance. During the early years of the 20th century, information on forest resources was collected, a classification system of forest types was created and a permanent sample plot experiment was established. Presently, State Forest Reserves and National Parks have their own research programmes. Other institutions study natural taiga forests and natural forest are included in a number of other studies. Forest biodiversity and the effects of climate change are the current focus areas.

Research on the structure of natural forests has a long tradition in **Slovakia**. Current research of untouched forests can be classified into two categories: (1) detailed investigations of selected virgin forests, i.e. structure and development, growth and yield, regeneration processes and life cycle and (2) studies on anthropogenic impacts on forests, i.e. regeneration under different degrees of pollution stress, changes in soil chemical composition and physiological processes measured by dry mass extracts.

During the earliest phase of forest research in **Slovenia** the primary focus was toward stand structure and dynamics. Subsequently, research on stand structure continued and a new network of permanent sample plots was established. Since the 1980s, more emphasis has been placed on an interdisciplinary approach and on comparative research between forest reserves and managed forests, which have developed under similar edaphic conditions.

Nature reserves in **Spain** are not monitored in a co-ordinated fashion, although a pilot monitoring programme has been carried out in one of the National parks. Most work on the ecology of forests has been done in a limited number of the various forest types extant in Spain. However, a lot of research has been done on helm oak forests. Other forest types have been studied from a biogeochemical point of view.

Swedish Nature Reserves are monitored in permanent plots within the National Forest Inventory, i.e. measurements extended to reserves in 1994, and in the national network of integrated monitoring plots established in the late 1970s. A lot of research has been carried out on silvicultural methods, especially in experimental forests, which were

established nearly 70 years ago throughout the country. Scientific research has not been systematically directed to, or carried out in the Natural Parks. Recently, new projects concerning threatened species, indicators of biodiversity and lichens as environmental indicators have been initiated

In the United Kingdom research has been carried out on natural processes or on species specifically associated with minimum intervention management, in addition to direct studies of minimum intervention areas themselves. For example, historical and palaeoecological studies of past species composition have been done as well as studies on woodland management, succession, species indicative of old growth conditions, comparative studies of protected and managed forests, and the structure and dynamics of canopy, shrub layer and ground floral zones.

Specifications for the statistics of the forest area and forest protection

The headings in Table 1 are explained in more detail as follows:

1. **Forest and other wooded land, area of forests**
   - see explanations as separate page
   - use national definition[1] / or FAO 1992 definition (indicate which one is used)
2. **Naturalness (degree of human influence on forests)**
   a) natural forests = virgin forests, primeval forests, untouched, old growth forests
      - original forest cover (only natural regeneration can occur)
      - uninfluenced by human activities for specified time

   b) semi-natural forests = consist of tree species which occur naturally on a specific site
      - only natural regeneration (no planting, no seeding)
      - human influence allowed (traditional uses like selection cutting, coppicing, slash and burn cultivations)
      - mainly multipurpose or production forests at present

   c) altered forests = no more necessarily original forest composition (mainly production forests)
      - planted / sowing after cutting, artificial regeneration
      - includes also exotic tree species, or native species out of their natural range
      - afforestation of abandoned agricultural land
3. **Strict forest reserves** = strictly protected forests (left for free development without human influence) Note! This is the most important fragment for COST E4.
   - total area in hectares
   - number of reserves
   - average size / or range
4. **Total area of forest reserves** = different categories of protected forests, forest areas outside of normal forest operation (management)

[1] Definitions: see more detailed in: 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. European Forest Institute, Working papers 3. 62 p.

- mainly protected forest areas of rare and vulnerable ecological / biodiversity value
- not forest areas for landscape management
- not forest areas for protection of erosion, water, avalanches

Table 1: Area of strict forest reserves and natural forests in European countries. Data based on country reports and forests statistics. For explanations, see 'Specifications' on previous page.

Country	Area of forests area (1000 ha)	Forests of total land area (%)	Area of strict forests reserves (ha)	Number of strict forests forest reserve	Ave. size or range of strict (ha)	Total area of protected forest ha of forests	Total area of protected forest % of forests
Austria	3924	47	6072	159		755000	19,2 %
Belgium	623	11	1734	46	39	~5000	0,1 %
Bosnia-Herzeg.	2589	51	3125	27		25506	1,0 %
Bulgaria	3357	30				335000	10,0 %
Croatia	2485	44	2856	32		181405	7,3 %
Czech	2637	33	25000	103	2-2500	175000	6,6 %
Denmark	445	11	5086	292	17	890	0,2 %
Finland	23000	76	1300000	311	4180	2700000	10,7 %
France	15156	28	14000	30	1-500	180000	1,2 %
Germany	10700	30	24000	659	36	400000	4,0 %
Greece	6513	49	142000	39		951700	14,6 %
Hungary	1738	18	4000	69	58 / 3.4-300	327178	18,8 %
Ireland	570	8	5736	33	174	5736	1,0 %
Italy	8700	29	1841	4		560409	6,4 %
The Nether.	334	10	2198	48	5-500	18500	5,5 %
Norway	11950	37	148000	160		199500	1,7 %
Poland	8726	28	3687	106	44	183246	2,1 %
Portugal	3306	37	1841	4		560409	6,3 %
Romania	6370	27		55		527000	8,3 %
Russia (eur.)	132341	39	1726			39956	3,0 %
Slovakia	1920	42	15428	76 (19)	203	270000	14,0 %
Slovenia	1050	52	10420	186	56		
Spain	12511	25	32644	87	375	3000000	24,0 %
Sweden	24400	59				832370	3,4 %
Switzerland	1186	29	1018	39	30	13529	1,1 %
UK	2300	10		81			

Factors affecting the comparability of the forest area data

This review is based on KÖHL, M., PÄIVINEN, R. TRAUB, B. and MIINA, S.: European Forestry Information and Communication System. Reports on forestry inventory and survey systems. European Commission 1997. Volume 2. Comparative study, pp. 1265-1322.

One major cause of differences is the definition of forest (Table 2.). For instance, the Scandinavian countries define the forest land using the productivity and tree growth as the defining factor. In the most European countries the definition of forest land can be based on crown cover combined with tree height. The FAO definition requires, that area classified as forest should have a crown cover of 10% and a height of trees of 5 meters.

Figure 1 shows the variation of the growing stock volume depending on the density and structure of the forests classified according to the forest land area.

Also other definitions are used differently in different countries due to their management practices and land use history. The most of the Southern European countries have large areas of shrubland and coppice forests and only a few amount of high forests. The naturalness of forests is often described with different classifications or the definitions have different meaning. Only few countries have made a nation-wide inventory where naturalness of the forests has been evaluated.

The statistics available varies as well, because often the data is collected with different methods. The accuracy of the data can alternate also because of the inventory methods used. Exact information does necessarily not exist about all specific subjects and approximations have to be used. For example, the precise area of forests in the nature reserves is often not known.

Figure 1: The total volume of the forests in some European countries classified according to the forest area.

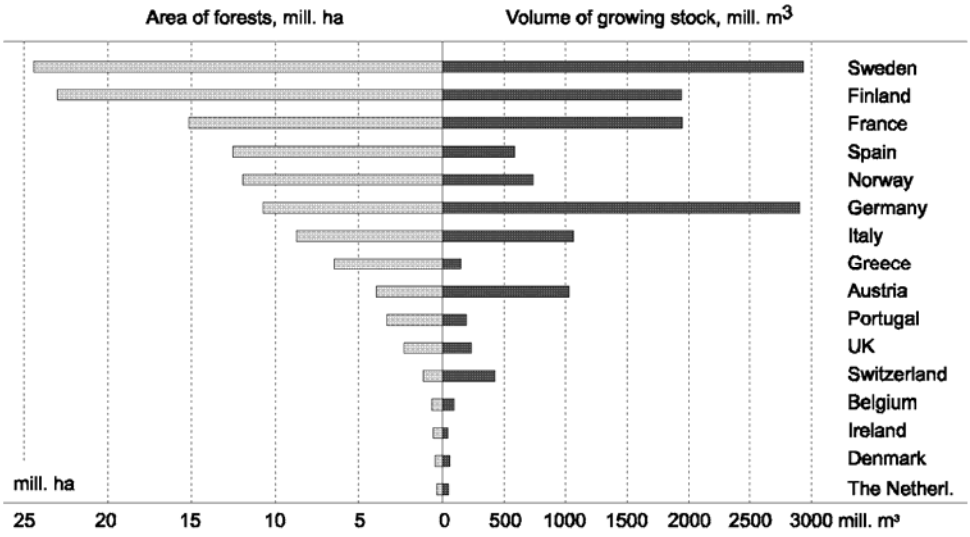

Table 2: Definition of forest area and other wooded land in several European countries.

Country	Min. width	Min.crown cover	Min. area	Min. Potential production	Comments
Austria	10 m	30 %	0.05 ha	-	
Belgium	9 m / 25 m	- / 20 %	0.1 / 0.5 ha	-	
Denmark	20 m	-	0.5 ha	-	trees in the forests should be able to grow taller than 6 m
Finland	-	-	0.25 ha	1 m3/ha/a	
France	15 m	10 % or 500 stems/ ha with c.b.h. < 24.5 cm	0.05 ha	-	
Germany	10 m	-	0.1 ha	-	
Greece	30 m	10 %	0.1 ha	-	large coppice forest
Ireland	40 m	20 %	0.5 ha	4 m^3/ha/a (conifer) 2 m^3/ha/a (broadleaf)	
Italy	20 m	20 %	0.2 ha	-	large coppice forest
the Netherlands	30 m	20 %	0.5 ha	-	
Norway	-	-	0.1 ha	1 m^3/ha/a	
Portugal	15 m	10 %	0.2 ha	-	large coppice forest
Spain	20 m	5 %	0.25 ha	-	large coppice forest
Sweden	-	-	0.25 ha	1m^3/ha/a	
the United Kingdom	50 m	20 %	2 ha	-	

Source: Study on European Forestry Information and Communication System. Reports on forestry inventory and survey systems. European Commission 1997. Volume 2. Comparative study, pp. 1265-1322.

Protection of virgin forests and establishing new forest reserves are preconditions for successful scientific research in natural science. They are also of importance for conservation of the natural heritage and promotion of other social functions of the forest.

For forest management practice it is vitally important to gain insight into the structure and development of natural forests. Therefore, forest reserves are reference sites for assessing the efficiency of close-to-nature forest management.

The international professional public is well acquainted with the fact that the largest remains of temperate virgin forests in Europe are situated in Eastern and Central Europe, for instance, Bialowieza in Poland or Peručica in Bosnia and Herzegovina. It is less well known, however, that in these countries there is a rich tradition of protection and research of forest reserves.

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