2nd Symposion on Fire Ecology

Institute of Forest Zoology
The University of Freiburg

Bertoldstrasse 17
D-7800 Freiburg

24 - 27 May, 1983

Program
Map of Localities
Abstracts
List of Speakers
Information on Forestry in
Germany and the Black Forest

Tuesday, 24 May 1983

14.00 - 19.00	Arrival of participants and registration, Institute of Forest Zoology, Bertoldstr.17
15.00	Meeting of leaders of IUFRO Subject Group S.1.09 (Forest Fire Research)
19.30	Informal gathering, Hotel "Bären" (Oberlinden 12, see map)

Wednesday, 25 May 1983

9.00	Welcome address by the Dean of the School of Forest Resources
9.15	Opening address by J.G.GOLDAMMER
9.30	Coffee break
10.00	R.E.MARTIN and M.W.DIEMER (USA): Grundlagen der quantitativen Feuerökologie
10.30	T.KARLIKOWSKI (Poland): The effects of fire on plant environment in pine tree stands
11.00	P.DELABRAZE and J.C.VALETTE (France): Das Feuer als Methode der Erhaltung des französischen Mittelmeerwaldgebietes
11.30 - 12.00	Discussion
12.00	Lunch break
14.00	C.CALABRI (Italy): Experience and prospects for prescribed fire in Italy
14.30	J.A.VEGA, S.BARÁ and M.C.GIL (Spain): Prescribed burning in pine stands for fire prevention in the northwest of Spain: Some results and effects
15.00	L.TRABAUD (France): Prescribed fires and their application on a *Quercus coccifera* L. Garrigue
15.30	Coffee break
16.00	F.C.REGO, J.M.DaSILVA and M.T.CABRAL (Portugal): The use of prescribed burning in the northwest of Portugal
16.30	C.S.CRUZ (Portugal): Propagation risk of prescribed fires in a forest park

Wednesday, 25 May 1983 (cont.)

17.00	R.E.MARTIN (USA): Jetzige und zukünftige Nutzung des verordneten Brennens im Westen der Vereinigten Staaten
17.30	L.LIACOS (Greece): Prescribed burning and grazing: Valuable tools in management of mediterranean warm conifer forests
18.00 - 18.30	Discussion
19.30	Reception by the Mayor of Freiburg (Old Town Hall, see map)

Thursday, 26 May 1983

9.00	R.VELEZ (Spain): Recent droughts and forest fires in Spain
9.30	S.BARÁ and J.A.VEGA (Spain): Effects of wildfires on forest soils in the northwest of Spain
10.00	Coffee brak
10.30	L.TRABAUD (France): Recovery of Pinus halepensis Mill. woodlands after wildfire
11.00	J.G.GOLDAMMER (Germany): The use of prescribed fire in South American pine plantations
11.30 - 12.00	Discussion
12.00	Lunch break
14.00	T.KARLIKOWSKI (Poland): Methods of determining the tree damage level caused by forest fires
14.30	K.SOLBRAA (Norway): Pests and diseases on pine planted after wildfires in Norway
15.00	Coffee break
15.30	J.SCHIEFER (Germany): Auswirkungen des kontrollierten Feuers auf Vegetation und Standort auf verschiedenen Brache-Versuchsflächen
16.00	K.LUNAU and L.RUPP (Germany): Auswirkungen des Abflämmens von Weinbergböschungen im Kaiserstuhl auf die Fauna - Fragestellungen und erste Ergebnisse
16.30 - 17.00	Discussion

Thursday, 26 March 1983 (cont.)

17.00 Meeting of the ECE/FAO Project Group 14.3.1.1.2 (Forest Fire Prevention and Control)

20.00 Closing session: Informal dinner and meeting in "Oberkirch's Weinstuben" (Münsterplatz 22 see map)

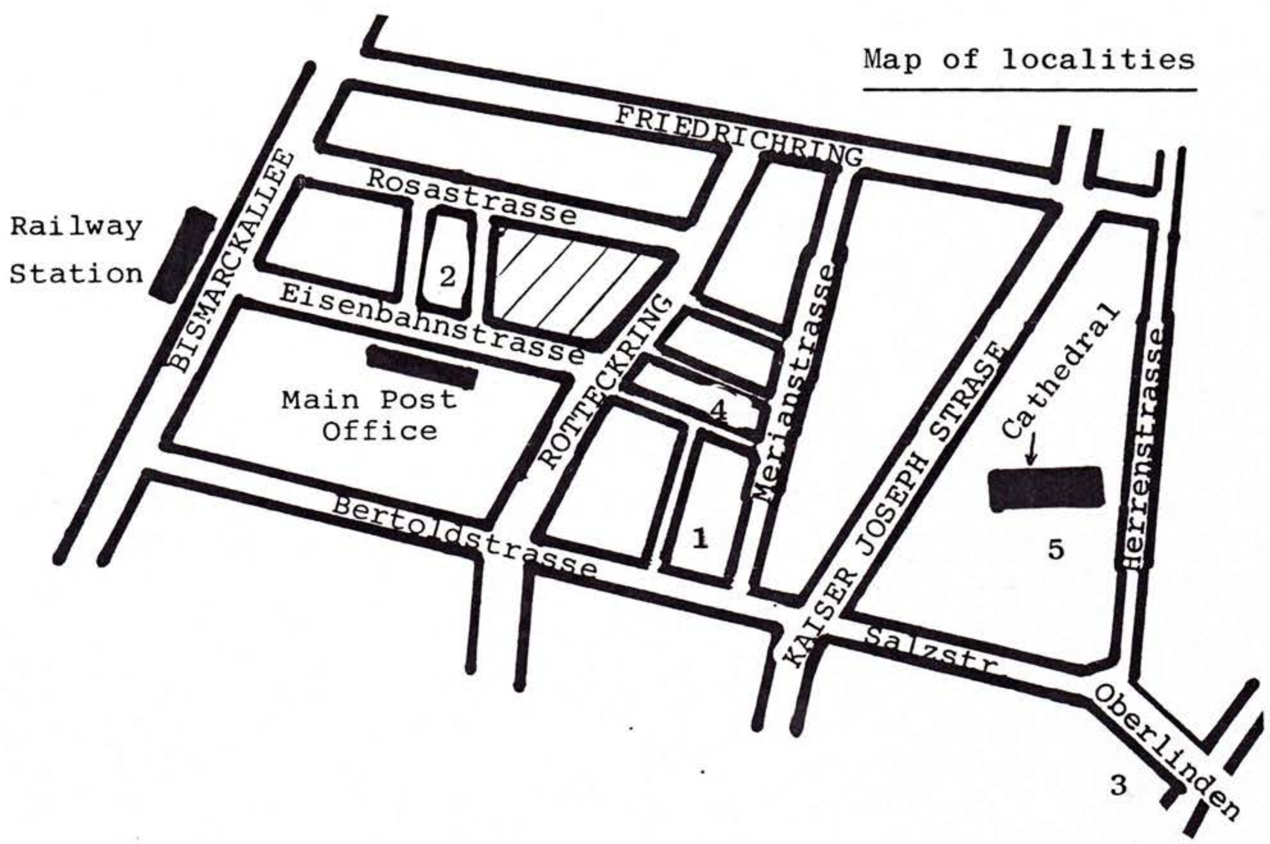
Friday, 27 May 1983

9.30 Field trip to the pine plantations in the Rhine Valley and to the Experimental Forest of the University (Black Forest)

Lunch break at the field station "Mathislemühle"

End of excursion depending on weather and departure of the participants

Map of localities



1 Institute of Forest Zoology Bertoldstrasse 17

2 Park Hotel Post

3 Hotel "Bären" Oberlinden 12

4 Old Town Hall (Rathaus) Rathausplatz

5 "Oberkirch's Weinstuben" Münsterplatz 22

2nd Symposion

on

Fire Ecology

Abstracts

(in order of presentation)

Robert E. Martin and Matthias W. Diemer:

Einige Grundlagen der Quantitativen Feuerökologie

Kenntnisse der grundlegenden Eigenschaften von Feuer und der sich daraus ergebenden Wärmestrahlung sind wichtige Elemente, die zum Verständnis von Feuerverhalten, -wirkung und -anwendung notwendig sind. Die komplizierte Beschaffenheit des Verbrennungsvorgangs und der Temperaturmessung haben zu vielen Mißverständnissen und Fehlergebnissen beigetragen.

Der Zweck dieses Vortrags ist es, einige wesentliche Grundlagen der Feuerforschung, sowie des Brennmaterials und deren Erfassung anzusprechen. Die Bestimmung des brennbaren Materials und dessen Eigenschaften (Abmessungen, Feuchtigkeitsgehalt, usw.) beeinflussen das Verhalten eines Feuers.

Der Verbrennungsvorgang, sowie Intensität und Energiefreigabe sind für das Verhalten eines Feuers verantwortlich, und fraglich ebenfalls für die Auswirkungen an einem bestimmten Standort. Die Erfassung von Temperaturen und herkömmliche Meßmethoden können zu drastischen Meßfehlern führen. Die Wärmeleitung in Pflanzen und Böden und die sich daraus ergebenden Konsequenzen haben, im Zusammenhang mit den bereits erwähnten Faktoren, direkte oder indirekte Auswirkungen auf die Bodendynamik, Flora und Fauna des Standortes.

T. Karlikowski:

The effects of fire on plant environment in pine tree stands

P. Delabraze und J. Ch. Valette:

Das Feuer als Methode der Erhaltung des französischen Mittelmeerwaldgebietes

Die Bestimmung der Entzündbarkeit und der Brennbarkeit der niedrigen Formationen des Maquis und der Garrigue standen im Vordergrund unserer Untersuchungen mit kontrolliertem Feuer.

Die Erkenntnisse aus diesen Messungen erlauben die Aufstellung eines Brandausbruch- und Brandausbreitungsmodells.

Die Analyse des physiologischen Verhaltens der Bäume nach dem Brennen zeigt die Voraussetzungen und Grenzen dieser Erhaltungsmethode an.

Giancarlo Calabri:

Experience and prospects of prescribed fire in Italy

Forest fire cause heavy damages to the Italian forests. In recent years numbers of fires and areas burnt tend to increase, despite the strengthened firefighting systems based on ground forces and several types of aircraft. Most fires are man-caused. Fuel accumulation, because of rural exodus and abandon of many woods, especially coppices, has made the situation worse and worse.

Since 1982 an experiment of prescribed fire has been carried out by the Experimental Institute of Forestry in Tuscany with good results. But all over this country a policy of total fire exclusion is always in force. Introduction of prescribed fire meets with adverse local conditions, legal constraints and misunderstanding of the public opinion. In any case a better knowledge of fire behaviour and effects will be helpful to improve forest protection against wildfires.

José Antonio Vega, S. Bará and M.C. Gil:

Prescribed burning in pine stands for fire prevention in the North-West of Spain: some results and effects

Prescribed fire experiments are being developed in *P. pinaster* and *P. radiata* stands in the NW of Spain for wildfires hazard reduction. Total fuel loads range from 13 to 49 Ton/Ha. (5.8-22 $\frac{\text{Ton}}{\text{acre}}$). Fire intensities from 22 to 86 Kcal. $m^{-1}s^{-1}$ (27-103 Btu. $ft^{-1}s^{-1}$) were used.

A year later, shrub biomass of the understorey was only 20 % of the initial one. Dead fuels 0-1"diameter class were 46 % of initial accumulation; none significative difference was detected in other components of fuel complex. Mineral soil analysis do not shown significative differences neither textural composition nor nutrient contents in the 0-15 cm. layer with regard to the control ones. Two years later, shrub was 25 % of initial amount. The other fuel components had recovered the initial loadings.

A study on edafic microflore in 0-10 cm. layer did not indicate significant favourable effect in burned plots. N cicle microorganisms showed a favourable enhance on burned areas. Those of C cicle, close similar in burned and control plots, could be increased in amilolitic and hemicellullosolitic groups.

After that same interval of time, significant difference were not detected among vegetative stage of trees in burned plots and control ones. Electrical resistance measurements in tree boles showed close relations with general physiological status of trees and can be used satisfactory for damage predictions by fire.

Louis Trabaud:

Prescribed fires and their application on a *Quercus coccifera* L. garrigue

A *Quercus coccifera* garrigue stand was prescribed burnt in an experimental area. This experiment has been set up to precisely analyse the effects of fire on mediterranean plants. The experiment mixes the seasonality of burning (either in late spring or early autumm) with three frequencies (a fire every 6 years, a fire every 3 years, a fire every 2 years).

If there is no change in the floristic composition, the burning frequency and seasonality induce quantitative modifications. Autumm burns lead to a decrease in the importance of woody plants and an increase of the herbaceous plant importance. Thus, the proportion of woody plants, estimated by point-quadrats a long a line intersect, goes down from 85 % at the beginning of the experimentation and in unburnt plots to only 45 % two years after the sixth burn in plots burnt every two years in autumn they represent 60 % two years after the sixth burn.

Carefully managed autumn prescribed burnings can have an important value for grazing improvement in this type of community.

Francisco Castro Rego, José Moreira da Silva
and Maria Teresa Cabral:

The use of prescribed burning in the northwest of Portugal

Forest fires are very common in Portugal as in all Mediteranean regions. Conifer forests are specially susceptible to fire. Large areas of the country are burned every year, as shown in the paper.

Fire detection and attack are not a complete solution for this problem. More importance should be given to the management of the understory fuel.

This paper reports some actions carried out in order to reduce the importance of the wildfires in the Northwest of Portugal, by using prescribed burning for the maintanance of fuel breaks. This "Emergency Plan" was used to study the effects of prescribed fires in soils (mesofauna and chemistry) and vegetation. Results are also presented.

The first results provide information that will be used for a "Fuel Management Plan". This Plan includes prescribed burning as a management tool, in order to minimize fire hazard, but taking in account multiple use objectives of the forests. Justification for further research is presented.

C. S. Cruz:

Propagation risk of prescribed fires in a forest park

Robert E. Martin:

Jetzige und zukünftige Nutzung des verordneten Brennens im Westen der Vereinigten Staaten

Feuer ist ein wichtiger Bestandteil vieler natürlicher Ökosysteme, besonders im westlichen Nordamerika. Diese Feuer wurden hauptsächlich von Indianern und Blitzschlag verursacht. Der Zeitraum zwischen Bränden war abhängig von den Tätigkeiten der Indianer, der Vegetation, der Anhäufung des Brennmaterials, der Anzahl von Trockengewittern und der Feuersaison. Glücklicherweise bestehen im Westen noch viele Urwälder, und demzufolge haben wir hier in Nordamerika, anhand von Feuernarben und Waldbränden in der Gegenwart, ein ausgezeichnetes Protokoll der historischen Funktion des Feuers. Diese Erkenntnisse geben uns eine ökologische Basis für die Anwendung des Feuers.

Das verordnete Brennen wird in Nordamerika in unterschiedlichen Bewirtschaftungsformen eingesetzt. Die weiten Flächen zusammen mit deren relativ geringem Nutzungsgrad und den vielfältigen Bewirtschaftungsmethoden in unseren Forst-, Weide- und Parkflächen ermöglichen die Anwendung von Feuer.

Jedes Feuer erfüllt mehrere Funktionen und deshalb sind heutzutage Experten von verschiedenen Sachgebieten an der Planung verordneter Feuer beteiligt. In diesem Zusammenhang werde ich die jeweiligen Disziplinen einzeln erörtern.

Das verordnete Brennen wird unter anderem zur Reduzierung der Brandgefahr, Verbesserung des Weidezustands und der Habitate des Jagdwildes sowie der Standortvorbereitung benutzt. Feuer kann ebenfalls zur Niederdurchforstung, Reduktion der Konkurrenz und zur Kontrolle von Forstschädlingen eingesetzt werden. Weitere Anwendungsgebiete sind Verbesserung der Zugänglichkeit von Forst- und Brachflächen, Anregung von Nährstoffkreisläufen und Verbesserung der Grundwasserquantität und -güte.

Bestehende Forschungsvorhaben zielen darauf hin, die Nutzung des verordneten Brennens in der Gegenwart und Zukunft zu erweitern und dessen Auswirkungen besser zu verstehen.

Leonidas Liacos:

Prescribed burning and grazing, valuable tools in Management of Mediterranean Warm Conifer Forests

Mediterranean warm Conifer forests have survived for centuries, renewed by natural regeneration, although they were suffering the destructive effect of natural or man caused wildfires and the irrational grazing practices, in parallel with heavy negative selective cuts.

Scientific management techniques applied now a days in many circumediterranean countries are not effective and economically justified. The main features of these management schemes, developed and successfully applied in Middle Europe, are: (a) elimination of any grazing, (b) high stands density (inspite of severe competition developed among individual trees for water, that is the main regulating and limiting factor of the ecosystem) to secure natural prunning, suppression of understory vegetation etc.

To author's oppinion, animal grazing and fire should be considered important functional components of mediterranean warm conifer forests. Relative experiments, carried-on for 15 years now, show the effectiveness of the use of prescribed burning and rational livestock grazing to control understory vegetation, which consequently suggests that they should be considered most valuable tools in forest management schemes. The effective control of understory vegetation allows forest managers to apply intensive treatment, keeping the stands to proper tree density, so that to: (1) avoid competition among trees and thus obtain the maximum of net wood production, (2) avoid losses of primary production in clearings and unommercial thinnings, which are becoming, besides, very costly and even impossible with time progress, (3) obtain the maximum of timber production in quantity and quality, (4) increase the vigor of stands, (5) shorten considerably rotation time, (6) minimize fire hazard, (7) justify the application of mineral fertilization, (8) obtain a secondary income from grazing, which might be more important than that from timber.

Ricardo Vêlez:

Recent droughts and forest fires in Spain

Forest fires are a permanent phenomenon along Mediterranean countries. In recent years drought has been a main factor in fire effects by extending fire seasons and creating burning conditions in new areas. The number of big fires has increased changing plant cover structure along very large surfaces. Erosive effects after fire due to typical torrential rainfalls have been prevented when a long dry period has followed fire allowing plant regeneration.

S. Bara and J.A. Vega:

Effects of wildfires on forest soils in the NW of Spain

A study on wildfire effects on forest soils developed on fortytwo experimental plots showed that immediately after fire, available P, exchangeable Ca, K, and Mg contents in 0-5 cm. layer increased strongly.

Increments of one pH unit were measured. Organic matter content decreased about 40 % and C/N ratio lowered from 20.9 to 12.1; towards 5-80 cm. layer no significant changes were detected.

Two years later, Ca and Mg. in 0-5 cm layer of burned soils were the same level as the check ones. K decreased 30 % and P was fourfold with regard to check. pH was 0.1 higher than check one. Silt and clay dropped 15 % by soil erosion on slopes. No change were found in 5.30 cm. layer about these textural components.

Louis Trabaud:

Recovery of _Pinus_ _halepensis_ Mill. woodlands after wildfire

Wildfires are an important ecological factor in the French mediterranean region because they often occur during plant succession. Pine woodlands are ones of the most flammable communities of this area and are frequently burnt by fire, therefore a study on the recovery of pine woodlands has been carried out. The direct (or diachronic) method was used during the dozen years period of observation of 7 plots burnt by wildfires.

During the years of recovery, the floristic richness of plots follow a general model type: during the first months immediately following fire there are few species present, then floristic richness increases and reaches its maximum two or three years after fire, afterwards it decreases, then tends to stabilize. In fact, floristic richness is not very different from those of more mature communities which apparently have not been burnt for a long time.

Concerning the quantitative growth of the vegetation, the tendency of the communities is to revert towards a structure similar to that existing before fire. Rapidly enough the plants reappear and recover the ground surface. The vertical growth was also studied: as the communities get older the importance of the lower layer (< 25 cm) diminishes, whereas that of higher layers increases.

Infrequent wildfires do not profoundly modify the flora and structure of pine woodlands in the french mediterranean region.

Johann Georg Goldammer:

The use of prescribed fire in South American pine plantations

A prescribed burning program in Brazil has been underway since 1981 as a part of the scientific and technical cooperation between Brazil and the Federal Republic of Germany. The research and development project is being carried out by the Institute of Forest Zoology, Freiburg University, and the Institute of Forest Protection, Federal University of Paranâ, Curitiba.

Since the mid 1960's the Brazilian governement has greatly subsidized afforestation programs. Today pine plantations cover about 400.000 ha in the State of Paranâ. The most common species are slash pine (Pinus elliottii) and loblolly pine (P. taeda).

Needle litter and the debris from pruning and thinning create an extreme fire hazard. Studies are being conducted in the application of controlled fire to reduce the aerial fuels without damaging the site and the stand.

T. Karlikowski:

Methods of determining the tree damage level caused by forest fires

Knut Solbraa:

Pests and diseases on pine planted after wildfires in Norway

Compared to several other countries, only small areas are anually hit by wildfires in Norway. On low productivity sites, however, some of the burned areas have shown difficult to regenerate because of widespread attacks from fungi and insects. In southern regions of low elevation these may restrict the regeneration for a couple of years only. Under less fortunate climatic conditions other species of both fungi and insect may restrict the regeneration of Pinus sylvestris for longer than one decade.

I will present results from one area with short-time damages, mainly caused by the fungus Rhizina undulata and the insects Hylobius abietis, Brachyderes incanus, and Strophosoma capitatum. All of these are dependent on dying tree roots for their propagation. Their attachs were thereby restricted to the first 2 or 3 years after the fire. The plants could therefore probably attain sufficient protection after one treatment with selected fungicides and insecticides under Norwegian conditions.

The long-lasting damages were mainly connected to the fungus

Gremmeniella abietina, while also Phacidium infestans and the insects Microdiprion pallipes and Rhyacionia duplana have attacked various shares of the plants. Even if it should be possible to protect the plants with frequent treatments with chemicals, this seems economically impossible in a practical scale. Artificial regeneration with Pinus silvestris could therefore not be recommended on such areas, while Pinus contorta show promising results so far.

Jochen Schiefer:

Effects of prescribed burning on vegetation and soils on different landscape management sites

On behalf of the Ministry of Agriculture and Environment since 1975 different measures of landscape management are tested on 16 experimental fields in Baden-Württemberg. The experimental fields are covered with grassland vegetation in the broadest sense. Apart from prescribed burning there exist also experimental plots with mulching, mowing, grazing and undisturbed succession. Burning takes place in winter (1.11. -15.3.) with the aim of a partial removal of dead organic matter.

Hot fires are damaging first of all mosses, caespitose plants (e.g. Bromus erectus) and rosette plants (e.g. Hieracium pilosella), while species with rhizomes (e.g. Agroypron repens) are expanding their coverage. Cold fires do not damage the vegetation directly, however, changes in the plant stand are possible in this case too, because fire increases vigor and vitality of some species (e.g. Brachypodium pinnatum).

In Mesobromion communities prescribed burning effects - compared to undisturbed succession - an increase in soil temperature from March till September in a depth of 5 cm by 2-5 ^{o}C;

this causes a precocity of the phenological development of some species (e.g. Salvia pratensis) by 2-3 weeks. In Arrhenatherion- and Filipendulion communities these effects could not be observed.

On burnt areas with Mesobromion communities soil moisture was 2-6 % lower during the vegetation period than on abandoned fields. On moist sites, however, no differences could be proved.

Hot fires result in a reduction of yield; this effect can held for years. On the other hand cold fires increase the biomass production by up to 50 %. These differences in yield are caused among other things by an increase respectively reduction of the nitrogen mineralization.

Klaus Lunau and Leo Rupp:

Effects brought about on the fauna of the Kaiserstuhl, due to the use of controlled burning on its vineyard slopes - problems and first results

The Kaiserstuhl, located near Freiburg, covers approximately 100 km^2 of loess-covered vulcanic mountains. It's faunal, floral and geological conditions are unique to middle Europe.

The change from less profitable cattle keeping to an intensive cultivation of grapes brought with it the replacement of a previous cutting of the vineyard slopes for fodder production to a method of controlled burning. Controlled burning is regarded by the vineyardists as the only practical method of preventing the unwanted accumulation of plant material. A 1975 Baden-Württemberg law prohibites controlled burning, despite this the practise is continued. The consequences of controlled burning for the nature reserve are regarded as dangerous for the animal life, especially because of the vineyard slopes are important refugiums in the intensively cultivated land.

Our present investigation aims to show the effects of controlled burning on the fauna of the vineyard slopes. Temperature recordings were made during the controlled burnings. We seek to determine the direct effects of the heat on selected animals in different strata and the indirect effects on the animals as far as the character of the zoonose is changed from burned to unburned (control) areas.

The Speakers:

Giancarlo Calabri

Chief, Forest Fire Service, Ministry of Agriculture and Forestry (Rome, Italy). Doctor in civil engineering (Bologna University), specialized in forest sciences (Florence University).

Carlos Souto Cruz

Silvicultural engineer, Parque Florestal de Monsanto-Cruz das Oliveiras (Lissabon, Portugal). Forest Fires and ecological planning. Prescribed burning.

Pierre Delabraze

Director, Institut National de la Recherche Agronomique, Station de Sylviculture Méditerranéenne (Avignon, France). Ingénieur agronome (Paris), Ingénieur des Eaux et Forêts (Nancy). Mediterranean silviculture. Herbicides. Production and physiology. Prescribed burning.

Johann Georg Goldammer

Assistant professor, Institute of Forest Zoology, Freiburg University (Freiburg, Germany). Diplom-Forstwirt, Assessor des Forstdienstes. Project leader of a prescribed burning program in university cooperation with Brazil.

Tytus Karlikowski

Professor and Chief, Forest Fire Control Section, Forest Research Institute (Warsaw, Poland). Dr.eng. Leader of the ECE/FAO project on Forest Fire Prevention and Control. Forest fire ecology. Prescribed burning.

Leonidas Liacos

Professor, Aristotelion University of Thessaloniki (Greece). Multiple use of mediterranean conifer forests. Fire ecology. Prescribed burning.

Klaus Lunau

Institute of Biology I, Freiburg University (Freiburg, Germany). Diplom-Biologe. Presently working on Ph.D. thesis. Project on effects of controlled burning on the fauna of vineyard slopes.

Robert E. Martin

Professor of Wildland Fire Management, University of California (Berkeley, USA). B.S. (Physics, Marquette University), B.S. (Forestry, University of Michigan), M.F. and Ph.D. (University of Michigan), Research Forester and project leader in the US Forest Service. Working in prescribed burning and fire effects since 1958 (including training sessions and seminars). Physical properties and anatomy of bark. Heat flow and fire behaviour. Prescribed burning and effects.

Francisco Castro Rego

Research Forester, Ministry of Education and Science, Instituto Universitário de Trás-Os-Montes e Alto Douro (Vila Real, Portugal). Effects of prescibed burning on soils and vegetation. Use of prescribed burning in fuel breaks.

Leo Rupp

Institute of Biology I, Freiburg University (Freiburg, Germany). Diplom-Biologe. Presently working on Ph.D. thesis. Project on effects of controlled burning on the fauna of vineyard slopes.

Jochen Schiefer

Project leader, Staatliche Versuchsanstalt für Grünlandwirtschaft und Futterbau (Aulendorf, Germany). Ph.D. on landscape management. Plant ecology of grasslands.

Knut Solbraa

Associate professor, Division of Forest Regeneration, Norwegian Forest Research Institute (Ås, Norway). M.Sc. (silviculture), Dr.agric. (bark for plant breeding), Dr.scient. (seedling mortality). Conducting research in 1: Artificial regeneration of burned areas, 2: Direct seeding of conifers and 3: Bark utilization

Louis Trabaud

Research scientist, Centre National de la Recherche Scientifique (Montpellier, France). Ph.D. (1962), Dr.sc. (1980). Ecological impact of forest fires on the french mediterranean vegetation. Succession and dynamics of mediterranean vegetation.

Jean-Charles Valette

Institut National de la Recherche Agronomique, Station de Sylviculture Méditerranéenne (Avignon, France). Ingénieur des Techniques Forestières. Fire protection in mediterranean forests. Prescribed burning. Herbicides. Ecophysiology.

José Antonio Vega

Project leader, National Institute of Agricultural Research (INIA), Forest Department, Lourizan (Pontevedra, Spain). Ingeniero de Montes (Politechnic University of Madrid). Fire effects on soil, vegetation and use of prescribed fire.

Ricardo Vélez

Chief, Forest Fire Prevention, Forest Fire Service, ICONA (Madrid, Spain). Doctor Ingeniero de Montes. Conducting national programs on fuel management, propaganda, fire danger rating and statistics. Coordinator of the Spanish forest fire research and training programs.

World Forestry

Forestry in the Federal Republic of Germany

Richard Plochmann

ABSTRACT—With a long history of forest management that includes many contributions to the science of silviculture, the Federal Republic of Germany is intensively and realistically practicing multiple use. The small land base and heavy population admit no other choice. Recreation is a leading use, but protection of water supplies, preservation of natural areas, and amelioration of climate are also important. Diversity in stands, age classes, and treatment is the key to achieving these purposes while also providing timber for industry.

During the 19th century Germany became an example for many countries starting planned and sustained forest management. Its objectives and methods today are commented on diversely from many sides. To form a fair judgment one should know the natural and the historical facts as well as ownership patterns, the market situation, and social aspects. They will be the subject of this article.

Natural Facts

At the end of the latest of four or five glacial periods, some 20,000 years ago, central Europe was free of trees. Reimmigration of trees started about 12,000 years ago, but less than 40 species were able to return. The combination of southward-moving glaciers and the mainly east-to-west-running mountain ranges of Europe led to the extinction of large parts of the preglacial vegetation. With only one species of spruce, fir, beech, larch, ash, two of pine, oak, birch, and basswood, and three of maple and alder, the tree vegetation of Germany is much poorer in its structure than that found in North America on comparable sites.

Climatic conditions have not changed very much during the last 2,000 years. Average yearly temperature is between 5° and 10° C, and there are up to 180 vegetation days (i.e., days with a mean temperature over 10°C) annually. Mean annual precipitation is 20 to 40 inches, of which around 50 percent occurs during the growing season. In such a climate, postglacial natural reforestation covered nearly 90 percent of the land area of the Federal Republic of Germany (FRG).

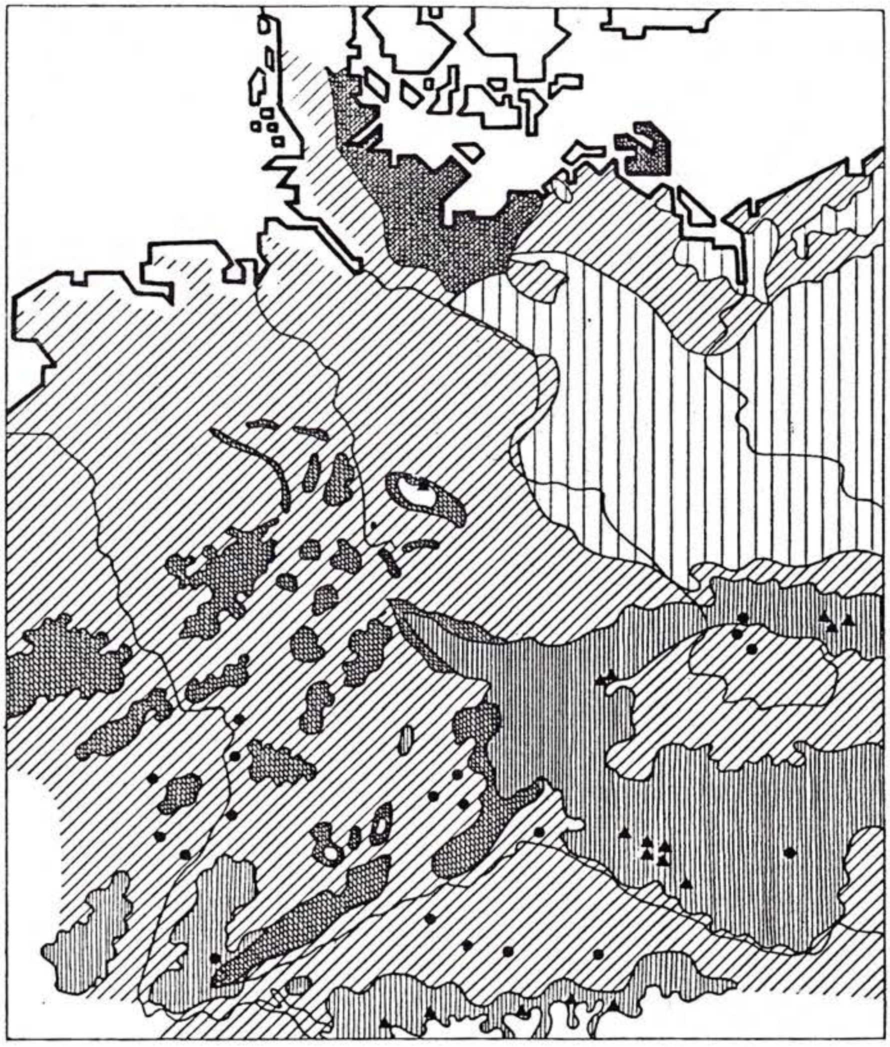


Figure 1. Natural forest vegetation types in West Germany. (SOURCE: Ellenberg, H. 1963. *Vegetation Mitteleuropas mit den Alpen in kausaler, dynamischer und historischer Sicht.* Eugen-Ulmer-Verlag, Stuttgart, 943 p.)

A rough picture of the distribution of natural types is given in *figure 1*. It indicates that hardwoods would predominate by nature. In those virgin forests, fire was not essential for stand renewal. Local thunderstorms, wet snow, and fall, winter, and spring gales sweeping in from the Atlantic Ocean opened patches here and there. In most cases the climax forests were followed not by a pioneer generation but by a composition close to the climax.

(Continued on page 452)

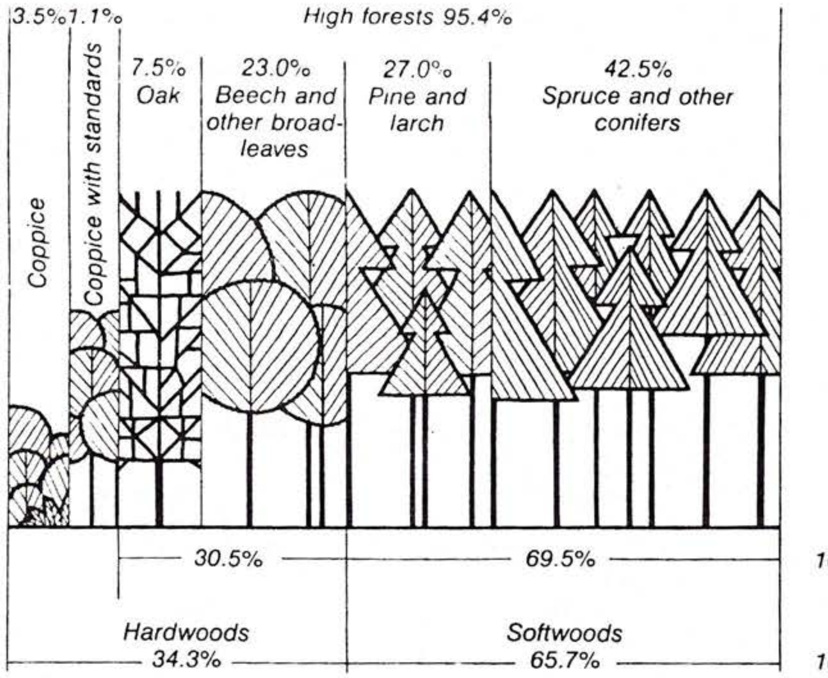


Figure 2. Distribution of tree species and management types. (SOURCE for this, an figures 3 and 4: Department of Forestry, Forest Industries and Hunting, Federa Ministry for Food, Agriculture and Forestry. 1976. *Silva: Forestry, Forest Industrie and Hunting in the Federal Republic of Germany.* Landwirtschaftsverlag GmbH Muenster-Hiltrup, 183 p.)

Historical Facts

Man as a farmer clearing forests appeared in central Europe not more than 6,000 to 7,000 years ago. For a long time the population was too small to clear very much fertile land. Grazing probably affected the forests more than the clearing. By 900 to 1000 A.D., the population had risen to an estimated 2 million—nearly the same number as now live in Oregon, which is comparable in size to the FRG. This population still did not put much pressure on the forests.

The most rapid clearing occurred between 1000 and 1350 A.D., when the population rose to nearly 15 million. As a result the forest area fell to its lowest point in history, hardly more than 20 percent of the total land. And, of course, the land left uncleared was that least suited to farming.

Up to the late Middle Ages, forests were used almost exclusively by farmers, who managed large parts of them as coppice stands for fuel and charcoal wood. By setting a rotation length and establishing yearly cutting areas, these users made the coppice and coppice-with-standards forests the first in Europe to be managed under sustained yield. Even at the beginning of the 19th century they probably occupied over half of the forest area and kept it in hardwoods. The high forests, on the other hand, produced primarily fodder for livestock and acorns for hogs. They had to be open stands of oaks with large crowns. Many such oak forests in Germany were and still are "man-made," on sites that naturally would be stocked by beeches. This high forest was managed by single-tree harvesting—i.e., selection management.

While the farmers developed the coppice and selection systems, other forest users became inventors of the clearcut and shelterwood techniques, of artificial reforestation, and of the propagation of softwoods. Metal, salt, and glass works, established by landlords from the 14th century on, needed large forests to supply fuel, construction timber, potash, kegs, and the like. Softwoods were preferred not only for building material but also as fuel for some purposes—oak and beech, for example, gave too hot a fire under the big copper pans that were used for evaporating the salt water. The forest areas for these early manufacturers had mostly to be wrenched away from farmers, an act leading to uproar and revolution.

During the 17th and 18th centuries conditions worsened considerably. Overcutting, overgrazing, and litter raking depleted productivity, deteriorated the soils, and turned forests into brush stands and wastelands. Excessive population, deficiencies of administration, and the agrarian and trade policies of the absolutist states were the underlying reasons for these abuses. Nevertheless, species composition remained close to natural even in the poor remaining stands. The propagation of softwoods had not yet gone very far.

In the 19th century, beginning about the second decade, an astonishing melioration took place. Chief events behind the change were:

- the political, economic, and social reformation of Germany in the wake of the French Revolution and the Napoleonic wars;
- the liberation of farmers from the feudal landlord system—the farmers became owners;
- development of a forest science that acquired the methods and techniques of modern management;
- availability of well-trained professionals, educated at private or public forestry schools;
- establishment of effective, efficient, and independent forest administrations by states and large private owners;
- release of forests from grazing and hog-herding through the introduction of modern crop rotation in agriculture and the cultivation of imported plants like clover, potatoes, and corn;
- construction of a railroad system and the dawn of industrialization opening new demands and markets;
- the fact that development rights of forestland were not and did not become part of ownership rights. The owner needed state permission if he wished to clear land for crops or sell it for development.

The melioration was performed b converting coppice and coppice-with standards into high forests, by the affo estation of heather- and wasteland, an by the natural and artificial restockin of high forests in poor condition. Th management planning aimed at, and th melioration led to, age-class forestr On many sites in poor condition, eve aged stands were achieved only by th introduction of Scotch pine and Norwa spruce. Conducive also to even-age management was the newly develope theory of soil rent, which influenced th thinking and work of foresters deeply.

By the beginning of the 20th centur the German forests were highly produ tive again. Their yield surpassed a known records. The price was the turn ver in the species composition (*fig. 2* From this time on German foresters ha to manage on more than half of th forest area with species not indigeno to the sites and with monocultures u known in nature.

The Lesson Learned And The Consequences Taken

The positive result of nearly 200 yea of management is an average standi volume of 20 cunits per acre in the FR and a mean annual increment of 0 cunit per acre. More than 70 percent the yearly harvest is softwood—a pr portion that constitutes a real econom advantage for the landowners as well the forest industries.

On the other hand, the softwood fo ests have proven not to be as stable a as resistant to biotic and abiotic dange as the native hardwoods. It is not much the degradation of soils that bot

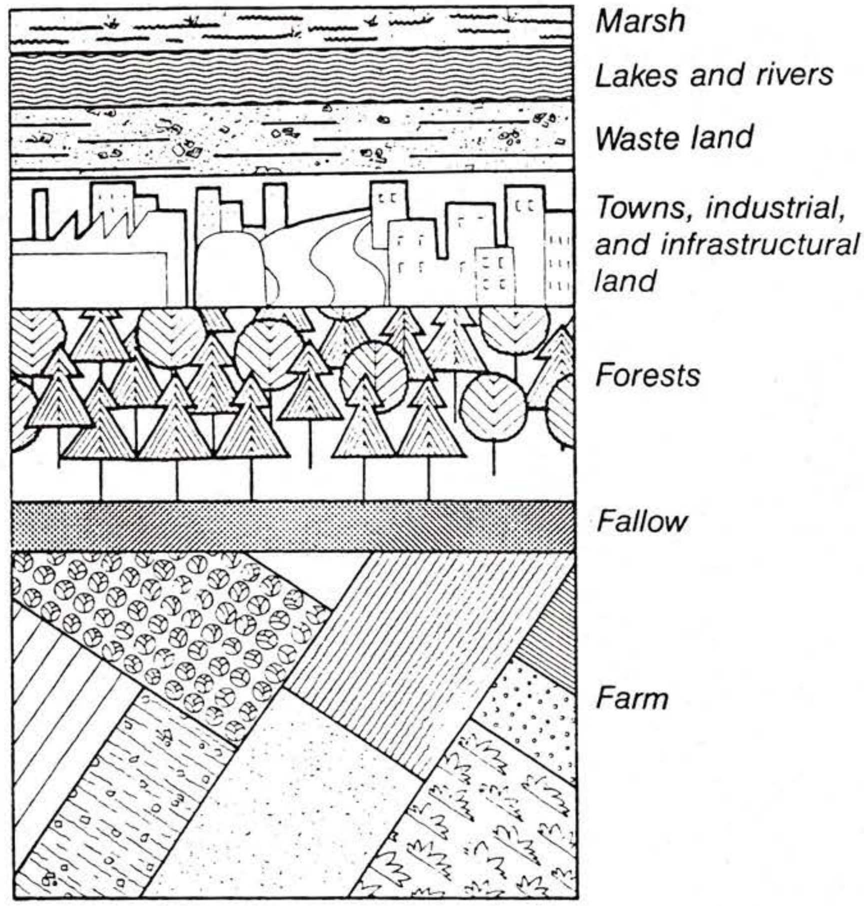


Figure 3. Land use in the Federal Republic of Germany, 1977.

ers us (and which we long overestimated) but the losses to storms, snow, insects, fungi, or fire. That more than 20 percent of the yearly cut represents salvage indicates the risk we run by managing softwood monocultures for large timber on rotations over 80 years—often much over.

We have also been taught that forests must serve a multitude of functions in a country so heavily populated and industrialized as ours. What are the consequences for our forestry in present times? Before discussing them, a few remarks are necessary about land use and ownership, owners' goals, the market situation, and social aspects.

Land Use, Ownership, And Owners' Goals

How the FRG uses its small land base of not even 100,000 square miles is shown in *figure 3*. Forests cover 29 percent; their area was slowly increased over the last 150 years by the afforestation of submarginal farm land. Heavy losses around centers of population were overcompensated in the rural regions. Cities, towns, and residential and industrial areas take up more than 11 percent of the land in the FRG, and nearly 54 percent is in farms.

The ownership structure is shown in *figure 4*. It can be split up in three distinctive groups: the Federation and its 11 states own nearly one-third of the forest area, around 15,000 communities and public corporations own about one-quarter, and over 700,000 private persons and private corporations hold the rest. More than 95 percent of private owners and 50 percent of the communities have forest areas of 50 acres or less. Only 434 estates belong to the group of large private forests—i.e., with 1,250 acres or more. The average size of private forests is therefore only 10 acres and of community forests 250 acres.

The land reforms of the nineteenth century, and the repeated splitting up of properties by equal division among the children of deceased owners, have severely handicapped efforts to encourage intensive forestry. The social and ecological aspects, however, we estimate as an advantage. More than 80 percent of the small private forests are owned by full- or part-time farmers. The forests are a factor stabilizing the farm economy, and the varied objectives and management practices of the many owners have a diversifying effect that we esteem for its ecological and esthetic values. One other fact has to be mentioned: all private forests are nonindustrial. The forest industries in the FRG cannot rely on a resource base of their own.

Owners try to maximize the return from their land, but what they are aiming for and what they achieve are sometimes very different. In that respect three facts are most important:

- Very few owners depend heavily on the yearly income from their forests. Therefore the yearly income has not the highest rank within the goal hierarchy.
- Practically no owner rates his forest by the interest it pays on the capital invested. Since the actual rate under favorable conditions is 1 or 2 percent in real terms, such calculations have not much importance anyway.
- Land is so scarce and ownership is rated so high in social status that the price does not correspond to the possible return from farming or forestry.

In discussing priorities, one has to differentiate between owner groups and size of ownership. The state forests have lost much of their importance as income producers. Rather, they are valued as suppliers of wood to forest industries and for their social and welfare functions. In addition, their standing timber is a strategic reserve. For example,

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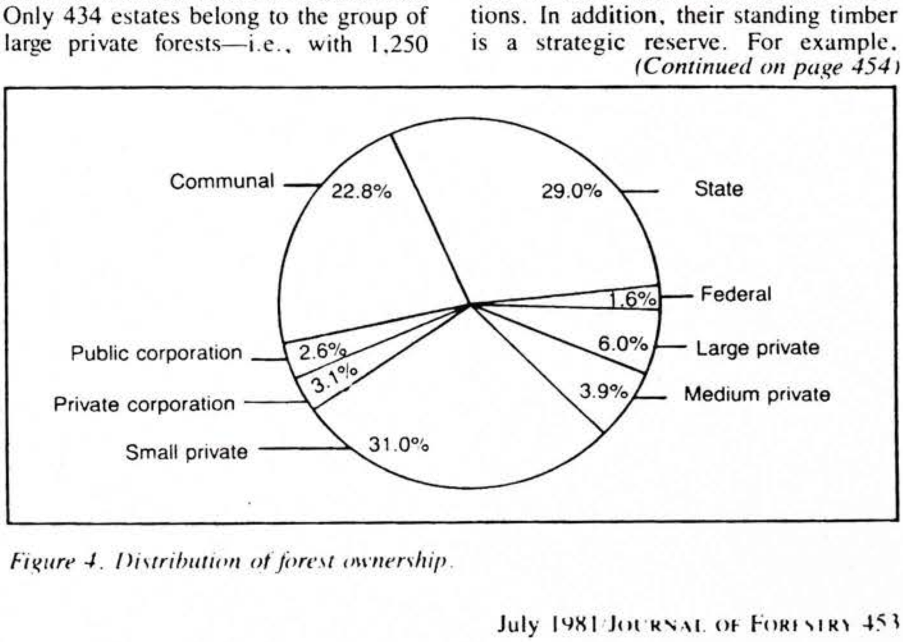

Figure 4. Distribution of forest ownership.

standing volume on the Bavarian state forests already averages 40 cunits per acre, but plans are to increase it 15 percent by the year 2000.

For community forests, recreation, protection of water resources, and climatic compensation are the prime objectives, but land-reserve values are also very seriously regarded.

The goals of private owners can be judged by the fact that the ownership rotation is as long as or even longer than the approximately 100-year rotation of spruce. To these owners the proven security of their forests, as considered against two total devaluations of the mark and against inflation, is of more importance than the maximization of profit. Besides, the wealth, ground, and inheritance taxes paid for forest property (even with high standing volumes) are remarkably less than for other assets of equivalent value. As a result, the mean volume even on small private forests is comparable to that of the state forests in Bavaria. On large private forests, volume averages 50 cunits per acre.

Timber-Market Situation

The German timber market is almost completely free. There are no limitations on imports or exports, and tariffs are collected only on a few half-finished products like pulp. Sovereignty for market regulations rests with the authorities of the European Community. Because nearly half of the wood used in the FRG is imported, mainly as semi- or fully finished products, prices are strongly influenced by the world market.

There are no big, integrated forest industries. Sawmills are small or very small, with few cutting more than a million cunits of round logs per year. The mills are numerous, though, and because their aggregate capacity exceeds the national roundwood supply, some of them operate only part time. In partial contrast are a small number of pulp mills and panel plants whose capacities are remarkably lower than the normal national cut of pulp- and chipwood. Strong international competition causes them to try to reduce their costly roundwood consumption and rely as much as possible on wood residues and wastepaper. The situation has pushed the price per unit for spruce sawlogs to two and more times that for pulp- or chipwood—even much more for large logs of veneer grade. Under such circumstances it is profitable to grow as much sawtimber and as little pulpwood as possible (if soil rent calculations are not applied). That means long rotations and high stand volumes, and it also means that foresters are often handicapped in making proper thinnings.

Social Aspects

The FRG has a population of 61 million. The average density of 640 persons per square mile compares with 60 in the United States. (The population peak is reached in the state of Nordrhein-Westfalen, which has 1,300 persons per square mile.) Forest area per capita shrank to one-third of an acre during the last century and now is only a little over one-quarter acre. One could argue that urban forestry is a universal fact.

Around 70 percent of the population uses the forests for recreation. By federal law all forests without exception are open to public access. Public use necessitates a large variety of installations like parking lots, trails, and picnic areas. These facilities occupy land and cause high investment and maintenance costs, but while they sometimes hinder forest management they never prevent it.

From the standpoint of recreation, the preference is for long rotations, varied stand composition, intensive thinning, reliance on natural regeneration, and a minimum of mechanization. Areas and volumes per cutting operation are therefore small. The high estimation in which our society holds state forest services and foresters generally has as its main reason that management practices are accepted by recreationists.

In the densely populated FRG, forests have to serve a number of protective functions, among which water protection, climate compensation, and nature preservation have the highest importance.

In the water sector, compliance with run-off regulations and protection of groundwater from pollution are the priority obligations. They can be fulfilled as long as the managers use no fertilizer or only controlled amounts, rarely or never apply pesticides and herbicides, and make no clearcuts or at least no large ones. About one-third of the forestland is classified as water-protection area.

Under environmental functions, one must understand the importance of the climatic services rendered by forests in and close to concentrated areas and cities. The cleansing and intermixing of polluted air is one of these functions. Another important factor is the fast exchange of air between cities and their adjacent forests, a result of the temperature difference between them. Such environmental functions depend less on any special kind or type of management than on large enough areas and their strict preservation. Zoning and preserving forests around concentrated areas and cities, where they are endangered most by development, form one of the critical policy problems in the FRG.

With over 11 percent of the land area paved and 54 percent in more or less industrialized agricultural use, the public is becoming increasingly aware that forests are the last refuge of nature. They are about the only more or less self-steered ecosystems left in the country. Preserving these ecosystems does not mean abandoning management or taking the trail back to wilderness, but rather renouncing management oriented only to economic aims.

Consequences for a Multiple-Use Forestry

Central Europe as the cradle of sustained-yield forestry developed the first models of normal or ideal forests and their growth and yield as well as the first economic theories for forestry. It has applied them in management systems ranging from clearcutting to selection. Its forests today are man-made or man-shaped from the first to the last acre as nowhere else on the globe (if plantation forestry is left out of consideration). Two hundred years of experience constitute a wealth of learning, if not allowed to become a burden of narrow-minded tradition.

The individual objectives of owners, the goals of an optimal supply of timber for the national economy, and the public needs for recreation in and protection by forests have to be brought into an acceptable compromise. There is reasonable ground for thinking that such a compromise can be achieved. For example, nobody wants to turn back the wheel and lower the percentage of softwoods drastically. Nobody wants to shorten the rotations, which today are around 100 years. Rather, the tendency is to raise rotation ages to increase the amount of standing timber, to produce larger sizes and better qualities. Everybody wants to minimize the risks of long rotations, which are especially high in monocultures of species not indigenous to a site.

Our solution is to preserve or establish mixed forests wherever possible. The hardwoods within softwood stands thereby serve primarily as biological stabilizers. Where monocultures cannot be avoided, interspersing small pure stands of different species must be resorted to. Diversity within or between stands, diversity of age classes, and diversity of treatment are therefore the main principles of multiple-use forestry. Such principles undoubtedly restrict the application of modern technology. They force conservative methods of thinning and regeneration. They encourage new kinds of mechanization that take much of the harvesting job out of the forest and concentrate it at a central processing point.

These principles are and will be criticized by some economists and some preservationists. But they seem to be the best bet to manage our scarce forest resources for the optimal production of timber as well as for unpriced and unpriceable values. ■

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The Black Forest

The Black Forest, a mountain range with elevations up to 1493 meters (Feldberg) in the south and 1164 meters (Hornisgrinde) in the northern part, stretches along the eastern edge of the upper Rhine valley within the boundaries of Baden-Württemberg. It extends approximately 150 kilometers from the vicinity of Basel in the south to Pforzheim in the north and has an average east-west extension of 30 to 40 kilometers.

Forestry is the major land use of the region. Mainly coniferous forests of approximately 400 000 hectares cover about two-third, in many parts more than 80 percent of the land.

Up to an elevation of 550 to 700 meters above sea level in the northern and almost to the very top in parts of the southern Black Forest, primitive rocks --granite and gneiss-- are found, occasionally mixed with lower red sandstone and other geological formations. Variegated (New Red) sandstone is the determining substratum above the volcanic rocks.

At the transition zone of the two major geological formations, water that has percolated down through the permeable sandstone comes to the surface and is utilized by the waterworks of the communities. The city of Baden-Baden, for example, gets about 50 percent of its watersupply from this source.

Annual precipitation, at higher elevations a more or less large part of it as snowfall, increases from 1000 millimeters at the western edge (Rhine valley) to more than 2000 millimeters at the highest elevations of the region, decreasing again towards the eastern edge to approximately 800 millimeters.

Mean annual temperature reaches almost 10 degrees Celsius in the west --one of the decisive factors for successful viticulture, the predominating land use on the lower western slope-- and averages 6,0 to 6,5 degrees C. in the east and at the high elevations.

The most important commercial tree species presently found in the forests of this region and their approximation area percentage distribution ranges are:

Norway spruce	30 - 70
Fir	15 - 40
Pine and larch	up to 15
Beech	up to 30.

Norway spruce, with some admixture of fir and beech, is the major species at the high elevations; fir and beech dominate on the primitive-rock soils; pine and Douglas fir --the latter steadily increasing-- are found on the drier sites.