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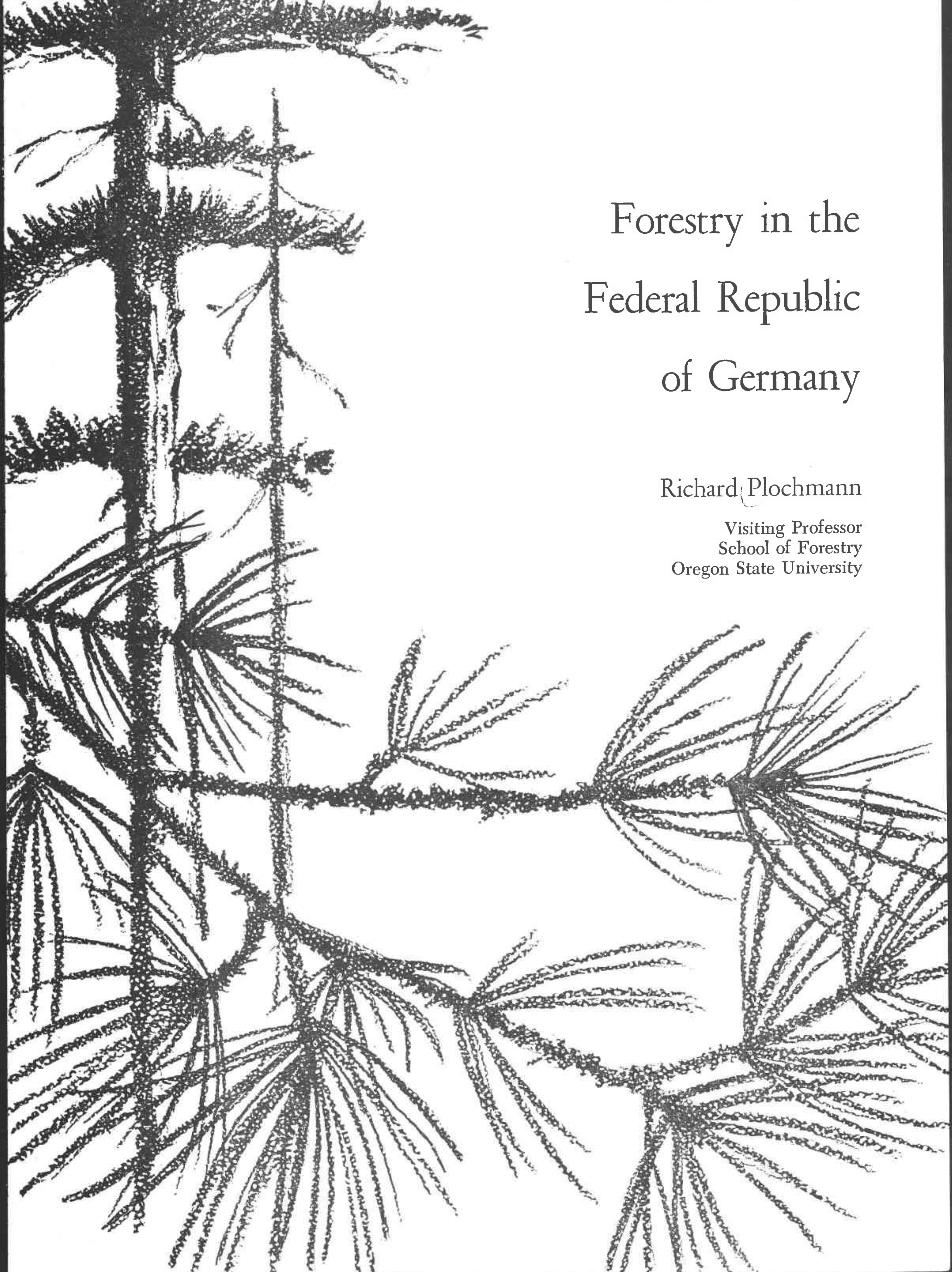
Forestry in the Federal Republic of Germany

Richard Plochmann

Visiting Professor
School of Forestry
Oregon State University



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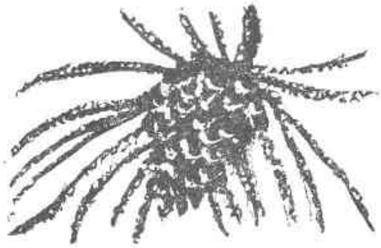


Foreword

In 1958 a party of about twenty foresters and forest industry men, mostly from Oregon, led by Dr. Richard Dilworth of Oregon's School of Forestry, visited western Europe to see and learn forest management where it has been developing for several centuries. In June the party was welcomed by Dr. Richard Plochmann at the University of Munich whose School of Forestry and Forest Research is a top center in this field in Europe. Here the party was received most hospitably, and attended lectures on various phases of forest management given by experts on forest taxation, soils, silviculture, and so forth. We became especially acquainted with Dr. Plochmann and his work, and some of us began to realize how effective he could be at some time as a visiting professor at the School of Forestry in Corvallis.

Dr. Plochmann, after earning his doctorate at the University of Munich in 1951, spent two years in practical work as a forester in the Forest Service of Bavaria, Germany, and as a laborer and later as a timber cruiser in the sawmills and forests of Alberta and British Columbia. Then at the Bavarian Forest Research Station and Forest School in the University of Munich, for six years his time was occupied partly in research work in silviculture and partly as assistant professor in the school. In 1960, on a forest related research grant, he toured forests and forest activities in the United States, Japan, Korea, Thailand, and India. Since then he has combined the applied and the theoretical as manager of a forest district of the Bavarian Alps and as associate professor at the University of Munich. Thus he is a man of fine training and broad experience in the management of German forests.

Dr. Plochmann's lectures at Corvallis, presented in this booklet, give an intimate picture of the history, silviculture, and economic management of German forests. There is so much "meat" in these lectures that they should have far more than a casual reading; they should be carefully studied, especially by those here in America responsible for planning for or executing the management of our forests, whether privately or publicly owned.

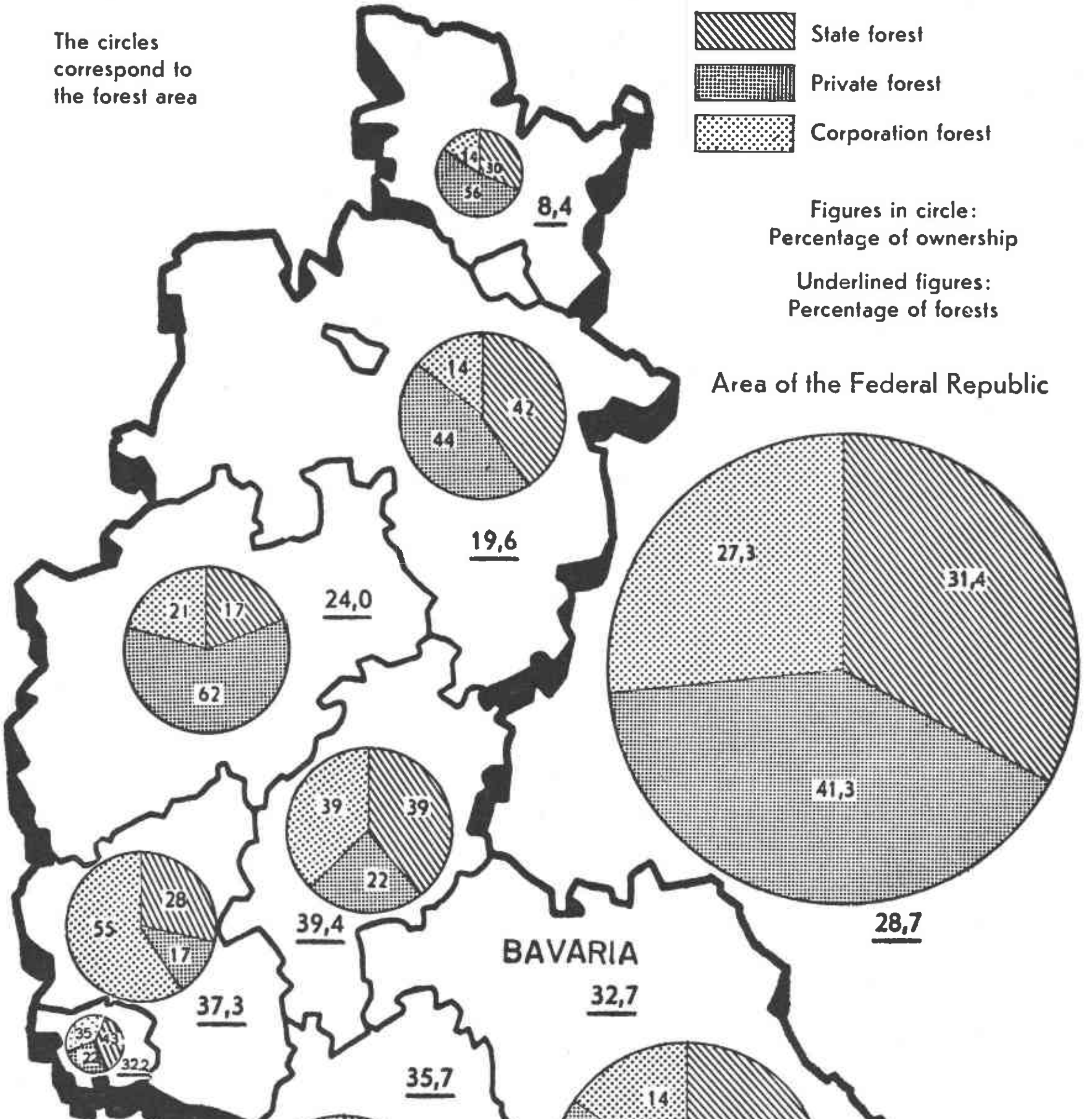
It is impressive to see how much of the income from the sale of timber in Germany is reinvested in intensive forest management—for roads, for close planting, for precommercial thinnings, for fencing to protect young plantations from deer, and for many other similar projects. The money value of logs at the roadside in Germany (where the forest owner usually sells his timber) is higher than the comparable figure here in the United States, but the expenditures for intensive management and for logging greatly reduce the net value of the standing trees.

During the two decades since World War II, the economic problems of the forest manager have become highly complicated as the result of infllation, increasing wages, new competition with imported wood, and other developments. Also even more intensely than here in America, the pressure of population for recreation is a growing problem. The forests are overstocked with deer; this is damaging to the trees but adds value to the hunting rights—a considerable source of annual income.

As I see it, these intensely interesting lectures, especially the two final ones, are "must" reading for American foresters.

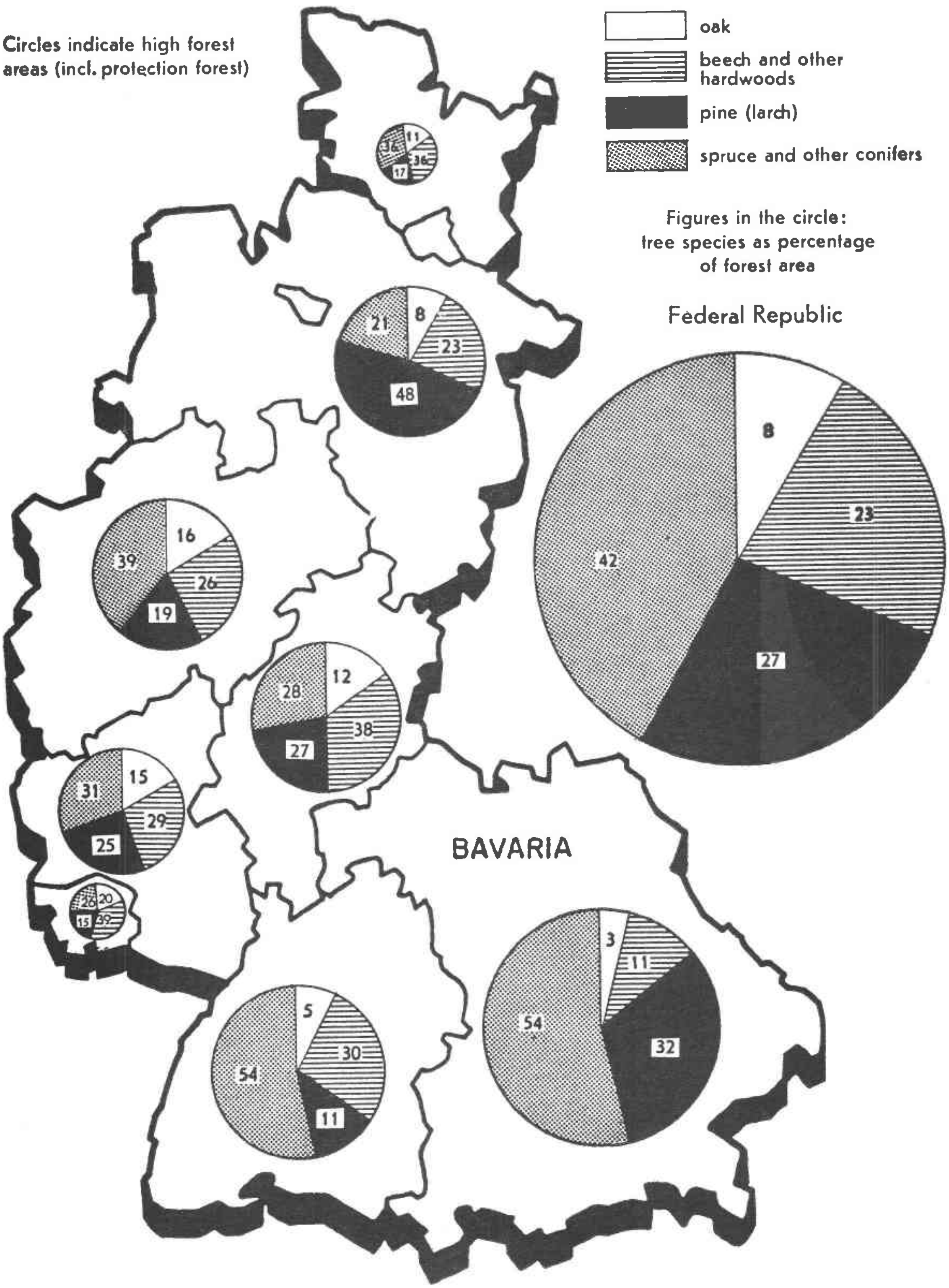
David T. Mason
Portland, Oregon

Forests of the Federal Republic of Germany as percentages of land area and classification by ownership.



SOURCE: *Forestry in the Federal Republic of Germany* published by "Land-und Hauswirtschaftlicher Auswertungs-und Informationdienst-AID," Bad Godesberg, on behalf of the Federal Ministry of Food, Agriculture and Forestry, Bonn, Germany.

Distribution of tree species in the Federal Republic of Germany and percentages of the forest areas.



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Contents

1. The Natural Forests of Germany and Their Changes Under Five Hundred Years of Forestry

At home I have a rather unusual position. On the one hand, I manage, as chief, a district of the Bavarian Forest Service in the Alps, and on the other hand, I teach silviculture at the University of Munich. It is my feeling that this combination is a good one. It forces me to keep up-to-date in the theoretical field and to stay in close contact with practical work. Out of that combination, I will try to draw a broad picture of forestry in Germany today.

It is a difficult task to describe our forestry in readily understandable terms, not so much because of the differences of sites, tree species, or methods of management, but because of the completely different historical and economic situations between our two countries. During the last decade, I often had the pleasure of guiding American foresters and talking to tourists and armed forces people. When discussing their impressions of German forests and forestry, I usually could predict one of their statements: "Your forests all look so neat, as though newly cleaned; we never see a snag; we never find dead timber on the ground, hardly ever a branch. What are you doing out there? Are you foresters or gardeners?"

Knowing your continent a little, too, these questions are easy to understand. My deepest impression of your country is the tremendous vastness of land, the beauty and wildness of almost never-ending virgin forests. Germany is a small country, densely populated and heavily industrialized. On the average, one person lives on each acre of land. For hundreds of years all timberland has been cut, grazed, and raked for litter. Much timberland was put to agricultural use and reforested later, some of it two or three times. The first artificial reforestation we know of was the sowing of Scots pine on a large scale during the second half of the 14th century in the once, and still so-called, imperial forests around my home town of Nuremberg. That sowing may be considered as the beginning of forestry. It took about another 400 years until, under the pressure of a feared lack of timber, the principle of sustained yield was formed in Germany. This principle is now characteristic of every true forest practice around the globe.

The result of this historical development was that not one acre of virgin wood is left, and that the natural composition and characteristics of the forests have been preserved only on very limited areas. Over large areas, most of the forests were changed completely. Another result is that every acre of forest remains under more or less intensive management. In spite of this and in spite of the relatively high percentage of forest area in relation to the total area (approximately 28.7 percent, which is about the same as the U.S.A.), Germany is today one of the big wood-importing countries of Europe.

This short introduction seems necessary to explain why I propose to start with the theme: "The Natural Forests of Germany and Their Changes Under Five Hundred Years of Forestry."

Basic Factors

Before talking about forest regions and forest types, it may be helpful to give some information on such basic factors as climate, geology, soils, and topography, even if this is possible only on a very limited scale.

The climate of Europe is characterized by two types: the Atlantic, humid and mild, and the Continental, drier, with cold winters. Germany lies in a mixture of both zones. Its western and northern parts, the latter bordering the ocean, tend to the Atlantic climatic type; the eastern area and the Alps tend more to the Continental type of climate. But as a whole, taking high mountains out of consideration, the climatic conditions are favorable everywhere for forest growth. The average annual temperature range is from 37° to 50° F., and the average temperature during the vegetation period (May to August) is from 50° to 64° F. So the number of vegetation days (days with an average temperature of 50° F. and over) amounts to 80 to 200. Extreme temperatures of short duration in winter or summer reaching from about minus 25° to 110° F. only very rarely harm native tree species. The average yearly precipitation drops down to 20 inches only on restricted areas, reaches mainly 25 to 30 inches, and goes up on the western and northern slopes of the mountain ranges to 80 inches. Usually 50 percent or more of the rainfall occurs during the vegetation period, and this is favorable, too. Also, winter normally brings a lot of snow in the mountains of southern and eastern Germany and this, too, is beneficial. The highest dangers to our forests are the winter storms and gales blowing from the west and locally the heavy thunder storms in summertime.

It is very difficult to give a short description of geological conditions. They are so different and change so often that details would be impossible. A wide variety of geologic substrata, from Paleozoic to quaternary deposits, can be found. It is worthwhile to mention that vast areas in the north and south are influenced by the deposits of glaciers, which covered those regions during four glacial periods.

The soils and soil types developing under given climatic and geological conditions are also manifold. They vary from heavy clay to sterile quarzite sand, and from the skeleton soils and soils of the rendzina series to brown soils, gleysoils, and podsols. Simplifying very much, one may state: light soils, sandy loam, loam, and soils with a rock content, especially under hardwood stocking, tend to soils of the brown soil group. Heavy soils, heavy loam, clay, soils on mountains with high precipitation, especially under softwood stocking, tend to soils of the podsol group.

And now to topography: A view of the map shows that to the south, Germany is geographically limited by the east-west range of the Alps with peaks up to 9,000 feet. The rolling country north of the Alps, in its southern parts, mainly moraines, in its northern portions, mainly Jurassic, is drained by the Danube to the east. Along the eastern border against Czechoslovakia lies the Hercynian mountain range with maximum elevations of about 5,000 feet. The central part is drained by the Main River to the west and changes to flatlands, hills, and low mountain ranges, containing the Steigerwald, the Rhoen, and Spessart forests, famous for their hardwood stands. The west portion is drained by the Rhine River to the north. In the south, the river is accompanied on its eastern bank by the range of the Black Forest, close to 5,000 feet high, and the Odenwald; on its western bank by the Vosges and the West Rhenish mountain range. Northern Germany, the part north of the Main River watershed, embraces rolling country turning to coastal plains, with the exception of the Harz Mountains, a 3,750-foot high range extending its main part into Eastern Germany.

After this short review of basic factors it may be asked: what natural forests grew under these site conditions? To be frank, we do not know exactly. Neither do we know their natural extension nor their exact composition. But we do know that the whole of Germany was once heavily covered by forests, much more so than today, and we have a fair idea of what forest types existed then and would exist today without human influence.

Original Forest Regions

How many original forest regions one may distinguish is a question of intensity of classification. One of our scientists (K. Rubner) divides Germany into 21 regions. For our purpose here, I believe three will be enough: (1) the central European hardwood region, (2) the subalpine spruce forest region, and (3) the mixed forest region.

The central European hardwood region

Climatic factors determine the extent of forest regions. It is certain that exact quantitative measurements for a single factor cannot be given for each forest region. The complexity of climatic factors and the influence of other factors, such as soil or relief, are too strong. But despite this, climatic figures may still be helpful. For the central European hardwood region they are: average yearly temperature over 45° F., average temperature during May to August 61° to 64° F., or over 150 vegetation days. Minimum precipitation during May to August is 10 inches. This means that all areas in Germany below an elevation of about 1,500 feet and under favorable site conditions up to 2,700 feet potentially belong to the hardwood region. Because of these climatic factors, the whole of western and northern Germany (except the highest elevations of the Harz and Black Forests), central Germany, and southern and eastern Germany up to the foothills of the Alps and Hercynian Mountains are in the potential hardwood region.

The dominant tree species in the original forests were two oaks, *Quercus robur* and *Q. petraea*, belonging to the group of white oaks, and a beech, *Fagus silvatica*. The three were accompanied by a series of other broadleaves, such as two birches, two elms, two maples, two basswoods, one hornbeam, one ash, and a few more of minor importance.

This very small number of species formed a series of forest types within the region. In the warmest parts, on the heaviest soils, and on the drier sites, the oaks were dominant with some hornbeam and birch as the other main constituents. In the cooler parts, on the lighter soils, on the more moist sites, beech was most numerous, partly in pure stands, more often accompanied by elm, ash, and maple. But there were sites where all of them grew together, forming stands of a rich natural balance.

Of course, sites occurred within the region where a climax stand could not develop, mainly on account of the soil conditions. On the one hand, the flood lands of the rivers and small swamps were taken over by mixed hardwoods, poplars, alders, and willows. On the other hand, on the rock outcrops, bogs, and poorest sand soils, Scots pine, *Pinus silvestris*, the main pioneer species after the glacial periods, could not be pushed aside by the later climax species. But it was the only softwood within the region, and it probably grew only rarely in pure stands, mostly mixed with birches and oaks. The central European hardwood region took up about three-quarters of the forest land. The forest types were characterized by a mixture mainly of four or five species and by a prevailing many-storied structure during all of the life stages, because light-demanding and shade-bearing species were found in the same stands. Beginning in the middle of the 19th century, the character of the original forest was changed by extensive introduction (planting) of softwoods, primarily Norway spruce.

The subalpine spruce forest region

The counterpart to the central European hardwood region, covering the plains, the rolling country, and the hills, is the subalpine spruce forest region characteristic of the high mountains below the alpine meadows and rocks. Its portion of the total forest area was well below 5 percent and still is, because this region was hardly changed at all because of its difficult logging conditions and its high natural conifer percentage. Its climatic data are: average yearly temperature 35° to 40° F., average temperature from May to August 50° to 54° F., or 80 to 120 vegetation days. Precipitation from May to August reaches 24 to 32 inches. In this region, the timberline in the Alps is at about 5,400 to 6,000 feet elevation and goes down to 3,600 to 4,000 feet. In the Hercynian and Harz Mountains, the subalpine forest grows from the peaks down to about 2,700 to 3,000 feet.

The name of the region already tells that a spruce, *Picea abies*, is by far the dominant species. Only in the Bavarian Alps, especially in the eastern parts, European larch, *Larix decidua*, and a very restricted five-needle pine, *Pinus cembra*, are intermingled. Both species grow at a higher altitude than spruce. Only one hardwood, the mountain maple, *Acer pseudoplatanus*, can grow at that height. Rock fields are often taken up by a scrub pine, *Pinus montana*, or a scrub alder, *Alnus viridis*.

The mixed forest region

A more or less small band of mixed forest occurs between the areas of the other two regions. One may doubt whether it should be listed as a region of its own or better as a transition-type of both of the others. It is restricted entirely to southern Germany and grows at elevations of about

1,800 to 3,600 feet on the slopes of the Black Forests, the Alps, the Hercynian Mountains, and the adjacent foothills. It includes only one indigenous species of its own, the silver fir, *Abies alba*. Associated with it are Norway spruce, *Picea abies*, coming in from above, and beech, coming in from below. The three of them are the characteristic species of the region and are accompanied by varying amounts of maples, elms, ash, and Scots pine, in small quantities in local areas. Scots pine and scrub pine form islands within the region as dwellers on the many and often larger bogs between the foothills. This mixture and a many-storied structure, at least over long periods of a generation, were typical of that forest.

THREE CONCLUSIONS

From this short and simplified description, three conclusions are evident.

First, the natural forests of Germany are extremely poor in tree species. There are only five native conifers, of which two are of economic importance, and altogether about thirty broadleaves, and of these only three are abundant. The small number is a consequence of European geography and glaciation. The barrier of the Alps left the once much richer flora of central Europe no flightway as the glaciers pushed in from the north and down from the Alps. As they withdrew, all Germany was left practically a waste land. The process of floral re-immigration was a long and limited one.

Second, the distribution and extension of the forest regions show that the hardwood forests prevailed by a wide margin. By rough estimate, I would say at least from two-thirds to three-fourths, or even a little more, of the natural forest area was taken up by hardwoods.

Third, if one left out of consideration the subalpine spruce region, whose area does not amount to much anyway, practically all of the natural forests were mixed and had a more or less many-storied structure.

Present-Day Forests

Today, it is just the other way around: in the present forests, 68.4 percent of the forest area is taken up by softwoods—about 40 percent by spruce, 25 percent by Scots pine, and the rest by fir, larch, and alien species. Only 31.6 percent of the forest is taken up by hardwoods, about 22 percent by beech, 8 percent by oak, and the rest by other broadleaves.

The period of time during which this revolution happened hardly exceeds 200 years, but at least 300 earlier years prepared for it. Two main management systems were typical of our forestry during the Middle Ages. Large forest tracts in the hardwood region were changed into forests of coppice and coppice with standards. They furnished all kinds of timber needed at that time, chiefly construction timber and wood for many different kinds of handicraft from the standards, and fuelwood from the coppice. Management regulations for them were ordered as early as the 15th century which determined the yearly cut, the number of standards to be left, the extent of replanting, and so on.

At that time, the accessible high forests of the more backward areas, especially in the mountains, had to supply industrial enterprises first of all. These were metal and salt mines and metal, salt, and glass-melting factories. They used exploitation cuts for their management, taking out all the usable timber and leaving the rest standing on the cutting areas. Management regulations for these operations date back to the 16th century.

Besides or in conjunction with timber utilization, other kinds of forest utilization played an important role in most of the forests. Production of charcoal or potassium, grazing for cattle or pigs, raking of litter, and raising of bees for honey and wax could be found widely and intensively. The nobility put large forests under protection for their own hunting and raised game populations on them which gravely endangered not only the reproduction of the forests but also heavily damaged agricultural crops. That kind of wildlife management was one of the main reasons for some of the bloody farmers' revolutions of that time.

All of this led to a serious devastation of our forests. Overcut, overgrazed, overraked, or overpopulated with wildlife, around the middle of the 18th century they were in such bad shape that not only the timber supply of large parts of the country became inadequate but cultivation of the nonforested land was endangered too.

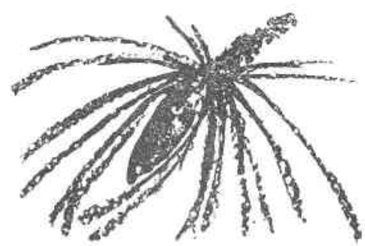
In the normal way of human behavior, people started to take notice only when they were already in the middle of the crisis. But as I mentioned, out of this crisis arose our modern forestry. The principle of sustained yield was acknowledged, and reconstruction work was started. However, conditions proved to be so unfavorable for the reforestation of many areas that the natural forest composition could no longer be attained. The use of pioneer species was inevitable, and that meant mainly the use of Scots pine.

Nevertheless, many forests were converted into pure softwood stands where biological circumstances did not force the forest managers to it. Conversion from natural mixtures to artificial pure stands without compulsion was partly the unwanted result of our regeneration methods, but most often it was the result of the wishes of the capitalistic economy which came into being just about that same time. Forestry came under its influence, too. A calculation of the possible yield of wood and its sale price between the different species favored the softwoods clearly, particularly Norway spruce. The decision to convert economically poor hardwood forests into softwood stands was a sound and right one from the point of yield and profit. What could not be taken into the calculation, at least at that time, through lack of experience, was the reaction of nature, which will occupy us later.

We would have been happy if the reconstruction period (mainly between 1810 and 1850) had produced forests in the proportion of species that we have today, but in mixed forests, not in blocks of pure stands. Unluckily, that is not the case. What resulted was the conversion of mixed natural stands into pure artificial ones.

Large forests of pure spruce or pine were established within their natural distribution area but even more often outside of it. However, the conversion did not spare the mixed hardwood forests which were left. It took place there, too, and changed many of them into pure beech stands, mainly as a result of the shelterwood method applied to them. Along with that process went, necessarily, the loss of the many-storied structure of the stands. The ability of pure stands to keep or develop such a structure is very restricted. It does not exist for spruce and pine. Anyway, the reconstruction of our forests within such a relatively short period of time was an admirable forestry performance from which we still profit today.

Out of its historical background, our forestry draws advantages and disadvantages. One or even two full rotations under regular management taught us a lot. But a long history can be a burden too, especially in our field. It can make you believe that you would be wiser than anybody else; and it can make you look backwards too much and not forward enough.



2. Forestry Organization, Legislation, Policy, and Education

In the last chapter I gave a review of the biological foundations of forest growth, contrasting the natural forest and the present forest composition in Germany. This chapter deals with an introduction into the social, organizational, and political circumstances of forestry. It has to be a heterogeneous bundle of information, questions of territorial jurisdiction, legislation, policy, and education; but this seems necessary to round out the picture so you may better understand the many peculiarities of our situation.

The Federal Republic of Western Germany has a land area of not quite 100,000 square miles. Of this, 28.7 percent, or a little over 27,000 square miles, is forested. With a population of over 54 million, that gives .31 acres per capita. Compared with the USA, this means we have one fiftieth of your forest land and not quite one fourteenth of your area per capita. Such figures are interesting, but they show the real picture only when you take distribution into consideration. One glance at the map inside the front cover of this booklet shows that central and southern Germany are much more heavily wooded than northern Germany. The percentage runs up to 32 to 39 percent in some regions, locally even over 60 percent, and sinks down to 4 to 20 percent elsewhere. This has nothing to do with natural distribution but is the result of cultivation which cleared the best agricultural sites and left the rest wooded.

As a general policy, we do not want our forest area to drop below 25 percent of the total land area. Therefore, the 28.7 percent of land in forest cover today is at least an acceptable lower level for our public needs.

Forest Ownership

The next question concerns the classification of forest ownership. The map inside the front cover shows this classification for the Federal Republic and the states. On the whole, state forests occupy a little less than one-third, about the same as in the U.S.A., private forests about 41 percent, much less, and communal, church and foundation forests some 27 percent, much more than in the U.S.A. Proportions of ownership within the states differ quite a lot as the result of their historical development. In the western, southwestern, and central states, the percentage of communal, church, and foundation forests is much higher than in the eastern and northern ones. In contrast, the private forests reach their highest percentage in the eastern, northwestern, and northern states.

For management, one very important fact of ownership distribution is that about seven million acres of private forests are owned by close to 500,000 people. The average size of the private forest is therefore fifteen acres. For the communal, church, and foundation forests, it is 200 acres. These figures alone indicate the difficult management problems of such holdings, which are mostly still split up in a number of allotments. Large private estates are restricted to a very small group of old nobility. Industrial companies, including the timber industries, hold practically no timberland. The forest ownership of the Federal Republic itself is restricted to about 2 percent of the total.

What may surprise you is the number of forest employees who manage the 17.5 million acres of German forests; altogether there are about 19,000, 2,350 of them university graduates, 9,400 district rangers, and 7,250 wardens. This is, on the average, 7,500 acres for a graduate and 1,100 acres for a ranger or a warden. About 85 percent of the graduates and 60 percent of the rangers and wardens are government officials. The number of employees gives an idea of the intensity of management.

Legislation

When the Federal Republic was founded in 1952, the constitution left to the states the right of legislation in a few fields such as education and cultural life and forestry. Only the Federal Republic is allowed to decree basic forest laws to provide a framework within which the legislation of the states has to stay. Such laws would deal with facts or problems of universal importance. The same is true for forest administration, which belongs to the Department of Food, Agriculture and Forests. It has to manage its own forests, deal with programs to increase forest production and intensify management on private forests, concern itself with interregional problems of natural reserves and landscape protection, the import and export of forest products, and the protection of forestry interests in operations with other administrations like tariffs, custom duties, timber prices, or international affairs such as the Common Market. It also assists the parliament with help in its legislative work, as with taxation. All other matters of forestry in legislation and administration are up to the states and fall under their responsibility.

One organization of high importance, the German Forestry Council, exists between the parliament and the governments of the Federal Republic and the states. Its members represent the public, communal, church, and foundation forests and the private forest owners, forest science, and professional organizations. Its main task is to act in an advisory capacity on all actual forestry problems and to make the voice of forestry heard and understood by the public amid all the clamor of daily life. The council works primarily with a series of technical committees, such as committees on the timber market, legislation and forest policy, taxation, and higher production.

Up to now, the Federal Republic has not made use of its right to pass a fundamental forest law. The question of whether such a law is necessary or not has been broadly discussed during the last few years. The results of the discussion are clearly in favor of a fundamental law. It is now in preparation but has not yet been brought into parliament. So at the moment, only a series of federal laws and orders are valid, of which four are of high importance. They are listed below.

(1) *The law against forest devastation (1934)* prohibits the felling of immature coniferous stands, mainly below the age of 50 years, and determines which part of a total timber holding may be clearcut. The percentage is lowered with increase in size of ownership.

(2) *The order on grading, measuring, and sorting of timber (1936)* regulates in detail how all commercial timber must be measured and classified.

(3) *The order on marketing of standing and felled timber (1938)* forbids the sale of all standing timber. Only felled timber, measured and classified by the regulations of the order of 1936, can be sold.

(4) *The law on forest seeds and forest plants (1957)* was called forth by the disastrous results of reforestation with seed or plants of origin not suitable to the site. Seeds collected from crippled trees, seeds from lowlands used on high mountains, or the reverse, and seeds from low-quality stands brought our forestry heavy losses. The law therefore requires that seed of the important tree species can be collected only in certified areas or stands. For each species, it determines origin regions and specifies altitude belts within each region. The certification of seed-collecting stands or areas is given by the state forest services which have to keep records on them. Each lot of seed gets an origin certificate from the forest owner on whose property it was collected. A copy goes to the state forest service. The certificate shows species, area, altitude belt, and collecting date. For example: VIII/15 over 3,000 feet, 11/65 means: VIII = Norway Spruce, 15 = origin area Bavarian Alps, over 3,000 feet = altitude belt, 11/65 = collected November 1965.

Seed dealers and nurseries have to store the seed separately by tree species, origin areas, and altitude belts. In the same way, seed must be stored, taken out, and sold separately. The origin certificate has to go along with the seed lot until the seed or the seedlings are sold for forest use. All seed dealers and nurseries have to keep account of the income and output of seed or seedlings. The state forest services supervise these books, storage rooms, and nurseries. Import of seed or seedlings is generally forbidden. Exceptions are only possible with a special permit from the federal administration. The law deals only with the collection, care, and trade of seed or seedlings. It does not and cannot order use in the right place. State, communal, church, and foundation owners do follow the spirit of the law, but when a farmer plants spruce seed from Lower Saxony in the Bavarian Alps, because it is much less expensive, we cannot prevent this.

We surely would prefer to get along without such a law, but our experience of the past and the knowledge that a mistake cannot be repaired for a whole rotation of 100 or more years forced us to it. In agriculture, where rotations rarely surpass one year, the use of the right seed is a simple matter; it can be determined readily. We have a hard time convincing our farmers that the regulation of seed in forestry is so much more important. It will take decades to remove the inferior trees and stands which are present today as a result of artificial regeneration from improper seed sources.

Besides federal legislation, each state has its own forest laws and their content is similar. The new Bavarian Forest Law of 1965 may serve as an example. It obliges the state forest service to manage the public forests under the principle of sustained yield and to promote the greatest public benefit. It puts the communal, church, and foundation forest owners under state supervision, and obliges them to manage by an approved plan under the direction of a graduate forester. It gives the private forest owners the right to use and manage their forests freely within the restrictions set by the constitution and the laws.

The heart of the law deals with the preservation of forests. Timberland can be cleared only by state permit. Two types of protection forests are determined. The absolute type must protect against erosion, landslides, and avalanches. The conditional type has protection functions in relation to neighboring stands. I stated previously that gales from the west are one of the highest dangers to our forests, especially coniferous forests, and I mentioned how small the farm forests are. Imagine two spruce stands, an 80-year-old one lying to the west and a 50-year-old one lying to the east. If the older one were cut clear, the younger one would be blown down by the next heavy storm because it would not be able to develop wind firmness soon enough to prevent damage. The protection function is given here for the stand on the west until the one on the east has grown to merchantable size. The owner, neighbor, or anyone concerned can apply to the county administration to put a stand under absolute or conditional protection. The county decides after hearing evidence from the forest service. The penalties threatened for breaking the regulations on clearing and protection are one year in jail and up to $2,500 fine. If any damage is done to a neighbor by improper cutting, it has to be made good.

For both types of protection forests, the law forbids clearcuts and thinning, which have a similar result, normally when over half of the standing volume has been removed.

The law also obliges the forest owner to reforest after a cut. If he does not, within a few years, the county administration sets a date for him to comply. If he is not punctual, he will not only be fined up to $1,200 but the forest service will reforest at his expense.

Along with the forest law is the forest penalty law which deals with theft of timber, damage of forests, endangerment of forests by fire, and so on.

This information about our forest legislation outlines the principles of our forest policy. It tries to better the condition, productivity, and the public benefit effect of our forests, as well as the economic situation of forestry. Two pressing problems to be solved here are closely connected.

Economic Situation

The economic situation of forestry has turned worse and worse during the last decade, a problem which I will cover later in more detail. Stable or, especially for hardwoods, declining timber prices are confronted with steadily rising production costs, mainly wages. The gap between prices and costs has become so great that many forests do not make any profit and even suffer losses. This situation is bad for all forest owners, but it hurts the private forest owners most, especially the many small ones. Forest policy tries to help in two ways: by lowering the heavy taxation and by improving management assistance. A large extension service has been built up, the formation of forest cooperatives is supported, and the development of forest roads is heavily subsidized—up to 80 percent of the cost.

The other quite different problem stems from the situation in agriculture. As a result of our open-market policy and the development of the Common Market, agriculture is in the middle of a revolutionary change. It is evident that about half of our farmers must go out of business in order to maintain agriculture on an economic base. The low yield of many soils will not allow their further agricultural use. We do not intend to let these soils go to waste. Land is about the scarcest possession we have. In spite of the poor economic situation of our forestry today, we sponsor afforestation of such land by paying subsidies up to 80 percent of the total costs.

Assistance to agriculture and forestry costs our taxpayers a good billion dollars each year. The first results are encouraging, but it will still be a long time before we will be on safe ground.

Forestry Education

And now, some information on our education. As I told you, our forestry services employ three categories of personnel: graduates, district rangers, and forest wardens. For the graduates, education starts at age 19 or 20, after finishing four years of elementary and nine years of high school, with a half year of apprenticeship in a forest district. Working with their hands, they get acquainted with all lines of forest labor. Afterwards, they join a university for eight or nine half-year terms. Four terms are reserved for basic fields such as biology, mathematics, economics, and jurisprudence, and four to five terms are devoted to professional forestry. The main fields here are forest policy, forest management, and silviculture. A preliminary examination finishes the studies after the first two years; the main examination comes after four to four and one-half years. There are no examinations in between.

If a graduate wants to join a state service, and practically everyone wants to, a three-year preservice training as "junior graduate" follows in forest practice and administration in a forest district and a regional office. The last and deciding step of the seven and one-half to eight-year education is the "great state examination," not given by the universities but by the services alone. A candidate is examined for ten days "to heart and kidneys," as we say. I never in my life had to work as hard as during that period. If the candidate passes, it will take about ten years more until he becomes chief of a district.

The district rangers start their education with a two-year apprenticeship after four years of elementary school and six years of high school. Afterwards, for one and a half years, they attend a forest school operated by the forest services. An examination must be passed at the end of this period. A three-year preservice training follows in all branches of practical forest operations. It has to be completed by the district ranger examination.

The category of forest wardens gives the opportunity to young, able workers to become civil servants. They must be skilled in their labor and must have proven it for a number of years. After successfully passing an entrance examination, they get practical training for one and a half years and attend a forest school for one-half year. Then they take their examination as wardens. The members of each category have the possibility of stepping up into the next higher category by passing its final examination.

The whole education in all three categories is concerned only with forestry and not with lumbering or forest products. I personally believe that our ways of education—especially for graduates—are no longer up-to-date. At the university level, it seems to me that everything is too theoretical, too occupied with matters of pure forest management. Not enough regard is paid to modern tasks of forestry such as recreation, watershed management, conservation of natural resources, landscape-formation planning, and similar modern problems. The program is too strongly restricted to the conditions of our small country. The three years of preservice training are ,on the contrary, too practical. They serve only as training for a state service and they do not leave time for a deepening of the knowledge gained at the university or for specialization in a certain field. The problems of educational reform are discussed widely, but this has not produced any results up to now. I am convinced that we do not have much time left if we want to retain a high level of efficiency or reach again a high standard of performance as compared to other nations.

3. The Forest Service and Its Management Methods

The first two chapters introduced the natural and social foundations of German forestry. The next five will deal with the practice of forestry in my country. The Bavarian Forest Service is used as an example here because it is the largest in Germany, and its methods of forest management are typical.

The Bavarian Forest Service is part of the Ministry of Food, Agriculture, and Forests. The Department of Forestry, as the top authority, performs the leading forestry functions. At the middle-management level, there are six regional offices, mainly charged with supervisory functions. Both the department and the regional offices are split up in a series of divisions, which include personnel, timber sales, silviculture and inventory, labor, development, real estate, budget, and hunting and fishing. Each division chief of the regional offices also supervises a series of forest districts. The management level is the forest district known in German as Forstamt, headed by a graduate forester as chief and assisted by another graduate forester in the larger districts. The forest district normally comprises four to six subdistricts with a technician stationed on the larger ones and a forest warden on the smaller ones. The service maintains its own research organization with eleven institutes at Munich.

Our forest districts are "Einheitsforstamter," or united districts. That means that the foresters in charge manage not only the state forests but superintend the church, communal, and foundation forests, give extension service to the private forests, and administer the whole spectrum of forest functions. Each acre of land in Bavaria belongs to a forest district, even though only 28 percent of the land is forested. Forest districts may include only state lands or only private lands, or they may include a mixture of these and communal, church, and foundation forests. These forests may lie in one or more counties. The two million acres of state-owned forests, 750,000 acres of community, church, and foundation forests, and close to three million acres of private forests are in 290 districts. The amount of state land in forest districts may range from 5,000 to 25,000 acres, according to management intensity, work requirements, and extent of other forests. For example, my district at Murnau comprises 7,500 acres of state forests; 5,000 acres of communal, church, and foundation forests; and 25,000 acres of private forests.

Before discussing the concept and ways of management in the state forests, I would like to say something about the other functions of a forest district. The districts are responsible for a broad group of tasks. On its entire area, the district must enforce laws and orders concerned with forestry. If these laws are broken, it is necessary to notify the general county administration or the county court; these are the deciding bodies. The district chief acts as adviser to the attorney at court. The county administration hears the district chief before deciding any forestry matter such as clearing of forests, putting a forest under protection, and so on. We do not have to help the revenue offices in all questions of taxation.

On the other hand, the district has to protect the interest of forestry against all competing land uses. If, for example, a new highway, power line, or reservoir is to be erected which would encroach upon forests of any ownership, if the armed forces want a new training ground, or if a housing project is planned in a forest close to a settlement, the district representatives have to be heard and their arguments have to be taken into consideration. To be frank, our words do not carry much weight and often we are the losers, but at times we are able to prevent forest damage or diminish it.

The next task is extension service to the private forests. Private forest owners are not required to accept the advice; they can ignore it. The extension division informs the public with lectures and excursions, as well as giving assistance to single forest owners. If a farmer wants an afforestation project planned, a regeneration cut marked, felled timber classified and measured, or planting stock ordered, the district does it for him for nothing or at a very low cost. In the same manner, it makes road surveys and provides construction supervision. Especially, it advises and helps on all work which is subsidized by the federal or state government.

The communal, church, and foundation forests are required by law to be managed by an approved plan and under the direction of a forestry graduate. If the community, church, or foundation employs its own professional forester, full or part time, the district has only to approve the management and yearly working plans and to make sure that no overcuts are made and that reforestation is adequate. There are only a few community or other ownerships large enough to allow the full employment of a graduate. Private foresters for part-time employment are rare, so most of the communities, churches, and foundations sign a management contract with the forest district in which they are located. In that case, the district does all the practical work. It draws up yearly working plans, marks timber, supervises felling, does scaling, plans and supervises reforestation, and so on. Even the timber sales can be conducted by the district if this is wanted. Only the monetary business and the bookkeeping are then left up to the small owners. They pay the district for the major costs of supervision, based on a rate per acre and per cubic foot cut, which is valid for the whole state.

Of all the many-sided functions, the main task of a district is normally the management of the state forests. The Forest Service is obliged by the Bavarian forest law:

(1) to preserve and better the growth capacity of the forests;

(2) to increase timber production by volume and quality and to guarantee sustained yield;

(3) to protect the forests against damage;

(4) to utilize the forest products by economic principles; and

(5) to secure the beneficial effects of forests, especially the possibilities of recreation, and to improve upon the efforts of nature in landscape protection.

How these tasks can be accomplished is first a question of the means available. All German administrative agencies work with an historic bookkeeping system specialized for administration. Our trouble is that we, too, have to work with it in spite of the fact that we are mainly an independent operation and not an administrative body. Districts operate as described below.

For each year a budget plan has to be drawn up. It must be approved by the Parliament and becomes a law by that approval. Each district prepares a budget plan outline for its expenditures and its revenues about three quarters of a year in advance. The outline is split up into some thirty different working fields for expenditures like felling, reforestation, road construction, road maintenance, forest protection, hunting, and so on. There are ten budget classes for revenues, such as timber sales, rent for agricultural land, hunting, and so forth. Finally, the budget plan outline is drawn up for the whole service and the Parliament decides how much we have to earn and how much we may spend under each category. These figures now drop down the ladder again until they reach the district.

For expenditures, the district is bound strictly to the allowed amount for each category, and the district chief is himself responsible for seeing that the amount is not overdrawn. Moreover, switching an expenditure allotment from one category to another is not allowed. Allotments not spent until the end of a budget year, which is the same as the calendar year, revert to the Department of Finance.

The budget sets a figure which each district is expected to earn during the budget year. However, the allowable cut for the district is not disturbed to meet changing market conditions. In times of low timber prices, the district earns less through harvesting its allowable cut. In times of good prices, more revenue is earned by keeping the cut at its allowable level.

It is evident that such a system is not very well suited to the management of large forest properties. It is too rigid for a management depending to such a high degree on weather conditions. It is too complicated to be supervised readily; and it does not permit quick adaptation to certain developments of the timber market. The biggest fault is that yearly calculation of the profit or even a balance over a series of years is practically impossible because all the investments are charged fully to the year in which they are made. The same is true for all expenses made to accomplish the functions not belonging to the management of state forests. All of our efforts to change the system or even to better adapt it to our circumstances have failed because we are part of the state administration.

The district itself handles no cash money under this system. The whole fiscal business is handled by state accounting offices.

At the end of a year, according to its budget plan, the district draws up an operating plan for each operating division for the following year. The plans have to be approved by the regional office and are thereafter the basis for management. The most important of these is the cutting plan. It is separated into regeneration cuts and various kinds of timber-stand improvement, such as thinnings of older stands, thinnings of younger stands, and precommercial thinnings of very young stands. Each cut in a stand has its own position in the plan. The planned method of the cut, whether shelterwood, strip or clearcut, or high or low thinning, has to be described briefly and the area and volume given. The numbers of cutting units fluctuate around sixty on my district. That means the average volume of a cut is about 7,000 cubic feet. By our service regulations, regeneration cuts and thinnings of older stands have to be marked by the district chief himself. Only the thinnings of younger stands and stand-improvement measures can be undertaken by the subrangers or wardens after instructions by the district chief.

A main difference between your management and ours is that with rare exceptions we employ our own labor force. The workers are employed and paid by us and get their orders only from us. They work in all fields, cutting, skidding, cultivation, protection, road construction, and so on. We know that it might be less expensive to work with private contractors. But we believe that in a country where preservation of the forests plays such a high role, it is more important to be able to insure careful work than to save a few dollars.

In the lowlands and the rolling country, where snow and skidding are normally no problem, we cut timber from October to March. This is necessary especially for high-grade pine and hardwoods, which are quickly attacked by fungi during the summer. In the mountain areas, timber is felled mainly from June to December—first of all the spruce and fir. Pine and hardwoods are cut as late as possible. All timber is skidded to truck roads during the winter. The technician or warden in this part of the work acts as would the bullbuck on an American logging operation. He decides where the greatest value is to be obtained from the felled timber and marks the logs to be cut for grade and length. Our tendency today is to cut as long lengths as feasible because felling costs are lower and utilization is better at the sawmill. The greatest length allowed by highway regulations is 60 feet. The timber is sorted as veneer or peeler logs, sawlogs, mine props, pulpwood, or fuelwood. The production of pulp or fuel cordwood sinks from year to year because the demand for this material diminishes and production costs for both of these items have become too high. After timber is cut, the technician or warden scales it mostly at the falling area before skidding. He measures the length and middle diameter of the log and thereby gets its volume and diameter class. Each class comprises four inches. The middle diameter four to eight inches equals class 1; eight to twelve inches equals class 2, and so forth. Sawlogs, mine props, and pulpwood are also divided into four quality classes: Class A equals high-grade timber, straight with only a few small branches; class B equals normal timber, curved only to one side, sound without many large branches; class C equals low-grade timber, crooked with many or large branches; and class D equals timber only partly usable for sawlogs or mine props.

After the skidding team has brought the timber to a truck road and stored it there, separated into sawlogs, mine props, and pulpwood, the harvest is ready for sale by the district. Three ways of selling are available: (1) negotiated sales, (2) auction sales, and (3) sealed bids. The sales method used depends on local custom, the condition of the timber market, and the product. Veneer logs or peelers, especially our high priced oak and pine, are auctioned only. For sawlogs, the timber market situation is tested at the beginning of the sales period with a series of auction sales in different parts of the country. If the market is strong, we try to bring more timber to auction sales. If it is weak, we switch more to negotiated sales or sealed bids. The last method, however, is seldom used, at least within the Bavarian Service. In the Alps, we sell our timber almost exclusively by negotiation because of local custom and the difficulties of restricted storage capacity. For negotiated sales, the regional office gives us lower price limits for diameter and quality classes. If we want to sell timber below these limits, we need a permit from the regional office. High-grade veneer or peeler logs are sold by the piece; sawlogs, mine props, and pulpwood by lots of 1,000 up to 35,000 cubic feet. Selling lots on the average are around 5,000 cubic feet, and are mostly derived from one sawlog cutting operation.

Mine props and pulpwood are obtained as secondary products from sawlog cutting. About 75 percent of our cut is for sawlogs. The quantity of different kinds of raw timber products purchased during the last ten years has changed considerably. In general, the percentage of mining timbers and fuelwood sank and that of pulp and paper, manufacturing, and other industries rose. Sawlogs are sold in small quantities because of the structure of our sawmilling industries. The statistics of 1950 show that 3,494 sawmills were operating in Bavaria. This would be a much lower figure today. The mills in 1950 employed on an average only 7.4 people. Only 16 plants employed more than 100 workers and all the mills produced a little over 80 million cubic feet of boards. Today there are fewer mills, more employees, and greater production.

Cultivation, forest protection, road construction and maintenance, and erosion control will be discussed more fully in following chapters.

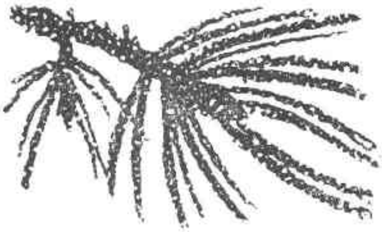
For each working circle, a yearly working plan has to be drawn up. The cultivation plan includes not only the stands and areas, but, for each one, the species to be used, the quantity of seed or seedlings and their age, size, and origin, the spacing, the calculated costs for material and labor and all other kinds of cultivation work such as soil preparation, fertilization, or weeding. Similar detailed plans are drawn up for all other forest operations. At the end of the year the district has to approve the plans for each single operation as to what was really done and how much it actually cost. Because the regional offices check that as well, they have fairly good control over district plans, calculations, and work.

Hunting Situation

As the last item concerning management, I will try to explain our hunting situation. In contrast to your country, the right to hunt in our country is connected with the property rights of land. To be able to exercise the hunting right, one must own connected land of a size determined by law. For single persons, the size of a hunting district must have 200 acres in the lowlands and 850 acres in the Alps. The owner can use the right himself or rent it to another person. All landowners below that acreage must bring their lands into the hunting cooperative of the community within whose boundaries they lie. The hunting cooperatives then have to rent the hunting rights to interested people for a period of 9 or 12 years. The size of cooperative hunting districts must be 625 acres or 1,250 acres in the Alps. No one is allowed to rent hunting districts larger than 6,250 acres. The hunting tenant has the exclusive right to hunt, so hunting in Germany today is a sport only for a few. They pay up to $4 rent per acre per year. The large state forests are hunting districts, too, and therefore hunting belongs to the management duties of a district. The forest service rents only one third of its hunting areas to private persons.

Our trouble is that this system does not allow adequate regulation of the big game population in spite of the law which is supposed to regulate hunting so it will be compatible with the interests of agriculture and forestry. Each owner or tenant of a hunting district reports his roe deer, red deer, or wild boar population to the county administration each spring and applies for the amount of game he wants to kill. It is easy to understand that people for whom hunting is only a very expensive sport want a great deal of game on their areas. Therefore, the animal population figures they give are in most cases far too low as is the requested killing rate. It is difficult to control the number of animals because of the small size of the hunting districts, game migration, and the unreliable census figures. Moreover, in the country administration the hunters act as advisors. In the state hunting districts, regional offices act without advisors.

Currently our game animals have reached higher numbers than ever before, in spite of our dense population and high industrialization. Ten to fifteen roe deer per 100 acres are not unusual. Red deer in one district were close to seven head per 100 acres when a desirable carrying capacity would be one head per 100 acres. If you take into consideration that most of our forests are far from natural in composition and that many pure coniferous forests offer only a minimum food supply, it is evident that such populations are disastrous for forestry. The damage done by game runs into millions each year. The service tries to reduce the number of animals on its areas, but progress comes slowly. The populations fill up again from the sides. So game has become one of the deciding factors of German forestry today. Our fight against this overpopulation is not only hindered by hunters and hunter organizations but by the public opinion that wildlife has to be part of our forests. We believe this to be true, but in our total responsibility to manage forest lands, we must keep all forest factors in balance. Apparently, the public does not realize that the preservation of sound, stable, and productive forests today is endangered ecologically by too much game, rather than by any other cause.



4. Management Planning

As mentioned before, the forest laws of the states oblige the state and public forest owners to manage their timberlands through management plans. The private forest owners cannot be forced to do this, but because a management plan brings many advantages for them in taxation, they do it of their own free will if their holdings are large enough for independent management. Therefore, management of forests on about three quarters of the private timberland is based on plans prepared by professional foresters. The period of validity normally runs 20 years. In the state forests, plans are checked every 10 years and brought up to date.

We can trace the beginning of management plans back to the 15th century when they were devised in the coppice forests of central Germany and in the high forests of the salt mines of southeastern Bavaria. The development of modern management planning started around the middle of the 18th century. The first two methods were used in an effort to plan the management over a whole rotation. They determined the total yield of a rotation and at first allocated an equal area to each management period of twenty years, and later an equal volume of timber for cutting was allocated. We call these methods "Flaechen- und Massenfachwerk," which may be translated as "area- and volume-framework methods." Today no one wonders why these methods did not succeed. They were planned for too long a period, and therefore the results were disturbed again and again, either because catastrophes changed the picture or because estimates of yield and growth proved inexact.

In the second half of the last century, the age-class method developed. We now use it with steady improvement, out of the experience of those first trials, and influenced by the development of the "normal forest" concept. The "normal forest" concept was an attempt to analyze theoretically how a forest must be built up and managed to secure maximum yield on a sustained basis. In these considerations and calculations, an estimated rotation was divided into a series of age classes. Because our forest-management planning aims to secure the highest yield and sustained yield, too, the practical work was based on these theoretical considerations. The age classes were mostly twenty years long. The concept of normal growth, volume, and cut was used to put theory into a realistic relationship to the actual growth, volume, and cut. A planning period of 20 years was set. At the beginning of this century, a new inventory method was developed in the selection forests of the Swiss Jurassic Mountains by Biolley. It was called the "Swiss method of control." This method is not based on a normal theoretical forest model to which the given forest conditions are related. It does attempt to regulate management and secure sustained yield by controlling the development of the actual growth, volume, and cut over a series of inventory periods. Undoubtedly, this method has many advantages. But it is tailored for selection forests and can be adapted to even-aged forests only with difficulty. In Germany, the quantity of selection forests does not reach even four percent, so we had to hold on to our age-class method. Today, normally four to six management plans have already been used in each district.

The inventory work itself is done by the silvicultural and inventory divisions of the regional offices. They maintain inventory parties of about four to five men, headed by a young graduate forester. Normally, they plan the management for one district each year. The district chief participates only as an adviser. He can express wishes and propose certain methods, but the party is independent and does not have to follow these suggestions. The division chief superintends the field and office work of the parties and is responsible for the results. After drawing up an outline of the plan, the district gets an opportunity to give a detailed opinion on it. The district may propose changes, but the division chief may or may not follow them. Anyway, he has to give his plan and the district's opinion of it to the department which decides and approves or disapproves as the final authority.

Practical work consists of three main parts: (1) the historical review, (2) the survey of the facts, and (3) the planning for the beginning period.

First, the inventory critically analyzes the management of the most recently completed period. What was planned the last time, to what degree was it achieved, what results were gained, what disturbances occurred biologically, nonbiologically, and economically, and what effects can be attributed to certain specific measures? This critical check concentrates to a high degree on biological matters, mainly silviculture and protection, and does not give much attention to the economy. A hint of this concentration is already seen in the combination of silviculture and inventory in one division.

The most significant field-work part of the inventory is the review of the facts. Today it begins with a survey and mapping of the sites, if this information is not already available. The survey is based on soil conditions, soil groups, soil types, water and nutrition supplies, and microclimate. Much of this work has to do with plant indicators that give an index to site conditions. The many different sites are condensed into similar site groups or site types, which allows a similar treatment. It is always a difficult task to keep the number of site groups low enough so that they still can be handled in practice without too much simplification. For each site type, the survey determines the probable natural forest composition and structure and sets limits within which they can be changed without endangering the productive capacity of the site. A site map with its legend is the result of this work.

The next step is the partition of the forest area. For a long time we have recognized four units: the district, the compartment, the subcompartment, and the section or stand. The first two units are historically the oldest; they are numbered and named and their borders are very seldom changed. As management grew more intensive, the compartments were separated into a series of subcompartments, denoted by a letter. They are today our operational and bookkeeping units with a normal size of ten to twenty-five acres. Their form changed often in earlier times; today we want them as fixed units, set up according to site and transportation conditions and if possible bordered clearly by natural or artificial boundaries, such as creeks or roads. Different age classes or stand compositions form the sections or stands within the subcompartment, each identified by a symbol down to the subcompartment letter. Their extent is variable, changing with regeneration cuts. Because today, the district, compartment, and subcompartment are fixed units, partition work concentrates on the separation and measurement of the stands. In most cases, therefore, we use aerial photography to reduce expenditures and to accelerate the survey.

After the partition of the forest area, a detailed analysis of each stand is made. First, it describes the site of the stand: its lowest and highest altitude, its exposure, its relief, the ground material, soil type, soil group, nutrition and water supply, form of the humus, the plant indicators, and the site type. The description of the stand itself begins with the determination of its age or age span, the average age, and the stand composition. The percentage of the canopy taken up by each participating species is therefore needed. If the stand is tallied partly or fully, it can be calculated; otherwise we estimate it. The exact determination of the yield class of each participating tree species is of primary importance for the whole work of compilation. Yield tables for all species are available. For taxation purposes, we have to use the same tables for the whole of Germany—in spite of the fact that we know that applicability changes in different regions. The yield tables are divided into five classes for the important species, such as spruce, pine, and beech. Three classes are used for the less important species, such as larch and ash. Because we determine half classes, too, we have 10 and 6 yield classes, respectively. The classification of the yield tables is based on the height of the mean stem at a given age. After knowing the age, we find out the mean diameter or the mean basal area stem by sampling test plots and measuring the height on a sufficient number of stems. Afterwards, the yield class can be read from the tables. The yield class is thereafter needed for the determination of volume, current increment, and degree of density. The highest accuracy in determining the volume is reached, without doubt, by tallying every stem over 5 to 6 inches in diameter. We are also anxious to determine the stand volume as closely as possible. Today, that is not only a question of costs but of labor. So a compromise was made, and we now tally all regeneration stands fully; we caliper some sample plots in stands more than half the rotation age and take the volume of the younger stands only out of the yield tables. The current increment for the next period also is derived from the yield tables for all stands. To check the true increment by stem borings is too expensive. But, because we have a series of inventories already, we can balance the total increment for the whole district (one may call it the historical increment) by adding to the new volume the total cut during the last period and subtracting the total volume of the last inventory. These figures are sufficiently accurate if both inventories are made with the same intensity and if the same yield tables are used.

Because we take all of our increment readings and in large part our volume readings out of the yield tables, it is necessary to correct them if a stand is not fully stocked. The degree of density is the ratio of the true basal area compared with the basal area of the yield tables. For fully tallied or sampled stands we get the density degree exactly, but in the younger stands we have to estimate it. For example, in a 40-year-old spruce stand, the degree of density is estimated at 80 percent of the full stocking of the yield table. Then the volume is reduced to 80 percent of the volume of the yield table, too. This is not true for the increment, because a stand with a density of 80 percent probably produces the full increment. The current increment is reduced only if the stocking sinks below 80 percent, but not as much as the degree of density. In the case of spruce, this means that a stocking of 70 percent corresponds to a current increment of about 90 percent.

The inventory must further describe the structure and mixture of a stand; whether it is one-, two-, or many-storied and whether the mixture is single, group, or for an area. For silvicultural and production planning it is important to explore intensively the quality and physical condition of a stand. Is it sound, or is it liable to diseases such as root rot? Is its seed origin suitable to the site? Is it damaged by game or human beings? Is it endangered by snow or storm? Are its stem forms satisfactory or are they below normal? What main quality classes of timber will be produced? These are among the questions to be answered.

In practical management planning, silvicultural and production planning go together with the survey of the stand. Only the compilation and evaluation of the facts gathered and the determination of the yearly cut are done indoors during the winter. That is possible because questions of rotation length, regeneration methods, aims of regeneration, or choice of tree species are already laid down by management regulations which are valid for different forest regions. For our purpose, I have separated the survey and the planning work because a few of the problems have to be discussed theoretically, at least briefly.

In contrast to the method of control, the length of rotation is one of the most important factors in the age-class method. Average increment, volume, and cut per unit change considerably by choosing a long or a short rotation period. In practice that question was settled a few inventory periods ago. It may be changed by 10 or 20 years now, but that does not amount to much. Today, we manage with rotations of 80 to 140 years, mainly 100 years for spruce and fir; 80 to 160, mainly 120 to 140 years for pine and larch; 100 to 160, mainly 120 to 140 years, for beech; 60 to 80 years for alder; 40 to 60 years for poplars and willows; and 160 to 340 years for oaks.

Theoretically, the rotation could be adapted to (1) the physical ability of the tree species for natural regeneration, which would lead us to a wide span of possibilities; (2) the highest volume production, which would lead to relatively short rotations; (3) the highest possible profit from the forest, which would lead to relatively long rotations; (4) the highest soil rent, which would lead to extremely short rotations; or (5) the most highly desired product.

Our rotations today are a compromise between the theoretical possibilities. They stay within the frame of the highest volume production and the highest profit, and they are adjusted to our silvicultural methods, especially the length of the regeneration period.

Another problem concerns the regeneration or stocking aims set by the management plan. Out of long-term prognoses of the timber demand, forest policy has to decide what species should be favored for the future and what species are wanted for other than economic purposes. Silviculture, as the technical science which has to accomplish the aims, also must be considered. For one thing, it is responsible for the maintenance of sustained yield. By this we mean not only that we are not allowed to cut more today than future generations will be able to cut, but that we are obliged to hold or even to better the production capacity of the sites.

Further, silviculture must state which aims are to be accomplished with the least possible cost. This means that in practice we try today to plant as many coniferous species as possible for economic considerations and as many hardwoods as necessary from the standpoint of soil conservation. Silvicultural planning, therefore, starts with a decision of the stocking aims in all stands ripe for regeneration. This is not only a question of age but of quality and physical conditions. If the stand is characterized by trees of poor stem form, we cut earlier; and conversely, if the stand is characterized by trees of superior form and growth, we delay our cutting. The rotation generally is only the desired production period on the district and does not apply strictly to any single stand. The regeneration method is then adapted to the stocking aims. The management plan establishes the regeneration method to use, the direction, extent, and volume of cut, and the wanted composition of the young stand. Silvicultural planning in the thinning of stands gives the area to thin, the method to use, special requirements to be observed, and the estimated volume to be taken out.

The management plan includes a road development plan. Main, side, and sled roads to be built during the next period are surveyed and mapped.

The last and most important step of the planning work determines the yearly cut. After the question of the rotation period is settled, calculations of the yearly cut have to take into consideration the given true and the normal age-class distribution and the true and theoretical volume and increment. The basis for this is the compiled data of the stand survey and the yield tables. Science and practice during the last century have developed an embarrassing multitude of methods and formulas for determining the yearly cut. Discussion here is limited to those most widely used today.

A fact of great importance is still the actual age-class distribution. In all cases, it differs to a more or less degree from the normal one, in which each age class contains the same area. If the age class distribution is normal or close to it, the yearly regeneration area is easy to determine by dividing the total area by the number of years in the rotation. If the age class distribution is abnormal, we try to reach the normal by estimating an equalization period of about 40 to 60 years. This results in a yearly cutting area higher or lower than normal, depending upon the age classes prevailing. Because all regeneration stands are tallied fully, we can compile an average cutting volume per unit on them. Multiplying this average by the cutting area, we get the yearly regeneration cut. Now the cutting volume in the thinning stands is summed up from the silvicultural planning for the single stands. This sum is divided by the length of the inventory period and so the yearly thinning cut is derived. Regeneration and thinning cuts are then the yearly total cut.

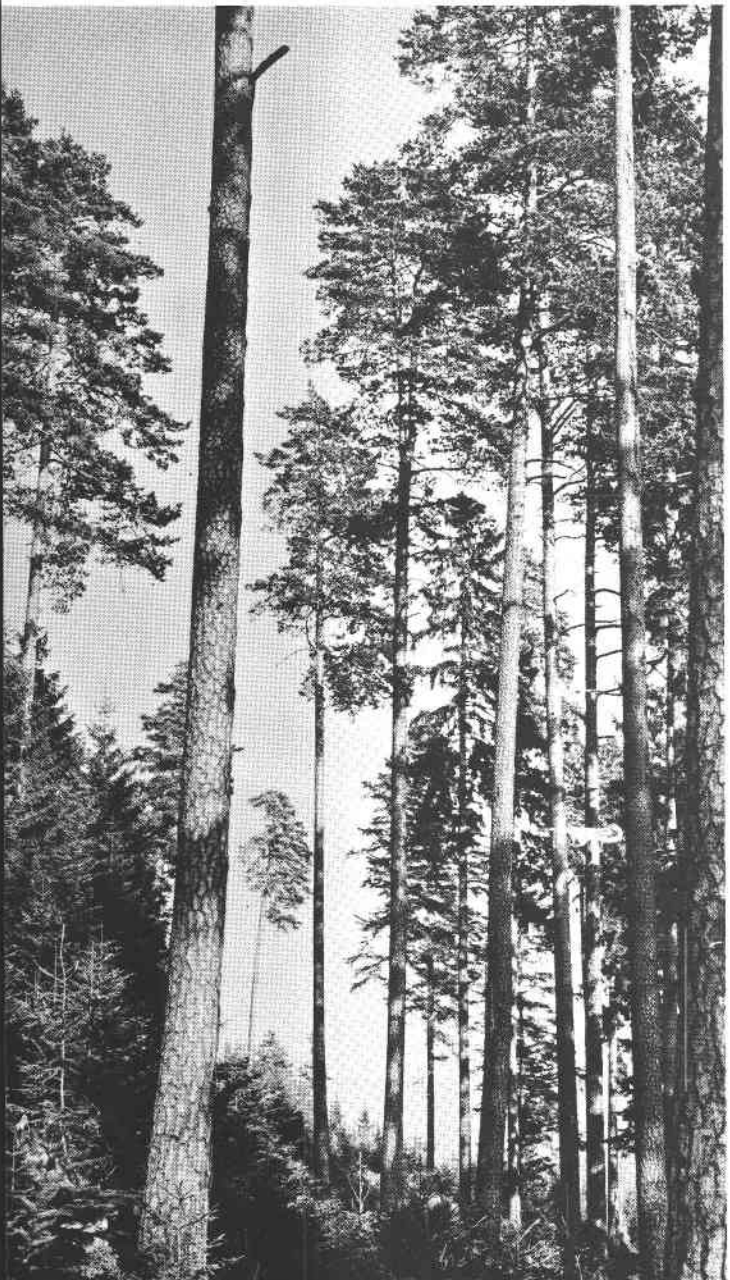
But the age-class distribution cannot be the only consideration. It depends solely on the area and does not include production conditions of the stands—their volume and increment. Therefore, the results have to be checked by a method which is based on volume and increment. Determination of the true volume and increment for each stand have been explained previously. These data are compiled for the whole district. From the yield tables we can compile the theoretical volume and increment as well. For those, we use the given species composition and yield classes, but with normal age-class distribution and a full degree of canopy. And now again, true volume and increment will vary from the theoretical, and so we try to approach them within an equalization period of 20 to 60 years, depending how far they are apart. Assume that we have a spruce forest of 1,000 acres, average site class II, rotation 100 years. Its theoretical increment would be 67,000 cubic feet, the actual increment 60,000 cubic feet; its theoretical volume would be 2,100,000 cubic feet, its true volume 1,600,000 cubic feet, and the equalization period would be 40 years. Then the formula would be as follows:

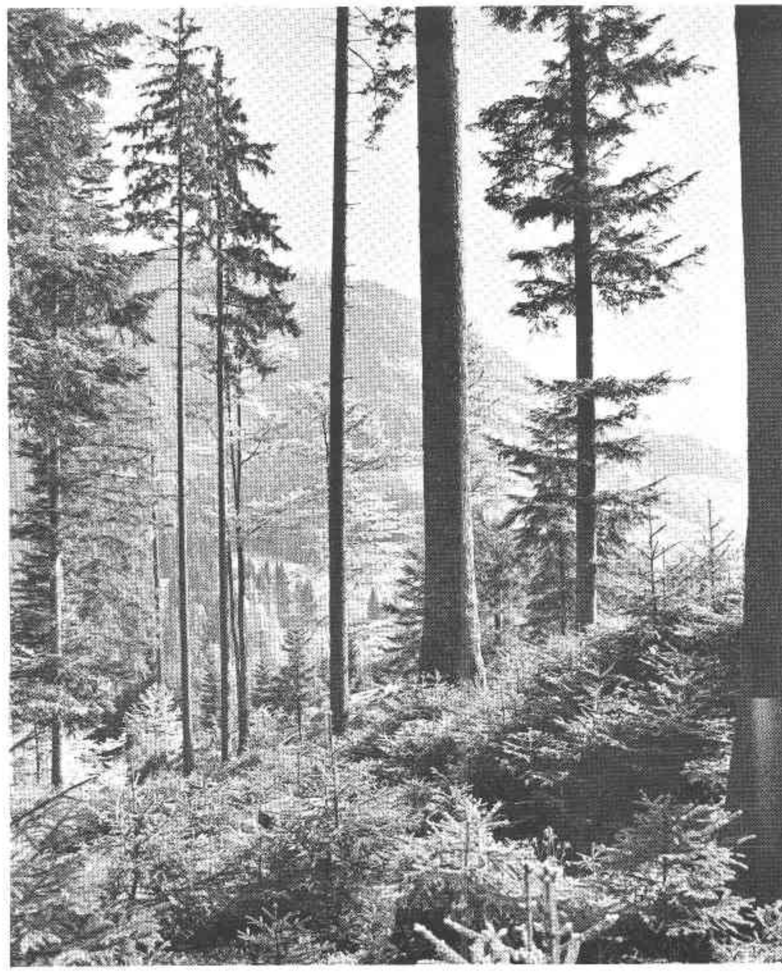
$$\text{Yearly cut} = \frac{\text{theoretical incr.} + \text{true incr.}}{2} + \frac{\text{true vol.} - \text{theoretical vol.},}{40}$$

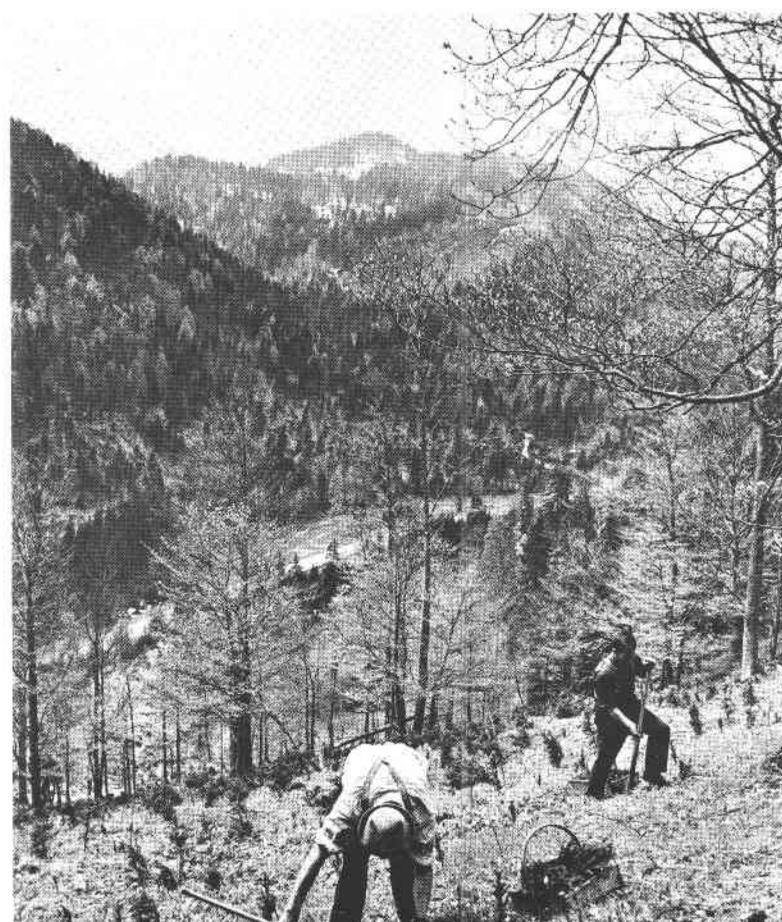
$$\text{or yearly cut} = \frac{67{,}000 + 60{,}000}{2} + \frac{1{,}600{,}000 - 2{,}100{,}000}{40} = 63{,}500 - 12{,}500 = 51{,}000 \text{ cubic feet.}$$

This brings us to three calculation methods: the silvicultural planning in the single stand summed up for the district; the calculation by the age-class distribution; and the calculation by volume and increment. The importance of each is weighed against the others, and a compromise is decided between them. As much as we try to approach the problems of a forest district with enlightenment, and as much as we try to settle the problems objectively, the determination of the yearly cut will always be a subjective decision, influenced by changing opinions. The different calculation methods set a frame in which sustained yield is secured but left with room enough to move toward either side.

Our management planning, in my opinion, is not really management, but mainly silvicultural planning. It concentrates too much on the biological aspects and neglects the economic problems. That is not only true for planning but equally, or even more, for control. Without a doubt, it can and does accomplish a good deal to secure a sustained yield, but it cannot and does not help in guiding the ranger to an economic management and it cannot control it either. One may say that would be possible by yearly reports. I doubt that very much. The long production periods and the large production areas of forestry need an economic planning and control over a period of years, especially in times of crisis as at present. The solution of these problems still lies ahead of us.







Above: Strip cut in Scots pine-spruce stand. (*Photo by H. Bibelriether.*)

Upper right: Strip cut in spruce-beech-fir stand. (*Photo by Gg. Meister.*)

Lower right: Planting of 2-2 spruce stock. (*Photo by Gg. Meister.*)

Above left: European larch standards over mixed regeneration of spruce, larch, and beech.

Above right: Selection forest of silver fir and Norway spruce on the northern slope of the Alps.

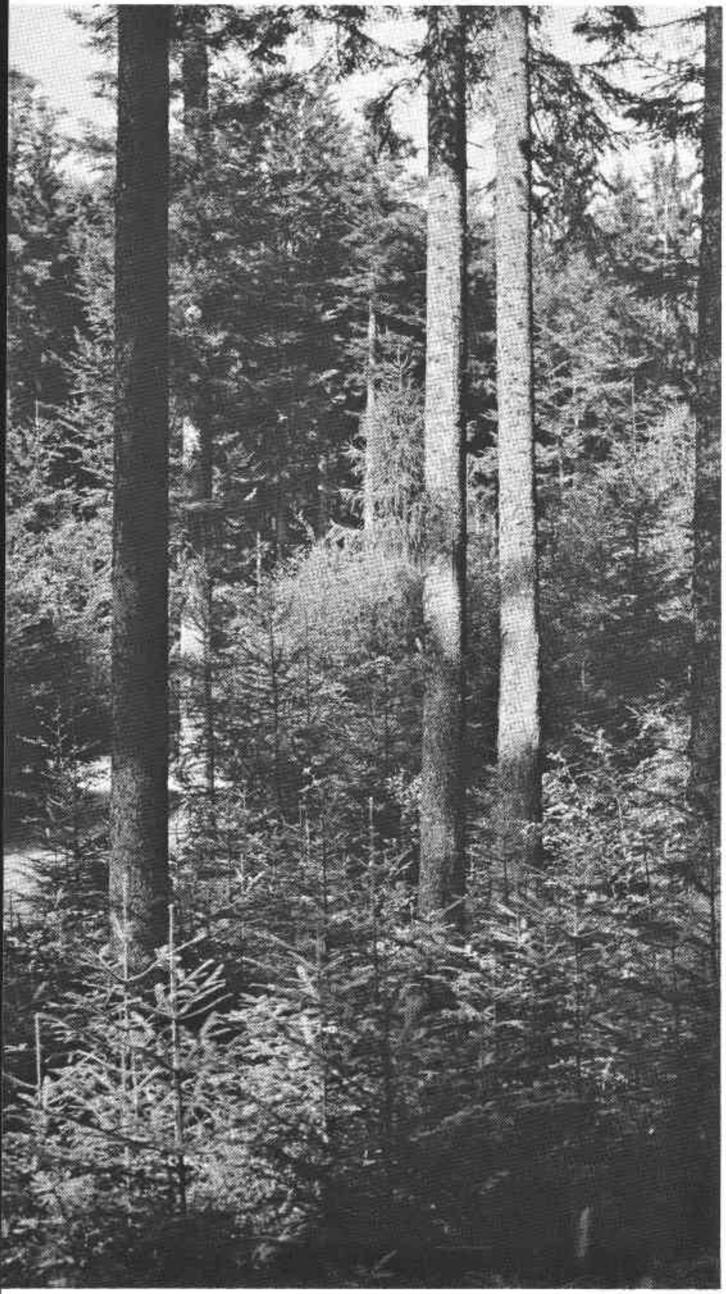
Left: European larch as a high-yielding mixture with beech in the central European hardwood region. (*Photos by H. Bibelriether.*)

Above: A 40-year-old Norway spruce stand heavily damaged by red deer eating the bark. (*Photo by H. Bibelriether.*)

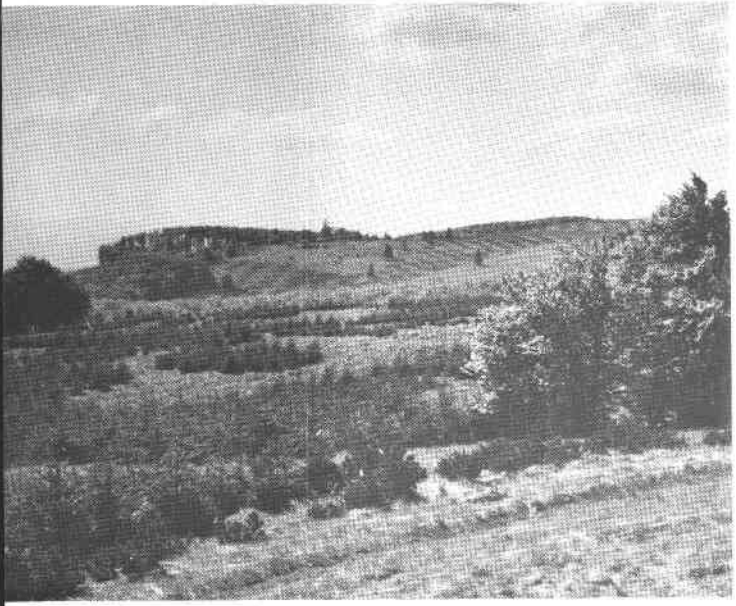
Right: The effect of browsing by red deer on 40-year-old Norway spruce. (*Photo by Gg. Meister.*)

Above: Natural regeneration of Norway spruce in a strip cut.

Upper left: Natural regeneration of silver fir in a group cut.



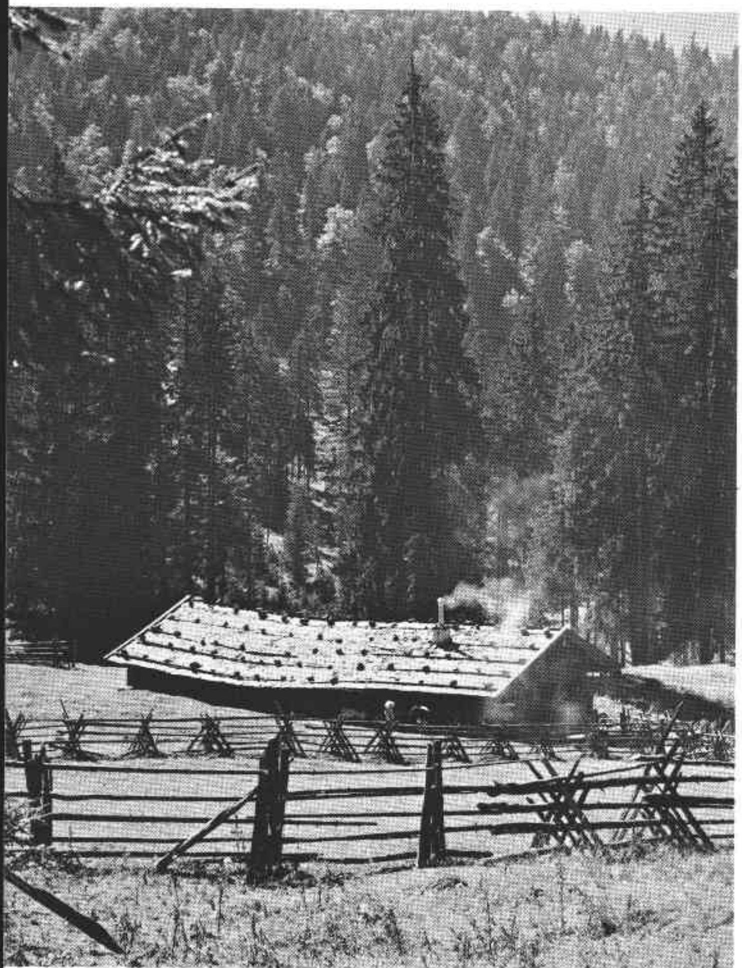
Left: Natural regeneration of silver fir and Norway spruce in a combined group-strip cut. (*Photos by H. Bibelriether.*)

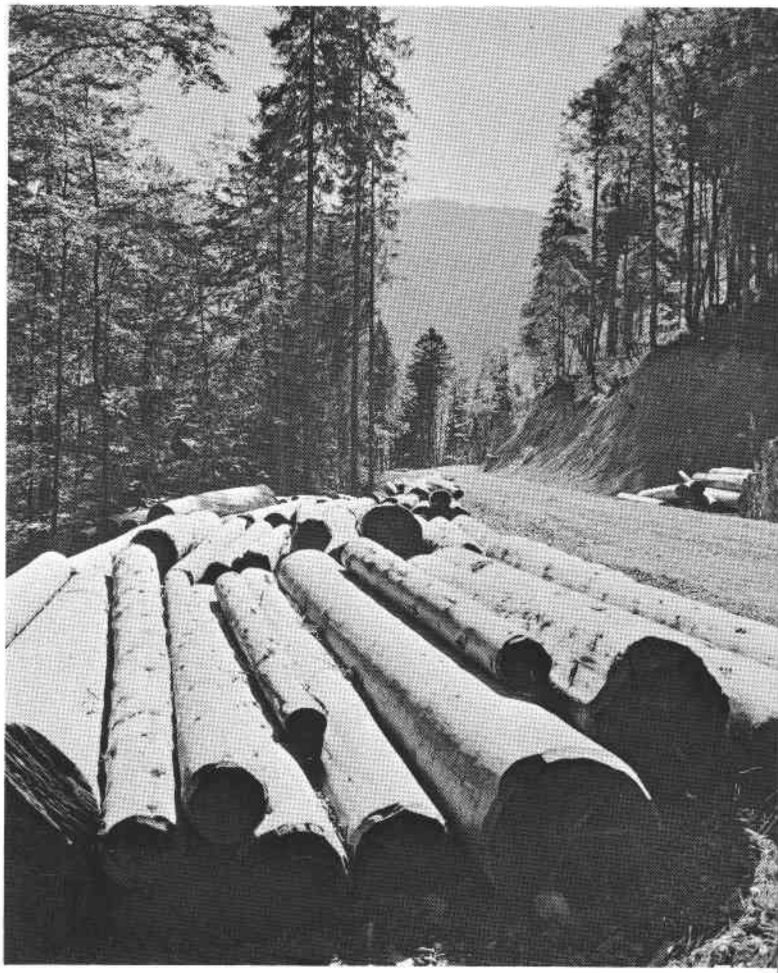


Above: Afforestation of submarginal agricultural land with Norway spruce.

Upper right: Degraded coppice-with-standards forest.

Right: Poorly formed, slow-growing Scots pine, resulting from litter raking for hundreds of years. (*Photos by H. Bibelriether.*)





Above: Saw logs and fuel wood stored along a forest road and ready for sale.

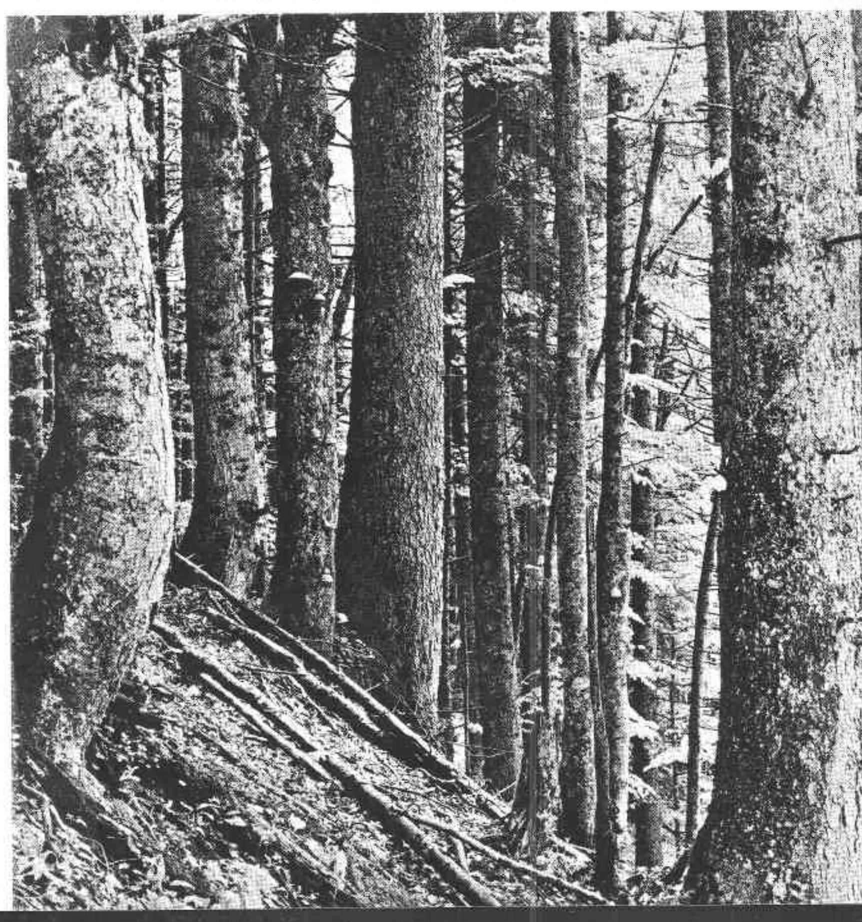
Above left: Multiple use shown by an Alpine grazing area with a cow barn and cabin surrounded by mixed forests of Norway spruce, silver fir, and beech at an elevation of 3,500 feet.

Left: Typical mountain forest of beech, spruce, and fir in the Bavarian Alps. (*Photos by Gg. Meister.*)

Above: High-grade veneer oak with beech understory in the central European hardwood region. The price range for the high-quality oak on the right would be between $3,000 and $5,000 today; this tree is about two feet in diameter. (*Photo by H. Bibelriether.*)

Above right: High-grade Scots pine in eastern Bavaria. (*Photo by H. Bibelriether.*)

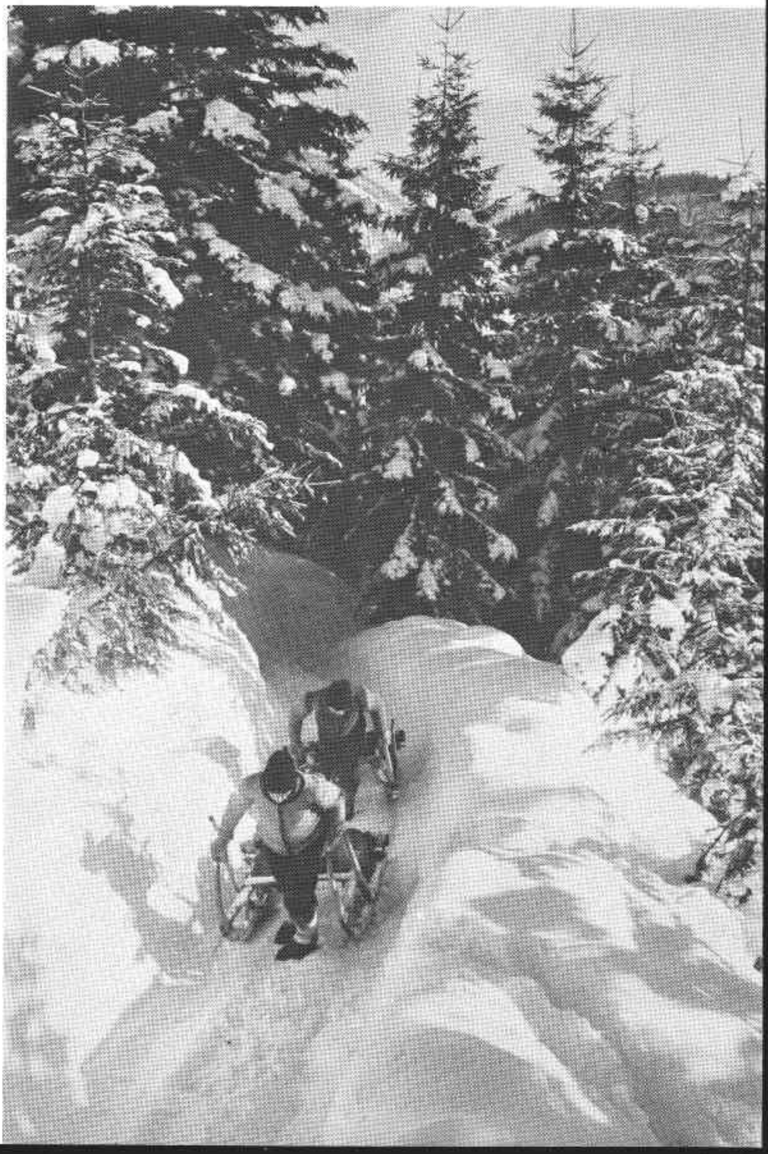
Right: An old stand of Norway spruce, silver fir, and beech in the mixed-forest, mountainous region. (*Photo by Gg. Meister.*)

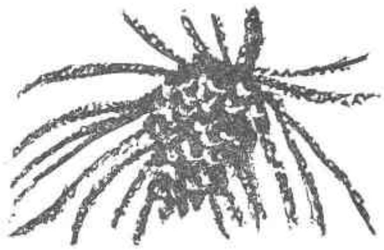


Right: Horse skidding in the Alps.

Below right: Loggers pulling up their sleds for a winter haul.

Below left: Cable logging with the "Huber" system. (*Photos by G. Meister.*)





5. The Concept of Silviculture

Silviculture has always been the favorite enterprise of our forestry program. We still consider it the central field of forest management. This has both advantages and dangers. Looking back, it is surprising what silvicultural science and practice were able to devise and improve, and the goals which were attained. The good name of German forestry in many parts of the world is due to silviculture in a large degree. And yet, as a biological and technical and not as an absolute science, it followed many diverse ways. It followed fashions, tried to dictate, and overplayed its role. Nowhere in forestry was so much published, discussed so hard, and fought over, as in silviculture. And still today its questions are not always judged by objective aspects but by personal opinions, local experiences, and even romantic entanglements. That can be understood if one considers and accepts that a forest is a living body, or perhaps better, a community or a multitude or organisms—connected, related, and interdependent. As a technique to influence and to lead such communities into desired directions, silviculture must pay attention not only to one or a few components but preferably to all of them, or at least to as many as possible. As we all know, the ecology of a forest is complicated and complex. We know how much it differs from site to site and from stand to stand, and we know, too, how little we have penetrated it up to now in spite of a century of intensive research. We may have a good knowledge of many single factors, but our understanding of the total complex and its mutual dependence is restricted.

If we learned one thing out of our silvicultural history, it is this: silviculture as a technique should never try to simplify, never try to give general instructions or orders, and not "beat all shoes over one last," as we say. Therefore, our silvicultural education tries to give the students the best possible knowledge of basic biological and ecological factors. It tries to equip them with the scientific tools to analyze these factors later themselves. Among the techniques we teach are the classical methods of precommercial thinning, thinning, and regeneration; but we teach students, too, that they have to be adapted to the individual conditions found in every single case. Professor J. N. Köstler, the present silviculturist at Munich, named that concept "the free style."

So much for teaching. In practical management, the silvicultural methods to be used are laid down in a district's management plan. It contains the treatment for every single stand, but, as a result of our policy, the district chief is not strictly bound to the plans afterwards. He can modify the planned method as a stand reacts to a treatment. If the planned regeneration area of a stand is 5 acres, and if the regeneration comes in very well as a result of the method used, the district chief may expand the area to 10 acres. However, in the reverse situation where the regeneration is very slow to establish itself, the district chief may restrict the area to 2 acres. He is bound only to the stated amount of cut in the sum of the regeneration stands and not to the area. In the thinning stands, he is bound to the planned area but not to the volume.

The above concept makes it difficult to explain our silviculture. Only the major lines along which we try to solve our problems can be presented here. The economic and biological situations with which we start, the aims we set for ourselves, and the general concepts for their solution will be discussed.

Germany has a completely free timber market. Any amount of timber can be imported from anywhere without any customs duties. Therefore, our timber prices depend on the world market to a large degree. Only about 60 percent of the timber demand can be furnished by our own production. This means that competition of tropical hardwoods is severe for our hardwoods. It is difficult, too, for our softwoods because large amounts of pulpwood and coniferous sawn timber are imported from Scandinavia and Russia. As a result, our present prices are still sufficient for softwood of larger dimensions and for high-grade hardwoods, but they are absolutely insufficient for softwood of small dimensions and for hardwoods of normal quality. This is because of our high total costs, the better workability of tropical hardwoods, the better quality of northern pine and spruce, and changing consumer desires. The long-term timber prognoses for Europe foretell a steadily rising demand, especially in the Common Market. Here, Germany has a relatively strong position in softwood production. Probably, we will have no trouble selling our timber. However, we are afraid that a noticeable improvement of the price situation will not appear, especially not high enough to exceed our steadily rising costs. The best chance for our forestry that we can see at the moment is therefore in the production of high quality timber of larger dimension, mainly softwoods.

The biological situation is much more complicated and differs from state to state. A little over 5 percent of the timber area is still in coppice or coppice with standards. These forests are all owned by communities and private persons. Their soils, mainly good ones in the lowlands, generally have undepleted nutrient reserves, but the production of the stands is extremely low in volume and value. About 95 percent is high forest with a species composition about two-thirds conifers and one-third hardwoods. If this meant that all our forests were mixed in that proportion, we would be happy. Unfortunately, the area of pure forests prevails greatly over the mixed forests. Pure hardwood forests are biologically sound and stable but economically poor; and pure conifer forests are economically satisfying but biologically unstable and are susceptible to biological and climatic catastrophes. The problem of pure forests has to be judged in the first place from the point of ecology. I mentioned in Chapter 1 that our forests changed their composition amazingly during one and a half centuries, and that the proportion of hardwoods to conifers was reversed. In this process, many pure softwood forests of large size were established on sites where conifers did not grow naturally.

What consequences arose from all of this for forests and forestry? The calculations made 150 years ago without our modern knowledge and the help of yield tables, site maps, and so on proved to be exact in one regard. Spruce of the same site-class yields at least one and a half times more than beech and, moveover, its average sales value per unit is about one and a half times higher again today. The value relationships between pine and beech favor the pine too, but not by such a wide margin. Still they are considerable. The economic superiority of the softwoods over the hardwoods is an indisputable fact.

The biological consequences are less pleasant. It took about one century for them to show up clearly. Many of the pure stands grew excellently in the first generation but already showed an amazing retrogression in the second generation. The reason for this is a very complex one and only a simplified explanation can be given. A spruce stand may serve as an example. Our spruce roots are normally very shallow. Planted on former hardwood soil, the spruce roots could follow the deep root channels of the former hardwoods in the first generation. But in the second generation the root systems turned shallow on account of progressive soil compaction. As a result, the available nutrient supply for the trees became smaller. The spruce stand could profit from mild humus accumulated in the first generation by the hardwoods, but it was not able to produce a mild humus itself. Spruce litter rots much more slowly than broadleaf litter and is much more difficult for the fauna and flora of the upper soil layer to decompose. Therefore, a raw humus developed in most cases. Its humic acids started to leach the soil under our humid climate and impoverished the soil fauna and flora. This caused an even poorer decomposition and a faster development of raw humus. Then the whole nutrient cycle got out of order and eventually was nearly stopped. The nutrient accumulation in raw humus cannot be used easily. The soluble nutrients of the upper soil layer were washed down, and the spruce roots could not reach that far. This development in its extreme can lead to the formation of a bog. Anyway, the drop of one or even two or more site classes during two or three generations of pure spruce is a well-known and frequently observed fact. This represents a production loss of 20 to 30 percent. The reactions of the soil to pure pine stands are similar to those of spruce in many ways. These experiences can follow in pure plantations within and beyond the natural distribution area if one does not include the subalpine spruce region in this consideration. But generally one can say the farther out of its natural distribution a species is cultivated, the worse it becomes.

The consequences for the stands themselves were not much better. The hazard that biological or abiotic factors may harm pure stands is much higher than for mixed ones. The pure stands of spruce could not resist storms within and beyond their natural distribution area, because they lacked a supporting structure of deeprooting species, which mixed forests resisted easily. Tremendous storm catastrophes were the result. Similar results were caused by snow in pure pole stands of spruce and pine whose dense and equal crown canopies broke down under the weight of a heavy wet snowfall. The fact that seed origins which did not fit the site were often used made the effect of storm and snow worse. The conifer forests, mainly pine, brought us the problem of forest fires in the drier parts of the country. These fires were rare when hardwoods prevailed.

One further drawback, which is typical of all pure plantations, is that the ecology of the natural plant associations became unbalanced. Outside of the natural habitat, and when planted in pure stands, the physical condition of the single tree weakens and resistance against enemies decreases. This problem is compounded because we do not have control of all the ecological factors when we place trees in a strange environment; it may prove to be more favorable to tree enemies than to trees. For example, we imported the Douglas-fir from your country, and with the trees brought in two fungi. In North America, these fungi do little damage to Douglas-fir, but in our country the destruction was severe. The result was repeated insect and fungi catastrophes which destroyed large forests.

Our experiences with even three or four generations of pure conifer stands, mainly outside of their natural distribution area, shows that their cultivation is possible, their management in many ways easier, and their economic results even better than those of the natural mixed forests. But they show, too, that the risk involved is high, and that the productive capacity of the soil can be lowered markedly. The dangers involved can be checked only partially by artificial means. Artificial fertilization, chemical insecticides and fungicides, and the use of the most appropriate seed origin may lower the risk but cannot eliminate it. Besides, these costs will consume large parts of the anticipated profit. These experiences led us to the conviction that even from the economic point of view, plantations of pure conifer forests have to be restricted to the areas where they occur naturally; that means the subalpine spruce region, and to the best and most stable sites where the danger of a decreasing production capacity of the soil and of other disturbances are low or do not exist.

These ecological considerations warn us against planting domestic or alien conifers in pure stands of large extent. We do this in afforestation, on stable soils, or under favorable site conditions, but these are exceptions to the rule. Normally, hardwoods or silver fir should appear in stands in changing degree, depending on site conditions. Their functions are manifold and may differ from case to case. Mostly, they must be deep-rooted such as oak, fir, or alder to open up the deeper soil in order to start the nutrient cycle again and to furnish the needed supporting strength against storms. Their litter must rot to a mild humus, such as provided by maple, hornbeam, alder, oak, and fir, to hinder soil deterioration. All of these things help to lower the risks of pure conifer stands. Some of the trees also should be tolerant to give the stand a two- or many-storied structure and protect the soil against too much light. This would reduce the competition of shrubby vegetation, a high advantage during the regeneration period. And finally they are a security factor in the case of a catastrophe to protect the soil so that it does not become absolutely bare. In such instances, the hardwoods or the fir have little or no economic function but are valuable biologically. It does not matter whether they grow straight or crooked, fast or slowly. They just have to endure, and to protect the site.

As a rule one may say: if the site conditions are favorable and stable, the hardwood percentage can be low, perhaps 10 percent to 30 percent. It can be lower in the mountainous mixed forests than in the central European hardwood region, and it can be lower on northern or eastern slopes than on southern or western ones. However, the percentage must be higher where water supply becomes the critical factor than where water is sufficient. The problem is reversed where soil conditions are critical or the public benefit comes into prime consideration. Here, the hardwoods may run up to 60 percent or more. But that turns the problem around, because then we do not have a conifer stand with a biological hardwood mixture but a hardwood stand with an economic softwood mixture. This should explain our difficult decisions between an economic compulsion and an ecological responsibility which has to be determined anew for every single case.

Sometimes our silviculture is blamed for overemphasizing biological factors and neglecting economic aims. It is said to be more a philosophy based on romantic ideas about nature than a technique of economic management. I believe such criticisms do not do justice to our problems. Our concept of silviculture tries to combine multiple use on every acre of forest, and it must do so because there is no room left to separate these uses. Our broad silvicultural purpose is to preserve our country's forests so they can furnish all the forest needs of our age. To achieve this aim, silviculture must put more emphasis on economics in one place and more on ecology in others.

This explanation seemed necessary to give a better understanding of our general concept of practical silviculture. Another, but relatively unimportant, problem concerns forests of coppice and coppice with standards. They have to be changed into high forests as fast as possible. Private owners are paid subsidies for such practices, up to 80 percent of the costs, from the Federal Republic. The coppice stands are converted in all cases by replanting them artificially. Conifers are favored which can outgrow the sprouts in their youth, such as Japanese larch, eastern white pine, or Douglas-fir. The biological mixture of hardwoods can be achieved easily by the sprouts. Their control by chemical treatment is relatively inexpensive today. Large parts of the coppice-with-standards forests will have to be treated likewise. The only stands that are not changed abruptly are those where the number of standards is high, their form good, and where the structure of the stand already tends to a high forest. Here we stop the coppice cut, single out the sprouts and let them grow, and fill up the stand by artificial planting where needed. The change from coppice to high forest is then a smooth process of about 20 to 40 years. We prefer this type of conversion on sites where high-grade oak veneer can be produced and where a conversion into conifers is not wanted.

In the high forests, we divide the life cycle of a stand into five periods which we call the period of regeneration, the young stand, the pole stand, the middle stand, and the old stand. Using these periods, I will try to explain our concept of practical silviculture.

Let us consider regeneration first. If we can choose between natural and artificial regeneration, we prefer the former. It has the advantage of establishing itself more densely; the little plants thrive on a micro-site that suits them best; and the seed origin is known. Usually, natural regeneration is less expensive as well, even if the desired species composition has to be regulated artificially. But time is a factor of costs in forestry, too.

On an average, we have an annual volume increment of about 500 board feet per acre, or about a $40 value increment per acre. If five years of production can be gained by artificial reforestation, rather than waiting for natural reforestation, then the artificial regeneration costs are already recovered.

If natural regeneration does not come readily and the chance to secure the wanted species composition is low, we do not wait indefinitely. In many cases, we regenerate only one species naturally and plant the others, or we fill up (by hand) natural regeneration which comes too slowly or is not dense enough. Despite the fact that German silviculture has paid so much attention to the problems of natural regeneration during the last century, the average percentage of naturally regenerated stands actually is hardly 20 percent.

If we decide on artificial reforestation again, we prefer seeding above planting for the same reasons as in natural regeneration. But, to a large degree, the technical knowledge required to do it properly has been lost. Good seed sources are rare, the seed is expensive, and the risk of a failure is high compared to planting. Yet the importance of seeding now increases again, especially for the deep-rooting species, such as oak, fir, and beech.

The largest part of our reforestation is planted. We had to give up our hope that each district could raise its own nursery stock because this was too costly. Now about one third of the state forest planting stock is grown in our own large nurseries where modern machinery can be used. They supply the surrounding districts. The rest of the stock is bought from private companies. Normally, for planting stock we like little plants better than bigger ones because their survival percentage is higher and the planting costs are lower. For pine, larch, alder, and oak we prefer seedlings; for spruce, fir, and beech we use transplants. But if the weed cover is dense and high, we do not hesitate to use plants up to three feet tall for spruce and nine feet tall for hardwoods.

Our experiences with deer browsing and our economic calculations show that a fence is the best and least expensive protection practically everywhere, even if the costs run up to $1.00 per yard or about $125 per acre for a red deer fence in the Alps. As long as we are not allowed to bring our deer populations under control, a district should fence up to one-tenth of its total area. One can imagine the heavy burdens and the necessary investments and maintenance costs. The cost seems very high, but if the growth for just three years is saved, the expense is recovered.

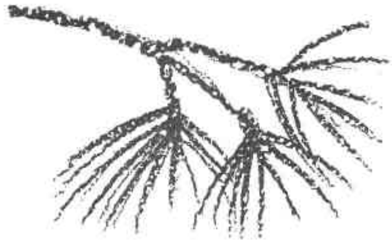
Where soil deterioration exists, we try to remove or better it by mechanical, chemical, and biological means during the reforestation period. Soil preparation from harrowing to deep plowing, chemical fertilization with single or combined fertilizers, and cultivation of nitrogen-forming plants are used on a large scale.

The regeneration period ends when the young stand closes to a thicket. The young-stand period, which comes next, determines to a high degree the forest which will follow, not only the stand composition but quality and value, too. The development of young stands, if left alone, rarely produces the desired result. Density and stand composition have to be regulated; the biologically weaker species need help and the stronger ones must be checked. To select the poorer stem forms, which always tend to suppress the good ones, is just as important. One may call this precommercial selection thinning. This work should be done as early as possible by hand or by the use of chemicals. It should be done so intensively in one or two working stages that afterwards the stand can be left to itself until the first commercial thinning. The costs of this work still apply under our system to the reforestation period and are charged there. To accomplish the stand improvement in the young-stand period which we believe absolutely necessary to reach our production aims, gives us many headaches today, not only on account of the costs involved but because of the amount of labor needed. We try hard to rationalize solutions that work as well as possible, but the problem has not been satisfactorily solved up to now.

During the pole-stand and the middle-stand periods, silvicultural work concentrates on thinnings. The central problems here are the type and the degree of the thinning. They have been discussed a great deal and changed considerably in the past 100 years. Dr. E. Assmann, professor of yield at Munich, developed a theory based on basal area which is widely accepted today. He could prove that the current increment sinks as soon as the basal area drops below an optimal mark not far from the natural basal area. The accelerating growth effect of a wider growing space for the single tree cannot compensate for the increment loss in the whole stand. To be specific, it is possible to thin a young pole stand and have it respond to the release and produce as much wood as an unthinned stand of the same age. A somewhat older stand will also produce more wood, up to an optimum point, after thinning. But, if a stand is too heavily thinned, it will produce less wood than the optimum because the fewer individual trees cannot take full advantage of the site. So we try to stay close to the optimum basal area and thin more heavily in the pole stands than in the middle stands. The percentage of thinning volume on the total cut of a stand may fluctuate between 30 and 40 percent in the case of conifers, and 40 to 50 percent in hardwoods. A thinning interval of 5 to 10 years is normal.

As to thinning types, we gave up crown thinning and low thinning and switched over to quality thinning. We can do this because the selection thinning should be finished when a stand reaches the pole age. Quality thinnings should secure enough life space for the best elite trees among all competing trees and should maintain a uniform width of annual ring to maturity.

Our aim is not only to secure the highest possible production but to let the stands grow into the old-stand period with an intact crown canopy that protects the soil well. The extent of thinning is therefore lowest in the old-stand period itself. It no longer aims for quality improvement but has to prepare chiefly for the following regeneration. Hence, the silvicultural ideal would be to lead a stand to the planned production aims without any abrupt or enforced treatments during its life cycle.



6. Methods of Regeneration and Thinning

The previous chapter covered the concepts of German silviculture. Now we come to the present practical silvicultural methods. In spite of the fact that natural regeneration is less important than artificial reforestation, I will begin with it because its basic premises also influence artificial reforestation.

Whether and how reproduction can establish itself depends on the state of the site factors. The supply of light, the quantity of heat, the water supply, the condition of the soil, especially of the upper soil layer, and the plant cover are most important. All of these factors can be altered to changing degrees on a relatively wide scale by manipulating the density of a forest canopy or removing it completely. A forester marking timber for felling in a stand has the power to allow more or less light to reach the ground. Thus, he may change soil temperatures, intensify biological activity in the soil, increase the water supply by lowering moisture interception by the canopy, encourage an immigration of herbs and grasses, or prevent their growth. Light, heat, and water factors cannot be altered artificially except by the variation of the canopy, in contrast to soil conditions and plant cover which may be improved mechanically or chemically.

The problem of natural regeneration is, therefore, to make the site factors optimal, not only for the establishment of regeneration but also for its development. Without a doubt, the various tree species make different demands on the site factors, and these demands differ again with tree ages. So the problem of natural regeneration becomes one of arranging the methods used in space and time. The form, extent, and stages of a method have to be adapted to the desired species. In addition, not only the regeneration area itself has to be kept in mind but the security of neighboring stands, too.

Theoretically, five basic possibilities are available: (1) clear cut, (2) strip cut, (3) shelterwood cut, (4) group cut, or (5) selection cutting.

(1) The *clear cut*, with or without a number of seed trees left, changes the site conditions completely and abruptly. Light and heat supply are increased to the highest possible point. The whole harvesting and regeneration process, including timber transport, can be organized easily. However, this method fits only pioneer species, such as the Scots pine. But even the Scots pine rarely regenerates on clear cuts in sufficient density to secure the production of high quality timber. This excludes clear cutting as a practical method.

(2) The *strip cut* concentrates the regeneration area on a relatively narrow ribbon along one side of a stand. There it considerably increases light, heat, and water supply on the regeneration area, but leaves the strip within the protection zone of the old stand. It is well adapted to species which demand light but need protection, such as the Norway spruce. Form, extent, and timber transport are easy to survey and to arrange but the

regeneration process is slow, about three to five yards per year. This makes it necessary to use a series of strips, which considerably weakens the stability of a larger complex.

(3) The *shelterwood cut* opens the canopy of a stand as may be required by the light demand of the desired species. It allows the close regulation of light, heat, and water supply and it allows working on large areas. It is well adapted to species which need a certain degree of shade during their youth, as our oaks and beech. Under this system, form, extent, and timber transport are no trouble at the beginning, but they become more difficult at the final harvest when the overstory has to be cut and transported out and over the already well-established regeneration.

(4) The *group cut* provides regeneration at a number of points within a stand. It opens up the canopy in these chosen areas and leaves the rest of the stand intact. The extent of a group may vary from a single tree to an opening of about one-quarter of an acre at the start. Because the level of light and heat supply rises very slowly, the group cut is most suited to shade-demanding species like our fir. Group cutting undoubtedly demands the greatest skill, as it aims at arranging and combining the regeneration process so well that it will not get out of control. How to get the old timber out of the young stand during the last regeneration stages without damaging it heavily is the most difficult problem here.

After this short introduction we may ask: Have these basic methods been used in practice? How did the regeneration technique develop and change during two centuries?

Two main management systems characterized our forestry during the Middle Ages. Coppice and coppice-with-standards forests prevailed in the hardwood region. These forests furnished all kinds of timber needed for construction, many different handicrafts, and fuelwood. Management regulations were in effect from the 15th century, determining the yearly cutting areas, the number of standards to be left, the extent of replanting, and other matters. The high forests of the mountainous regions primarily supplied the industrial enterprises of that time, mostly iron and salt mines and glass-smelting factories. They used exploitation cuts which took out all the usable timber and left the rest standing. Management regulations applying to them date back to the 16th century, too. In spite of these regulations, the forests were so heavily overcut that their condition became worse and worse until the danger arose that the timber demand could not be met anymore. As stated, that fear created the idea of sustained yield, but it could not be secured without planned management. The working plans now coming into use also had to include clear concepts of and provisions for regeneration.

Georg L. Hartig, one of the outstanding foresters of his time, was the first to publish detailed instructions about natural regeneration and its techniques. Hartig worked in the hardwood region. Probably, he did not invent the shelterwood cut, but he was the first to give it a clear definition. Management of coppice-with-standards forests and the exploitation cuts which left worthless timber on the cutting areas bore some similarities to the shelterwood cut. This may have stimulated ideas on this method and initiated its use on a more or less informal basis.

Hartig developed shelterwood as the first precise method and established three different cuts for it. The seed cut was to create shade and equal shelter over the area. Crowns of the remaining seed trees were to nearly touch. Under them, the regeneration was to establish itself and grow to about one to one and one-half feet high. Now an opening cut was to follow which would leave a tree about every 10 to 15 yards for later seeding and protection. This light shelter had to be kept until the regeneration reached 2 to 4 feet in height. The final cut then removed the rest of the old stand. Hartig wanted his shelterwood method to be used on large areas. He planned only two or three annual cuts per district and calculated on regeneration periods of about 10 to 15 years from the first to the last cut. His ideas were acknowledged widely and his shelterwood method became the main one used for hardwood in Germany for nearly 80 years. It was used on softwood stands as well.

The results reached with this method differed widely. Beside fine successes, there were complete failures. This was due mainly to two reasons. If the expected seed year did not occur after the seed cut or if restocking were not adequate, the weeds started to invade and made later natural regeneration impossible. If the method were applied to shallow-rooted softwood stands, there was great danger that the much more open shelterwood might be thrown by storms. In both cases, reforestation with high costs could not be avoided. The large size of the regeneration areas was, therefore, a heavy risk. But even where the method succeeded, it produced mainly pure stands because the short regeneration periods mainly favored one species which outgrew the others, such as beech under the hardwoods and spruce under the softwoods.

Clearcutting on large areas was abandoned completely as a method of natural regeneration, but not for artificial reforestation. Especially in pine forests and to a lesser degree in spruce forests, many stands were cut clear and reforested right away because this seemed to be more certain and more economical than to wait for doubtful natural regeneration.

Two developments arose from these experiences. The first one was to make the cutting areas smaller; and the second was to prolong the regeneration periods. The methods developed in the second half of the 19th century followed the earlier methods and tried to adjust the processes better to different species. Four of them may be named: the strip cut, the group cut, the clear cut on small areas, and the shelterwood cut on small areas.

The last two are just a modification of those we know already. These are the clear cut which is used mainly for pine, and the shelterwood cut used mainly for hardwoods. The regeneration area was restricted to a zone of about 50 to 100 yards in depth, using the same method. This could lower the risk and lengthen the regeneration time for the subcompartment, but it could not alter the end results of producing mainly pure young stands.

(5) The ~~*strip cut*~~ selection cut method proved to be suited to the regeneration of spruce. If the strip were cut on the wind-protected sides of a stand, mostly north or east, the risk of windthrow was much lower. But the regeneration advanced relatively slowly, only about three to five yards per year. This would mean a regeneration period of at least 40 years for a stand depth of 200 yards. If the forester cuts two or three strips into a subcompartment to shorten that time, the wind or storm danger increases again. The best known modification of the strip cut is the Wagnersche Blendersaumschlag. Its use was required in southwestern Germany for a period of over 30 years.

The *group cut* was intended to solve regeneration problems in the mountain region's mixed forests of silver fir, our most shade-demanding species, along with Norway spruce and beech. But it takes about 40 to 60 years to completely regenerate a subcompartment, and logging becomes more and more difficult with the passing of time. Logging damage to the young growth can hardly be avoided except at unreasonable costs.

Cutting on smaller areas and using longer regeneration periods are methods which undoubtedly lowered the risk of a failure or of damage to the old stand. But on the other hand, they produced chiefly pure stands, too, and also made it necessary to cut in many more stands every year if the given regeneration area of a district working plan were to be realized. Again, that made management more difficult, more complicated, and raised the risk involved.

Neither the first nor the second extremes were fully satisfactory. It was time to try a compromise and switch to new methods which combined parts of both extremes. This development—starting at the end of the 19th century—was strengthened by the unsatisfactory results which our forestry experienced with the pure stands established on large areas. It is to the credit of Dr. Karl Geyer, then a silviculturist at Munich, that he described the dangers and disadvantages of pure forests and gave our forestry its new objective, the mixed forest which we have kept up to now. He was also the first one who promulgated a combined method, the group-strip cut, based on the consideration that mixed regeneration is only possible if the method used does not chiefly favor only one species, but equally favors all of the wanted species. This combination attempts to arrange the cuts relating to space and time with the combination of the desired species. This again means that a great number of combined methods are possible, such as shelterwood-strip cut, shelterwood-group cut, shelterwood-wedge cut, and so on.

It is necessary to have a clear idea of the desired result and it is essential to adapt silvicultural techniques to both the site and the stand. In spite of this concept, we believe that the bulk of our regeneration tasks can be solved with two methods which leave enough freedom of movement to adapt them to meet the needs of the single stand: the shelterwood-strip cut and the group-strip cut. Their normal operation is described below.

The *shelterwood-strip cut* is applied mainly to hardwood stocking. The cutting area is restricted at first to a depth of 150 to 200 yards. A light cut on that area starts the regeneration by removing only about 10 to 15 percent of the standing volume. We call it the preparation cut because it aims not so much to establish the seedlings as to intensify the soil activity and thereby improve the seedbed. If we expect a seed year a few years later, the main or seed cut follows and removes about 40 to 50 percent of the remaining volume. It takes out the heaviest trees, mainly to decrease later logging damage and to decrease undergrowth, which would give too much shade on the ground. The middle-sized trees are left well distributed, to provide enough light and heat on the ground for the establishment of the tolerant species and to give enough protection against drought and frost. As soon as the tolerant species are established and reach a height of about one-half to one foot, a strip cut is started from the sides that are protected from wind and drought. The intolerant species can now follow naturally, or are planted. The strip proceeds as fast as the development of the young growth allows, about 8 to 15 yards per year. The skidding of the felled timber always goes in the same direction as the strip advances, so that the older regeneration is not harmed. A new preparation and seed cut follows about 5 to 10 years before the strip reaches the end of the first shelterwood cut. This method makes the shelterwood-strip cut a relatively fast working method with a regeneration period of about 10 to 20 years. This is of great importance to our hardwood stands, which will be enriched by softwoods. Beech is regenerated below the shelter, and spruce, pine, larch, Douglas-fir, grand fir, eastern white pine or oak, and maple are planted on the strip.

The *group-strip cut* is applied mainly to spruce, fir, and mixed spruce, fir, and beech stands. Its cutting area is restricted to a depth of about 50 to 100 yards. A light preparation cut is customary here, too. Simultaneously with this, or a little later, the group-cut opens holes in the canopy. These are scattered over the area wherever topography or stand favor the establishment of the tolerant species. They must get a headstart of 5 to 10 years over the intolerant species which usually grow faster during their youth. The volume removed may approximate 20 to 30 percent. Extension cuts enlarge the groups excentrically according to the progress of the regeneration. After the regeneration on the cutover groups has advanced sufficiently, the strip cut follows for the intolerant species, mainly spruce. It, too, runs against the endangered flanks or from top to bottom in the mountains. Desired species which do not regenerate naturally are planted. The progress of the strip is regulated by the developing regeneration on the cut over groups. As soon as the strip advances, the next group cuts are made in the uncut stand ahead. By this means, the depth of the cutting area is always about equal. At the completion of the regeneration period, the groups flow together and are amalgamated into one unit by the strip. Therefore, the logging has to be planned very carefully so that damage to the young growth is tolerable. All of this makes the group-strip cut a relatively slow working method with a regeneration period of about 20 to 40 years.

As already indicated, we never depend on natural regeneration completely. If it comes, so much the better. If not, we do not hesitate to help out artificially where that seems necessary to speed up progress or to improve the desired result. This may be done by planting, soil preparation, or fertilization. Harrowing, for example, is used widely where a raw humus layer hinders the germination of seed. Where topography or stand density will not allow mechanical soil preparation, we may try to reach a similar result by fertilization, mainly with nitrogen, phosphorus, or lime. These methods can be combined, too.

To conclude the explanation of regeneration, a few words relating to selective cutting might be added. True selective cutting is a very old management system of our farm forests in the mountain regions. It probably existed there much longer than our regeneration methods in age-class forests. The true selection management system knows no age-class, no rotation, no large or small cutting areas, and no long or short regeneration periods. It tries to keep a forest in a long-term balance of composition, structure, and volume. This means that all age classes are combined in a many-aged structure on the same area. Simply stated, it accomplishes what the age-class management system does in a great number of separated stands, but it is concentrated into a single one. Experience has proven that it can be practiced only in the fir-beech-spruce forests of the mountainous region which may be kept artificially uneven aged for a long time. Without treatment, these stands would lose their characteristics within a relatively short time and would grow together into a more or less one-storied stand. All attempts to transfer the selection management system to other European forest types have been a complete failure. The best example of this is the "Moellersche Dauerwald" which was much discussed about 40 years ago. The system attempted to adapt these principles to pine forests.

Within the fir-beech-spruce type, the selection management system undoubtedly works very well, especially for small farm forests. However, it is very difficult to bring about a change from an even-aged and one-storied age-class forest to a selection forest. It takes at least a conversion period of 50 to 100 years, in which many critical stages must be mastered and in which the yearly cut would have to be reduced drastically. These are the main reasons why we could not make up our minds to give up our age-class management system in that region where not even 5 percent are true selection forests today.

You may have noticed that up to now, little has been said about our second important species, Scots pine. Actually, we have given up the natural regeneration of Scots pine as the main species of a stand. This brings up the methods of reforestation, which will be explained for our main species.

Scots pine demands much light during its entire life and it is very sensitive to felling damages. The soils of most sites where pine dominates are poor and many of them are depleted and degenerated to a high degree. Therefore, intensive soil preparation has to precede reforestation in most cases. All of this proves that pine can be reforested best on clear cuts. Where harrowing is not possible to help prepare the soil, track-type tractors extract the stumps and plow the area as much as 30 inches deep, mainly in the fall, so that the soil can freeze during winter. In the next spring, shortly before planting, a fertilization follows with lime, nitrogen, or a combined fertilizer which is worked into the soil by harrowing.

Scots pine grows fast in its youth with wide annual rings and it tends to develop many big limbs if widely spaced. We can obtain good prices for high-quality pine only, and this requires an equal width of annual rings and does not permit many or large knots. Therefore, dense and uniform reforestation is a must. We say that pine regeneration must be dense like the hairs on a dog and as uniform as a crew-cut. Because young growth and limbiness are influenced by the site, too, we plant more densely on the better sites. It may be a surprise that we plant 8,000 to 12,000 two-year-old pine seedlings per acre. The spacing is 1.1 yards between rows and one foot in the rows. Where the area is large enough and topography permits, we plant with machines, otherwise by hand with the angle-planting method. A biological mixture of oak, hornbeam, beech, basswood, or leguminous species is seeded or planted. Because development of the reforestation depends to a high degree on the looseness of the upper soil, the plantations are harrowed once or twice during the first five years by machines and tended once by hand to reduce competition of herbaceous invaders. You can well believe that this kind of reforestation is not inexpensive. Today, we estimate that the cost of reforestation varies from about $200 to $400, with an average of $300 per acre.

Norway spruce can endure more shade in youth than pine; it grows more slowly, too, and does not become so limby, but it is very sensitive to late frosts. It does not suffer severely from felling damage. Its requirements for water supply and fertility of the soil are higher than for pine. An intensive soil preparation by machines is rarely needed; more often fertilization is needed before or after planting. All this favors the reforestation of spruce, not on large clear cuts but on smaller strip cuts or below a slight shelter, so that protection is given from above or on the side. Less planting stock is needed, down to 2,000 plants per acre. Seedlings 1-2 or 2-2 with a size of 10 to 20 inches and a spacing of 2.2 to 1.1 yards are normal today. We could get along with 1,000 to 1,500 plants per acre, too, without losing any increment. We would have to accept the fact of greater limbiness and the need to refill many plantations. We must also accept that about 20 to 30 percent of the planting stock will fail due to insects, fungi, and, especially, animal damage. But the planting costs of refilling are much higher than those of the first planting. That is one more reason why we prefer to overstock at the beginning so we can lose some of the plants without the necessity of refilling.

Late frosts endanger all plantations of spruce, true fir, and Douglas-fir on flat ground where cold air cannot flow off. In the foothills of the Alps and north to the Danube on endangered sites, we find frost every month of the year. Without frost protection, no planting of the above-named species could flourish there. If this protection cannot be given by shelter from the old stand, we mix in fast-growing, frost-hardy pioneer species such as alder, birch, or pine with a spacing of about 3 by 3 yards. In the same way, we add biological mixtures where they cannot be secured naturally. The main species for this mixture are beech, European fir, larch, Douglas-fir, eastern white pine, grand fir, maple, and elm. Today, we prefer a group mixture to a single one because there is less danger that it will be outgrown or its care neglected. Except for special sites, the angle-planting method is normal here, too. The costs of such spruce plantings run from $100 to $300 and average $200 per acre.

Plantings of beech to become the dominant species are very rare. To produce good quality, beech seedlings would have to be planted so densely that costs would be too high for profit. We would have to calculate on $500 to $600 per acre for planting, so we must depend on natural regeneration. If this is not possible, then intensive soil preparation and fertilization must be carried on.

Now a few words about oak reforestation. Oaks are both intolerant and very sensitive to late frost. They are typically deep-rooted and therefore difficult to plant. High-quality oak, more than any other species, demands a small uniform annual ring structure, a straight trunk, and a clean stem. The necessarily dense and uniformly spaced young stands can be attained best by an artificial method. Planting is difficult and very expensive, which leaves us the alternative of seeding. Because of frost danger, a shelter must be provided during the first years of plantation growth. A pure oak stand never closes densely enough to hinder the growth of epicormic branches which would spoil the quality; therefore, a mixture of hornbeam or beech is required to force the oaks into good form. So we try to regenerate hornbeam or beech naturally by a shelterwood cut on zones from 100 to 200 yards wide. As soon as they are established, the shelter is opened a little more and seed rows are prepared by hand or machine about one yard apart. In these rows, 100 to 200 pounds of acorns are seeded per acre and covered with soil about 1 to 2 inches deep. If hornbeam and beech do not come naturally, they are seeded in as well. The shelter cut follows 4 to 6 years later. The costs are about the same as for a spruce planting.

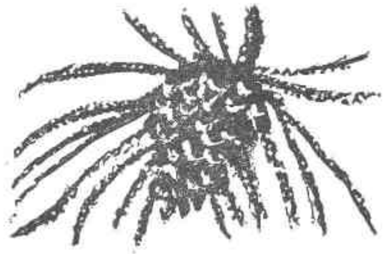
Let us now consider methods of thinning. As previously stated, commercial thinning begins in the pole-stand period, is heaviest at the beginning, and slows down at the end. The stand must be tended in the early stages by a selection principle, as mentioned earlier, to remove less valuable stems in the stand.

At an age of 30 to 40 years when thinning normally begins, the number of trees ranges from about 1,200 to 2,000 per acre. It drops to about 100 to 200 in the old-stand period. Therefore, 1,000 to 1,800 trees are cut during the whole thinning period. That is approximately the relationship, today. But degree and concept of thinning have changed considerably since forestry began. The stands were hardly thinned at all 150 years ago. Thinning from below came into use about 100 years ago under the principle of starting early, cutting moderately, and repeating often. Thinning from above was recognized 80 years ago in Germany, and in 1902 the Union of German Forest Research Stations devised grades A to C for thinnings from below and D and E for thinnings from above. At the same time, there was research work on the results of different thinning grades.

Today, our thinning work, which we call the quality thinning method, is based on the ideas of the Swiss silviculturist, Dr. K. Schaedelin. In this system, the thinning differs from tending and other thinning methods mainly in principle; we do not thin from above or below and do not select trees negatively but positively. We do not concentrate on dominant or suppressed trees, and we do not look for the badly formed stems but always for the good ones, regardless of the tree class to which they belong. The thinning aims first and last to help and promote the best or elite trees. The principle of moderate cuts is valid here, too. Helping elite trees will secure a steady development without heavy changes in their annual ring structures or crown forms. In addition to selecting in the upper canopy, going into the lower stories keeps the trees alive there and opens the stand to give the best trees a chance to advance. As soon as natural selection starts again, the next thinning should follow. As a rough estimate of how much to take out at one time, we use the rule: remove about one half of the current increment during the pole-stand period and later about one tenth of the standing volume during one decade.

On sites where good spruce, pine, larch, or Douglas-fir can be produced, the question of pruning must be decided during the pole-stand period. The diameter of the trees, breast high, should not be over 8 inches, the number of trees pruned, not over 150 per acre, and the pruning height at least one, better two, log lengths—or about 30 feet. That we do not prune to a great degree today is due to a labor shortage rather than the costs involved. At the moment, a German firm is developing a pruning machine which seems promising. It may change the picture.

This very short and compressed survey of practical silviculture perhaps has left wide gaps and made it difficult to give a clear picture. However, the manifold and sometimes complicated practical work of our intensive forestry may have been made a little more understandable to the reader.



7. Logging, Utilization, and Transport Planning

This chapter covers logging, utilization, and transport planning, fields of high importance and cardinal points of our economic situation. Before going into details, it seems necessary to explain our labor situation. All state and communal services and also the big forest owners employ their own labor forces. Where large forests exist, as in the Black Forests or the Bavarian Alps, forest labor as a profession has been acknowledged and respected for hundreds of years, and has been a traditional job for generations in many families. Often these laborers owned and still own small farms which they manage in their spare time and through the work of their wives and children. Often the man works during the summer on his farm and during the winter in the woods. In times of high labor demand, especially during cultivation periods, short-term laborers, mainly women, close the gaps. That splits our labor force into three groups: the permanent workers who stay all year around with us, the regular workers who are employed more than two months a year (mainly during the cutting season), and the irregular workers who help out less than two months a year.

The industrial development of Germany during the last 15 years brought a tremendous demand for labor. Today, the number of employed people surpasses 22 million, among them more than one and one-half million aliens. The percentage of unemployed is less than 0.5 percent and about five jobs are open for each unemployed person. This labor market situation influences forestry heavily. During the last ten years, we lost about one-fourth of our labor force. Today, not even 100,000 persons, less than 0.4 percent of all employees, work in forestry. As a result, the trend is toward permanent forest workers. Their number rises while the number of regular and irregular workers drops progressively. Our goal, therefore, must be not only to make forest work a permanent job and to improve the efficiency of labor but to make forest labor an attractive and socially respected occupation. We attempt to do this by means of an intensive training program and the promotion of a so-called "skilled forest worker" class, similar to other industrial workmen or craftsmen. A young man leaving elementary school at 14 to 15 years old can join us as an apprentice and obtain two years of training by forest workers who are experienced in the various forestry activities and practices. A training course at one of the forest work schools, which each state service maintains, and the passing of an examination will qualify him as "Waldarbeitergehilfe," which could be translated as a "forest worker trainee." During this time, he draws the normal wages for workers of his age. Then two years of more practical training follow which are interrupted by courses at the school, mainly in logging and cultivation. If he passes the final examination, he is granted a diploma as a skilled forest worker and receives higher pay than a man without a diploma. In addition, all our workers are sent to one-to-two-week training courses at a work school every two or three years where they are taught the newest methods and tools of cultivation, felling, skyline logging, building of chutes, or anything else of importance. All expenses for this in-service and promotion training are paid by the various state services.

The rising standard of living and the heavy competition in the labor market catapulted forest wages over 500 percent during the last 20 years. Strong trade unions enroll over 80 percent of our workers. The employers' organizations contract general labor conditions, wages, compensation for travel to the working areas, additional wages for particular achievements, and provisions for sick leave and annual leave in agreements which are valid usually for one year. The social costs paid by employers are a heavy burden on their budgets today because they reach close to 80 percent of the wages paid. For example, for all the hours during which bad weather conditions prevent work, employees are paid fully. A worker gets full pay for about 20 days of annual leave. Half of the sick leave, unemployment, and old-age insurance are also paid by the forest service.

Around 8,600 laborers worked in the Bavarian Forest Service in 1963. About 81 percent of them were permanent, 7 percent regular, 8 percent irregular workers, and 4 percent apprentices and trainees. They were paid for nearly 24 million hours. The actual working time was 19.8 million hours. The actual working time per worker per year averaged close to 2,300 hours and the working time per acre close to 10 hours. Out of that total, the actual working time was about 44 percent in logging, 31 percent in cultivation, 12 percent in road construction and maintenance, and 13 percent in other activities such as tending, erosion control, or forest protection.

Six million working hours were spent in cultivation. If one applies that figure, which includes all cultivation work such as weeding and nurseries, to the total reforested area, over 200 hours were needed for one acre, a figure which shows clearly how intensive that work is. In spite of the fact that a large proportion of the reforestation areas is already planted by the piece with good results, only about 12 percent of the cultivation work was contracted. This figure should be increased in the future.

Naturally, logging needs the largest amount of labor. Data from the Bavarian Forest Service during recent years may again serve as an example. The yearly cut was about 127 million cubic feet, or 71 cubic feet per acre of productive forest. This was distributed as follows: 53 percent to regular regeneration cuts, 33 percent to thinnings, and the remaining 14 percent to irregular cuts caused by disturbances. The cut was 80 percent softwoods and 20 percent hardwoods. Utilization was 87 percent for industrial purposes and 13 percent for fuelwood. Of the industrial timber, 75 percent of the softwoods and 61 percent of the hardwoods were sold as sawlogs. Of the softwoods, 9 percent was used as mining timber and 16 percent as pulpwood. Of the hardwoods, 3 percent was used as mining timber and 36 percent as pulpwood. To make this timber ready for selling took about 8.7 million working hours or about one working hour per 15 cubic feet.

Two-man crews and, less often, one man outside the mountains and three-or four-man crews in the mountains make up the normal working parties. About 9 percent of the timber is logged by piece work. Laborers at piece work should earn at least 25 percent more than at hourly wages. Actually, today their average earning rate runs about 160 to 200 percent above the base rate. To contract piece work in the forests outside the mountains, we use a logging tariff, valid for the whole of Germany. It is based on time studies and lists the working minutes necessary to produce ready-for-sale timber of different species, size, and use. After a cut is scaled and measured, the working time of the tariff can be totaled. Multiplying this total by the wages per minute, valid at that time, gives the total earning of the cut.

Working conditions, such as rough terrain, which make the work more difficult than normal, warrant extra charges up to 15 percent above the normal tariff minutes. The extra percentage has to be agreed on, where necessary, before starting a cut. Anything else is fixed by the logging and wage tariffs. The logging tariff does not fit the mountains where the working conditions change too much from stand to stand. The solution is a system which expresses in points the degree of slope, microrelief of the ground, stem form, limbiness, debarking difficulties, healthiness, type of cut, and so on.

A qualifying table lists the wage per unit for a certain number of points and the volume of the average tree cut. These lists are derived from time studies, too. It is easy to understand that the mountain logging tariff is much more difficult to handle than the so-called general logging tariff. The latter tariff does not need the volume of the mean tree cut, and the possibility for subjective changes is very small.

For the mountain logging tariff, everything depends upon the number of points one gives for the different criteria. These can change considerably, depending upon individual viewpoints and whether one estimates the volume of the mean tree exactly or not. It requires also that the contract for each single cut must be agreed on by both sides. Up to now we have not found a better way, in spite of many objections.

The normal work of logging includes felling the trees, limbing, debarking of the softwoods, and sorting the timber into the different sales classes. Therefore, we do not have nor do we want any exact specification of work. Each man must be able to do all the work which comes to his hands. We admit that more specialization would indeed lead to higher efficiency temporarily, but we are sure that, in the long run, monotonous work tires more and involves health damage. This is especially true in the use of power saws because of the steady vibration. Until about 10 years ago, over 95 percent of our timber was cut by hand saws. Today the relation is reversed. One-man power saws, owned, as are all the needed tools, by the workers themselves, are quite sufficient for our timber sizes. We pay the laborers one-eighth of the contract wages extra for using and maintaining their own tools. The money is paid either directly or into a fund for working tools for the labor force of a district. Both methods work well. The introduction of power saws led to much better efficiency per working hour. But beyond that, our possibilities for improvement and mechanization of logging are restricted.

Heavy logging machinery, as devised and used in your country and in Scandinavia, requires large areas and large volumes for economic amortization. Even where the terrain would allow their use, our working areas are too small and the volume handled is too limited. At the moment, we are attempting to introduce debarking machines for small saw logs, mine props, and pulpwood. But already this involves many organizational problems of organization, sorting, and storage which need more time for successful solution. The close entanglement between the necessity for economic management and our concern for conservation and the recreational function of all our forests undoubtedly hinder the use of less expensive logging methods.

In flat country, we sell timber on the cutting area. Formerly, it was up to the buyer to skid it to the road. Today, more and more, we must do this ourselves. We contract private parties for skidding or we use our own machinery and the buyer repays us for the costs. Because horses do less damage than anything else, especially on regeneration areas, they are best for skidding. Unfortunately, the number of horses is decreasing so rapidly that wheeled tractors have to be substituted. We do not like to use track-type tractors and skylines as means of skidding, for reasons I have already stated. On the average, skidding costs range around \$2.50 to \$3.00 per 100 cubic feet. The timber is stored by the skidders along roads or at small landings, and after sale it is picked up there by logging trucks with winches or cranes.

In the mountains, it is much more difficult to bring the timber to truck roads. Here we can sell it only at the roadside and we must also pay the costs. Until about 10 years ago, there were hardly any truck roads in the mountains. The timber was and still is cut during the summer, in contrast to the flatlands. It is transported on the ground to the next sledway and then sledded to the timber landings in the valleys during the winter. To get the timber to the sled roads, it has to run on the ground for distances up to 700 to 800 yards. If the terrain is not too rough or too flat, the logs are pulled by hand on wet ground or on a little snow into a hollow or a ravine where they slide down. On flat places, horses have to help. In rough country, wooden chutes are built out of the felled material. Our workers sometimes construct these chutes over a few hundred yards without any ground survey and without an iron nail, just by their experience and skill.

It is an amazing picture to see the logs come down the chutes at tremendous speeds. After the sled road is reached, the logs are stacked for the winter haul. Surely, much timber is lost or damaged by such methods and the remaining stand is not improved either. But still we have to use chutes, even if we try to switch to cables more and more today. Little mobile winches are favorites. They allow ground logging or high lead up to 400 yards and skyline logging up to 1,000 yards. The winches are either on wheels for self-propulsion or are mounted on sleds; motors are as small as 10 to 15 horsepower. The carriages and the rigging allow the logs to be yarded by either hanging in the air or dragging on the ground. The whole system is so simple that each of our working crews can manage it without special help. Setting up and operating costs are so low that even small cuts can be made with profit. Around 10,000 to 15,000 cubic feet will be the lower limit for skylines of about 500 to 700 yards in length. Costs range from $8 to $14 per 100 cubic feet. The short log length, a maximum of 30 feet, is one disadvantage in using our skylines. This is one reason why we prefer ground logging or high lead for distances up to 400 yards. The donkey used here has two cables, a heavier mainline cable and a lighter haulback. These are interlocked to make an endless cable. The ground cables are easy to move and can therefore be used for small amounts of timber. Where logging distances exceed 1,000 yards up to 2,000 yards, we need heavier donkeys but more timber, too. The Swiss "Wyssen" cableway is the best known system here.

Even the winter haul on the snow cannot yet be avoided on considerable areas. In my district, over one-third of the timber still has to be sledded. Where the sled roads are steep, with a 15 to 30 percent grade, the workers pull or carry the heavy sleds two or three miles up the mountains, load up to 150 cubic feet and then sled down. Under difficult conditions, four hauls a day per crew is the maximum. Where the sled roads are not as steep, horses or oxen pull the sleds up and down. Today, we have replaced manpower or horsepower with small track-type tractors or wheeled tractors. The track-type tractor pulls four sleds up the mountain and is then loaded on a sled for the down drive. On more level roads, the wheeled tractor pulls a sled downward, too, or the timber is dragged on the snow behind the tractor. Winter haul on snow is a very expensive method of timber transport. Ground skidding and the winter haul are the reasons why logging costs in the mountains are about two to three times higher than in other areas. They are the reason, too, that many of our mountain districts operate in the red. Logging costs eat up about half of the gross income. The average logging costs, including the social costs, for a typical mountain district are $22 per 100 cubic feet at the present time.

We know such costs make profitable management impossible. Because our concept of landscape protection and silviculture forbids the use of heavy logging machinery, our only way out of the difficulty is to develop a dense system of truck roads. That brings us to the problem of transportation planning. A short historical review is in order.

For hundreds of years, water was the main means of timber transport. Floating and rafting the timber on creeks, rivers, lakes, and streams were the only way to transport it for longer distances. Rafts of logs from the Black Forest went down the Rhine to Atlantic ports and rafts from the Bavarian Alps went down the Danube to Vienna and Hungary. Amazing technical installations were devised, exact floating regulations were ordered and a special craftsmanship was developed. However, the last cubic foot of timber floated down a small river of the Hercynian Mountains about 10 years ago and the few rafts moving down the Isar River to Munich today are for tourists only. Floating and rafting have lost their economic importance completely.

About 80 years ago, the first logging railroads were built. They never reached great importance in Germany and not one is now in operation. Even the transport of round timber on public railroads has decreased tremendously. Trucks deliver nearly 100 percent of the sawlogs directly from the forests to the mills to save the costs of reloading. Trucks and roads are necessary, and today nothing else can be substituted for them in our forestry. The problem became a pressing one about 20 years ago and it put new demands before us. Our older roads were built for horsedrawn wagons and not for trucks with 30 to 40 tons of weight and high speeds. These old roads could not meet modern requirements.

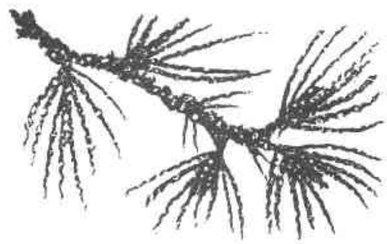
Out of that situation, our service drew up a general road-development plan 10 years ago which is now well on its way toward completion. On account of our management concept and the circumstances, the road system must be dense and permanent. It is our belief that a forest is fully developed if 14 to 18 yards of truck road per acre are available in the flatlands and 9 to 14 yards per acre in the mountains. Today 9,000 miles of truck forest roads and 1,370 miles of public roads already are finished through the 2 million acres of state forests in Bavaria. This means that our average road density exceeds 10 yards per acre. Because the districts themselves made the surveys, did the planning, and completed the construction, we are proud of the work that has been accomplished in less than one decade.

For each forest complex, we plan one or two main roads with a usable road width of 4 yards and appropriate turnouts and landings. These main roads should be intersected by a sufficient number of tributary roads that are to have a usable width of about 3.5 yards and a few turnouts and landings. Both must be able to carry traffic up to 40 tons. Under normal conditions, the distance between two roads should not exceed 300 to 400 yards and should not drop below 250 yards outside the mountains. Between these roads, a system of permanent skidding roads for tractors should be interwoven to complete the road network.

What type of road will prove best is still a matter of much discussion. It is mainly a question of construction and maintenance costs. Concrete roads undoubtedly show the highest construction costs and the lowest maintenance costs. The lowest construction and highest maintenance costs are involved in gravel roads. Black-top roads are a compromise but in most cases our traffic density is not high enough to make a black top stand up well. Today, we prefer gravel roads. On difficult soils we use gravel combined with mechanical or lime stabilization. They have the advantage of a simple and cheap structure and can be maintained in good shape by grader and wheelroller. They have proved to be completely satisfactory even on grades up to 20 percent and under high precipitation if the water runoff is taken care of and if the road has a good crown curve of about 3 to 4 percent. Normally we do not go over 12 percent grade for longer distances, but if necessary we accept 15, 18, or even 20 percent for short sections.

And now a few words on our construction principles are necessary. At first, we make a road survey and road project including a calculation of the amortization, which must be achieved within 20 years at the latest. The construction is supervised by us and is done with our own machinery. Each regional office maintains one or two machine pools with tractors, rollers, graders, cranes, loaders, compressors, trucks, and other machines. Only if our machinery is not sufficient do we rent private equipment on an hourly or contract basis. After the slope, a good ditch and enough culverts are most important. Short bridges and supporting walls of stone or timber are erected by our workers, too, just as we do most of the erosion control work ourselves.

One may ask why we do not contract road construction with private firms. The main reason is to save money. In 1963, 150 miles of new roads were built with costs of not quite $12,000 per mile, and 370 miles of old roads were changed to modern standards with costs of a little over $6,000 per mile. In the mountains, our costs are about twice as high as the average and they can go four times as high under the most difficult conditions. Private firms would cost us 30 to 50 percent more and we would not get as good results. The amount of money invested in a modern road system is tremendous, but we will have to invest many millions more until we reach our desired road density about 5 to 10 years from now. We believe these investments are necessary for our conditions, and we hope that they will enable us to carry on our forestry in the coming decades.



8. The Economic Situation of German Forestry

The previous chapters gave a glimpse into German forestry as it is today—its organization, its practical methods of management, its specialties, and its problems. Now and then a few figures on prices and costs were cited which indicated some facts about the economic situation without going into it deeply. One can judge the economy of a forestry regime only after he knows its natural and social foundations and its concepts and methods of management. Earlier chapters have attempted to supply the background knowledge necessary in arriving at a realistic appraisal of our forestry as an enterprise. There are two main difficulties in achieving such an understanding. One is the varying economic results within different parts of the country, depending upon the percentage of hardwoods, and the lack of adequate statistical material. We will have to restrict our consideration to the data of the state services and the Bavarian service which is still in a relatively good position on account of its high percentage of softwoods. The other difficulty is the difference between the rate of exchange of the dollar and the German mark, and their buying power. While the rate of exchange is one to four, the buying power may be guessed at around one to two or a little above. The rate of exchange will be used here as the conversion factor.

During the decade of 1953 to 1962, the gross national product of Germany grew about 2.34 times, to $87 billion. In contrast, the total yearly income of forestry stayed nearly stable, around $400 million. The forest industry percentage of the gross national product sank therefore from 0.93 to 0.45 percent. This shows very clearly that forestry did not participate in the so-called German economic miracle. This was in spite of the fact that wood consumption rose about 40 percent during the same time, from 20 to 28 cubic feet per capita each year. The drop in industrial forestry percentage decreased *in spite of the fact that we did increase our production* about 20 percent to a yearly cut of some 900 million cubic feet. The percentage of domestic production to the total domestic consumption dropped therefore from 78 to 62 percent. Close to 800 million cubic feet of timber or timber products per year are imported currently.

Also, the figures indicate that the importance of forestry is very low in the national economy. The relative importance of forestry to agriculture and to industry is about 1:10:100, and this percentage constantly shifts in favor of industry. On the other hand, this means that the noneconomic value of our forests must rise. Preservation of water resources, hindrance of erosion, and recreation push into the foreground and often become more important than a monetary profit. But their costs cannot be separated and therefore do curtail economic results. This should be remembered in the discussion of revenues and expenditures.

The main source of revenue is timber sales. Timber prices in Germany were controlled by the government from 1936 to 1952, at a very low level. Only from then on did timber prices develop under the law of supply and demand. After 16 years of a regulated market closed to imports, and under the tremendous demand on an economy repairing heavy war damages, prices rose fast and reached their top by 1955. From then on, they began to drop again to a level about 25 percent below our best year. The opening of our timber market to the present world markets without any restrictions was mainly responsible for this price decline. Timber and timber products can be imported to Germany without any tax or custom duties of any kind. The abolishment of price regulations was hardest on the beech, mine-prop, and pulpwood markets. Beech is much more difficult to saw, peel, dry, and work than tropical hardwoods, and the latter are usually more beautiful in color and texture. So our beech was replaced to a large degree by tropical hardwoods, mainly from the African countries which are associate members of the Common Market. Mine props and pulpwood from Scandinavia, Russia, and even America could undercut our prices in spite of their long transport. As a result, the price of beech dropped to 58 percent of 1955 prices, of mine props to 70 percent, and of pulpwood to 75 percent. This happened in spite of the fact that consumption of pulpwood and timber for furniture greatly increased. A second reason for price decline can be found in the substitution of other materials for wood, especially in housing construction. This had been the domain of our mass products of spruce and pine. Competition between wood and wood substitutes enforced the price decline.

Average prices for our main species and classes, classified as 100-cubic-foot units for solid round wood or one cord of stacked timber, are shown below and in Table 1 (opposite). Prices given are at the cutting area or beside a truck road.

Spruce and fir sawlogs make up about 37 percent of the total timber sold. Their average price comes close to $64 per unit, but it may reach twice as much for the best qualities. The price of pine and larch sawlogs, about 9 percent of the total, depends much more on their quality than does spruce. Larger diameters and good grades exceed prices for spruce of the same dimensions by far; small diameters and low grades cannot meet spruce prices. On the average, the price of pine sawlogs is a little below spruce at about $60 per unit. Six percent of the timber production is sold as mine props at $36 per unit. Pulp softwood makes up about 10 percent. Its price of about $39 per cord is so small that we try to decrease the amount of this commodity as much as possible.

Softwoods, including fuelwood, make up 65 percent of total production; over 70 percent is in sawlogs. Out of the 35 percent hardwoods, the sawlog percentage is just half as high. Of the total, about 2.5 percent is oak, 10 percent is beech, and 0.5 percent is other hardwood sawlogs. Prices differ greatly. They may run as high as $3,000 per unit for our best veneer oak, or $850 for the best veneer maple. Unluckily, the quantity of these valuable logs is so small that they cannot perceptibly better the situation of the whole hardwood market. Ordinary oak, mainly used for barrel and parquet production, reaches prices similar to spruce. But the beech market troubles us most today. An average price of $43 per unit was paid in 1963, but this is not enough. We cannot sell as much beech for that price as our concept of management demands. The beech market is so tight and weak that a higher supply would ruin the prices completely. About 8 percent of the total is sold as pulp hardwood for which we receive about $20 per cord, a price which makes a profit impossible.

Fuelwood runs about 80 percent hardwood and 20 percent softwood. The price situation here is a little worse than at the pulp hardwood market, averaging around $18 per cord. An increasing percent of this timber is not burned anymore but used for particleboards. Table 1 summarizes this information.

Table 1. Percentage of Total Cut and Average Price Paid for Different Timber

Species	Percent of total cut		Average price /100 cu ft.; or cord
	Percent		*Dollars*
Spruce sawlogs	37		64
Pine and larch sawlogs	9		60
Coniferous mine props	6		36
Coniferous pulpwood	10		39 (cord)
Coniferous fuelwood	3		18 (cord)
		65	
Oak sawlogs	2.5		65
Beech sawlogs	10		43
Other broadleaf species	0.5		*
Broadleaf pulp	8		20 (cord)
Broadleaf fuelwood	14		18 (cord)
		35	
		100	

* Prices exceedingly variable.

The overall sales price per unit was therefore $46 in 1963. The Bavarian service received about $2 more on account of its higher softwood percentage. Its revenues for timber sales came to $33 per acre of productive forest. Added to that figure, other revenues from activities such as hunting, land lease, sale of sand and gravel, and so on which aggregate about 12 percent of the timber sales, will come to a return of $37 per acre.

Turning now to expenditures, you will remember an earlier statement to the effect that our bookkeeping system does not allow a true calculation of profits. However, we can split expenditures into six groups: logging costs, silvicultural costs, road construction and maintenance costs, and other management costs. These four we call management costs. In addition, there are administrative costs and taxes.

During the period of 1958 to 1962, our wages increased 60 percent and today they are about 20 percent more than in 1962. In spite of this rise, logging costs increased only half as fast. This is mainly the result of the introduction of power saws and the development of the road system. In 1963, to log 100 cubic feet of timber cost $13 in the Bavarian service. This figure includes $3.60 for social charges. The expense per acre was therefore a little over $9, and logging costs took about 30 percent of the total expenditures. Therefore, logging is over twice as expensive in the Alps as it is outside of them. Felling costs are about 35 percent higher here but they amount to only about 60 percent of the total. The rest is apportioned about equally between skidding and winter hauls.

Silvicultural costs include cultivation work, precommercial thinnings, and protection of the forest against game, insects, and fungi. Of the total, 17 percent, or $6 per unit cut or $4.30 per acre, had to be spent for silviculture. In the Bavarian Forest Service, about 62 percent of that amount was needed for pure cultivation work. Each acre of reforestation cost $210. Five percent went into tending work, at average costs of $13 per acre. Two million dollars or 26 percent was expended for game protection. That is over $1.10 per acre of productive forest. In spite of this protection, heavy damages, which can hardly be guessed at in money, cannot be prevented. Hence, it is readily understandable that our overpopulated wildlife becomes a serious danger for the forests and their management. The remaining 7 percent for protection against insects and fungi amounts to only one fourth of the sum for animal protection.

At this point, a few words may be said regarding forest fires, which are such a great danger in the United States. Fire danger can be great in Germany, too, mainly in large pine and spruce forests after a long drought. Anyway, the danger is not nearly as serious as in most of your forests. Four main reasons lower our risk considerably: there is little combustible material on the ground, the dense road network gives many good firefighting lines, help is nearby everywhere, and everyone is obliged to help. During the four years of 1960 to 1963, an average of 165 fires were registered per year in the whole of Bavaria. They destroyed an average of 2.5 acres per fire. In 1963, 94 fires occurred in the state forests and burned an area of 150 acres. Human beings caused 97 percent of the fires; only one was started by lightning. Three percent of the fires were started by unknown causes. You will understand how happy we are that fire protection and fire fighting bothers us so little.

Costs for road construction and maintenance consume about 13 percent of the total expenditures. They averaged $3.35 per acre from 1958 to 1962, or close to $5 per unit. Because Bavaria reaches into the Alps, our costs are higher than average. In 1963, we spent nearly $7 million or $4.30 per acre for this purpose. Of that sum, 66 percent was used for construction of new roads and the modernization of old ones. A network of 9,000 miles of truck roads and 18,000 miles of skid roads was maintained at an average cost of $160 per mile of truck road and $32 per mile of skid road.

Survey, demarcation of boundaries and mapping, construction and maintenance of buildings, purchase and maintenance of bigger machinery, and some other expenditures are included in the other management costs. They reached 65 cents per acre or 90 cents per unit cut during the same period mentioned above. The most important emphasis here is on housing projects. To give you an idea of what that means, one figure may be enough. The average age of the over 2,000 ranger, subranger, warden, and worker houses of the Bavarian Service was over 100 years old a few years ago. Economic conditions during the last 20 years did not leave much chance to keep them in good shape. We must try to better our housing conditions quickly or run the risk that nobody will accept forestry employment anymore. A little different, but a somewhat similar situation, developed for our workers. Many of them will stay with us only if we can furnish them a good inexpensive apartment or house, or if we will sell them ground for very low amounts where they can build their own houses. We go both ways to maintain a force of permanent workers. My service spends over $2.5 million each year for housing projects alone.

The four groups of management costs make up 63 percent of the total expenditures; the rest goes to administration and taxes. This latter percentage of 37 seems amazingly high. In the Bavarian Forest Service, 1963 administration costs reached $8.70 per acre, or a little over $12 per unit cut. Of that expenditure, 82 percent was for personnel and 18 percent for nonpersonnel. Eighteen percent of the total was charged to overhead, 63 percent to the districts as the management units, and 19 percent to pensions and fringe benefits. Costs for tasks which do not belong locally to the management of the state forests, such as territorial functions, supervision of communal forests, and the extension service, are already excluded. Those costs are estimated at close to $3 per acre for the Bavarian Forest Service. The high percentage of pension costs may surprise you, too. It is influenced by the many refugees from the once-German areas in the east and the Russian-occupied eastern zone who are now paid pensions by us.

The state services are freed now from all taxes payable to the Federal Republic or the states. But they have to pay the land tax, which is one of the main resources of the communities. The basis for the land tax and the property and inheritance tax, which have to be paid by private forest owners, is property value or the so-called unit value. The value per unit was last fixed for most of the forests in 1936. It rests on the idea of a normal age-class forest. The realization value of such a forest was determined for the younger age classes as a cost value, for the older ones as a sales value, and between as an interpolated value. On this basis, one could calculate an average value per unit and could determine the value of each age class in percent of the average value. This calculation was made for different species, rotation periods, site classes, and degrees of density. The results were listed in tables.

Management plans for the actual enterprises contain the real data needed: species composition, degree of density, and age and site class. So that tax valuation can be given a uniformly equal basis, we have to use the same yield tables in the whole of Germany. After compilation, the derived data could be multiplied with the values of the normal forest; then the division of that sum by the total area gave the average property value per unit. This value now has to be changed by a correction factor to eliminate the different logging costs and sales prices in different regions of the country which were determined in test-management units. The value per unit was therefore planned as an income value. As a basis for taxation, it was unquestionably fair at the time it was established. But, meanwhile, two developments have changed the picture. The communities, on the one hand, raised their collection rate a few times on the value per unit which is fixed every year; and, on the other hand, the price and cost structure of our forestry changed completely during the last 30 years, to the negative side. At the moment, a new tax valuation which will follow the old principles is in preparation and will be carried out during the next few years. It will adjust our taxes to the circumstances which exist today.

In 1962, the state services had to pay a land tax averaging $1.70 per acre per year; this amounts to about 6 percent of total expenditures. The tax charge is, of course, much higher for private forest owners. Besides the taxes already mentioned, they have to pay an income tax which progresses up to 56 percent of their net income. A heavy burden for larger estates and a danger for their preservation is the inheritance tax which is progressive from 2 to 15 percent in a direct line. All of this puts one of the highest tax burdens of all Europe on our forestry; the total can amount to 30 percent of the revenues per unit cut.

If one adds the figures of the different expenditure groups, the sum reaches $29 per acre or $41 per 100 cubic feet cut for 1962. The Bavarian Forest Service had to spend $30 per acre and $43 per unit cut in 1963. Expenditures rose 25 percent during the five years of 1958 to 1962 and their tendency to grow continues.

If one asks for the profit or net yield now, the answer is not very pleasant. Profits in 1962 were only a little over 10 percent of revenues; $4 per acre or $5 per unit. During the five years of 1958 to 1962, profits were cut in half. But what makes the situation even worse is the fact that we were able to reach that 10 percent profit only by mobilizing the last reserves of volume. Now, our yearly cut cannot be increased anymore without abandoning the principles of sustained yield. This is forbidden by law. The average figures do not show either that only the districts with a higher percentage of softwoods and favorable logging conditions can gain a profit or that districts where hardwoods prevail or where logging is difficult always operate in the red. We calculate today that we lose about $16 on each 100 cubic feet of beech cut and about

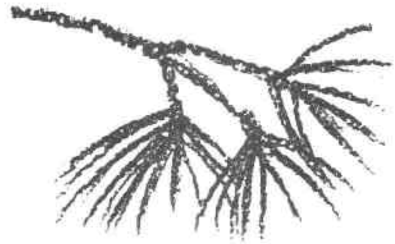
$8 on each 100 cubic feet of oak cut, if we estimate the same costs for all of our species and leave capital interest out of consideration.

Forestry was helped a little when it was freed from the turnover tax last year, and timber prices also climbed slowly. Therefore, we could hold to the average profit of about 10 percent. But that does not change the fact that the rate of interest return stays around one-half of one percent of the capital invested because we can calculate the average market value of one acre at around $1,000.

One may ask why we still maintain our forests if they gain hardly any profit or even bring losses? For the public forests, the question can be answered easily: management is obliged by the law not only to earn the highest possible profit but to preserve and better the social benefits of the forests. In our densely populated country, we would have to manage our forests even if we lost money on them every year. More astonishing is the fact that private owners are not willing to give up forestry either. That they prefer none or a very small rate of interest in forestry to a normal rate of about 4 percent in our economy can be explained only by two reasons: tradition and bad experience. Out of tradition, land ownership is rated socially higher than anything else, and it is a tradition not to separate from it as long as it is possible to hang on. That is why a market for forest real estate practically does not exist and why prices paid for it are not dictated by economic return but by personal satisfaction.

Besides, our experiences during the last 50 years agree with this tradition. Forest ownership was rewarded, and this made people anxious to keep such properties. Two total inflations during the 50-year period destroyed many fortunes but not the value of forest real estate which rose amazingly during the same period. An example can be cited out of my own experience. Thirty years ago my district was offered a forest of 400 acres. The asking price was a little over $40,000, but we were not willing to pay this much. Last year, the same estate was sold for over $800,000, and this time we really wanted it but could not meet the price. During the same period, inflation after the war cut the value of our money about 94 percent. In our economic situation, the buyer surely cannot make a profit out of that forest and he certainly knows it. But he estimates the security of his investment, its probable value increment, and his increased social respect higher than a rate of interest of four or more percent possible in other investments.

All of this means that our forestry will be carried on even under bad economic situations. We could better the return if we would be willing to give up the high intensity now maintained or if we gave up the principle of sustained yield. We cannot do both and do not want to do either. The first seems imperative for the multiple uses of our forest and the second for the benefit of following generations. In the next and last chapter, I will try to explain how we view our future operations under these two conditions.



9. Future Trends

In previous chapters, I tried to give an impression of today's German forests and forestry. The picture showed light and dark spots. Our forests outlived two wars and two inflations in little more than 30 years without irreparable damage. They still can supply the country's timber demand to a high degree. In spite of 500 years of heavy utilization, they still protect the landscape, house a great number of wildlife, contribute heavily to water resources, and have a high recreational value. There are points of dissatisfaction such as stand composition, soil depletion, or wildlife overpopulation, but they can be solved in the long run. However, these problems are minor compared to the one which has brought us to a critical spot, our economic situation. Steadily rising costs and our sinking or stable forest revenues have decreased the possible profit so much that only an extremely low rate of interest can be earned now. If this trend of the last decade continues, it can be easily foreseen that our forestry must operate in the red within the next few years.

This black cloud standing sharp and menacing above us raises questions. What can be done against it? What possibilities do we have? How do we see our future? You will understand how difficult it is, even how impossible, to give correct and forthright answers to these questions. We cannot foretell the future, but we can be sure that it will have many surprises in store for us. It is just as certain that we have a duty to think about it, to plan as well and as far ahead as we can. And this is true because forestry by its nature needs long-range planning more than any other kind of enterprise. When I try to outline what is ahead of us, what we could or should do, please understand that I will offer my own personal opinion and not at all an officially accepted or acknowledged line of action; there is none in existence. It is probably still too early to establish an official position in spite of a lively discussion about these problems, and in spite of many things that have already been done.

Let us first take a quick glance at our labor and timber market. We can be reasonably sure that our labor market will not ease in the near future, and we have to calculate that our labor costs will increase later on. Probably that is a fact we should not be sorry about, for it also means that our total economy is thriving and expanding and with it our timber market. If we have no depression and if the Common Market is completed within the next four years, we can be sure that our timber market will be uplifted to a remarkable degree. The question is whether this will mean that we can equal or even increase our revenues compared to our labor costs. A few glimpses of hope can be seen.

France and Italy still have over half of their forest area under coppice and coppice-with-standards management. They are converting this low-yielding stand into high forests at a rapid rate. Therefore, their hardwood cut is way above normal, and this timber competes strongly with our broadleaf timber, especially beech. Part of this process will slow down later and this competition will decrease. Besides, the associated countries of the Common Market in Africa are exploiting their tropical hardwood forests at a remarkable rate. Their logging costs will increase the farther inland they must go. The rising prices for tropical hardwoods, which can be foreseen, should give our beech a chance to recapture at least part of the market which it has lost to these African countries during the last decade.

The countries of the Common Market now import 1.4 billion cubic feet of timber per year, mainly coniferous. The demand should increase. On the other hand, the main exporting countries, such as Scandinavia, the Eastern Bloc, and North America, have only restricted means of expanding their production. They are subject to higher costs, too, so their prices should go up and thus permit our prices to rise as well.

Even if this assumption should prove to be true, it would be no excuse to do nothing in our country. There seem to be three lines we can work on: intensification, work improvement, and mechanization.

We are already working hard on intensification. One very important line of attack is research. The work on tree genetics especially will open a wide variety of new possibilities, be they hybridization or breeding for different kinds of resistance. Research on soils, plant nutrition, weed control, and disease control should lower the costs of reforestation or make regeneration more effective. Besides, we can hope that research in forest products will develop new opportunities for the products we harvest.

This research and more intensive management will enable us to produce more per unit of land. At the moment, our forests grow about 60 cubic feet of timber per acre per year on a sustained-yield basis. We know that we can raise this by about 20 to 25 percent. This is especially true for the large number of small farm forests. Production also may be increased by (1) the conversion of pure hardwood forests into mixed forests; (2) the amelioration of depleted and degraded soils; (3) the conversion of coppice into high forests; (4) the replacement of stands now comprised of poor trees with new stands from the best seed sources available; (5) the accumulation of growing stock in understocked stands; and (6) the use of faster growing foreign species.

One of the qualifications for this increased management effort is the full development of a permanent road system. Only this can make such intensification of administration possible. At the moment, we have accomplished only about two thirds of our given goal of at least 6 miles of truck road per section in the state forests. On the private forests, we are still farther behind. The construction of this needed road system would also mean a considerable improvement in logging. At the moment, the high investments which are necessary are a heavy burden. As soon as the road network is completed and paid for, we will profit from the results.

For our farm forests, two future developments are necessary to make intensified management possible. One is to consolidate the split-up ownerships. As soon as a forest becomes too small in total area or in form, profitable and proper management is impossible. This situation exists for a large group of our farm forests. Two ways to solve this problem are available: the establishment of forest management cooperatives or the exchange of ownership. Our experiences with management cooperatives are not too promising. On the other hand, exchange of ownership is a most delicate and difficult task which we have not tackled up to now. We are doing this on a large scale for agricultural land, where the same problems exist. I am sure we will try exchange of ownership for forest land, too, as soon as it is widely recognized that it is as essential in forestry as in agriculture. The other problem is the marketing of the timber produced in farm forests. The single owner normally sells so small an amount that proper grading and scaling are difficult, as is economic transportation for the buyer. That is why prices are mostly 10 to 20 percent lower than for timber bought from public agencies. Only the formation of marketing cooperatives can help to solve this problem.

If we should be able to increase our production per unit 10 to 20 percent by the means named, this would undoubtedly be a great help. The trouble here is that such an intensification normally needs quite a bit of investment and will provide a return only after a relatively long period of time. But we have to cut down our costs now as fast as possible to keep our heads above water. This can be done only by improvement of operation and by mechanization. Forestry calculations deal with very long periods of time, and times are changing very quickly. Naturally, that brings a forester into a personal conflict. Because of the nature of his profession, he has to be conservative, but he must be up-to-date for the management of his forests. The current setup of our forest administration dates back over 80 years. During this period, it was not changed basically. One proof is that our administrative costs run as high as 30 percent of our total costs. This unreasonably high percentage is derived mainly from two causes. The overhead is too large and the forest district, as the management unit, is too small. The management unit should be large enough to allow for the employment of specialized personnel and the use of modern business equipment for its administrative work. The size of the overhead should stay within a reasonable relation to the management level, which means it should be as small as possible. A modern administrative setup under such regulation could cut down our administration expense remarkably; not only for personnel but for nonpersonnel costs.

In addition to the problem of the right form and size of the organization, there are other potential areas of improvement. We have large areas of forest land which are submarginal under the given economic situation. They are either the poorest sand soils under pine stocking or the high mountain sites with poor growth and costly logging conditions. Their growth capacity is too low and managing costs too high to make them pay for intensive management. We should take them out of regular management and set them aside as forest areas where only protection and preservation are carried on. A similar problem exists for all forests which are only slightly above the marginal point. It does not seem economical to invest money in their amelioration as long as a higher benefit can be gained by investing the same amount on better sites.

Once again, I have to come back to our wildlife situation. The amount of money spent for game protection and lost by game damage is tremendous. In many cases, not only the question of making or losing money but of keeping or losing a sound and stable forest cover is involved, especially in the protection forests. It is necessary to take on the difficult but very important task of letting the public know the facts. We must convince people that the wildlife population has to stay within a limit set by the carrying capacity of the land and the economic and noneconomic functions of our forests.

Help for our forestry can be expected from our parliament and government, too. Forestry was freed from the turnover tax a year ago, as agriculture was earlier. Unit values of forests for land-tax purposes have been newly appraised. Because they are based on possible profit, the taxes will decrease remarkably and will ease the high tax burdens that forestry still has to carry. The subsidies given by the Federal Republic and the states will help our farmers intensify their forestry.

Compared to the possibilities offered by work improvement, the chances for mechanization seem to be small. The diversity of our forest composition, the small size of our stands, the concept of mixed forests, and the importance of noneconomic functions forbid large cutting operations on most of our forests and thereby limit the economical use of heavy machinery. However, I am quite sure that changes are coming. We will concentrate our cutting operations to some degree. We will employ cable logging, especially in the mountain areas. We will use more machinery in logging and reforestation. Machine debarking will be one item coming up fairly fast. All of this will alter the picture of our woods operations, but will not change it completely. We will have to be lucky if we are able to hold our logging costs at the current level.

So far we have considered forestry only as a business enterprise. There is the question as to whether forestry will keep its economic importance in the future or whether its social-welfare effect will take precedence. Some men in my country believe that the period of economic forestry is reaching its end rather rapidly, that the forester of the future will have to serve as a kind of park warden, and that the forests will have more protection and recreation functions than commercial ones. This would probably be true if we carried on without change. However, change is inevitable, and foresters with economic goals have a fair chance of being successful. Germany still grows 865 million cubic feet of timber per year, and it can grow over a billion cubic feet. This important amount of timber cannot be left out of commercial use. There must be ways of growing and harvesting it at a profit.

Economic considerations do not mean that the noncommercial values of our forests are underestimated. These values can hardly be overestimated in a country as densely populated as Germany. The forests protect our settlements and agricultural land against erosion, landslides, and avalanches; they stabilize our water resources; they ameliorate water and air pollution; and they provide recreation. This means, however, that practically every acre of both public and privately owned forest has to contribute to some degree to all, or at least one, of these functions. In this regard, our forest legislation strictly restricts the freedom of the individual owner to manage his own forests as he pleases. Public owners are limited to an even higher degree.

Remember that we have many regulations. All of the forests are open to the public, and there are restrictions on protection, clearcutting, reforestation, preservation, and so forth. These restrictions imply, as previously stated, that the forest manager is not free to follow the most economical way of operations. Added costs are incurred which could be saved otherwise and these costs lower possible profits. This is not too important for public owners, because their forests have to serve the highest overall value anyway, and the income they can draw from their timber amounts only to a very low portion of their total revenues. But it does not seem fair to load the burdens involved in serving the public onto the private owners without compensation. The public needs the beneficial effects of the forest and it enforces them. It should pay for them, too. The problem is how to evaluate the benefits in dollars and cents. For example, how can one calculate the fair price of the stabilizing effect of a forest on the water resource? Values cannot be estimated even for a forest which is put under protection to prevent danger from avalanches which would threaten whole settlements. If a payment system could be devised, one could only guess at the higher costs of management and that is already an expensive area.

We will have to find a solution to this problem, because social benefits will become more and more important in the future and additional severe restrictions will be placed on forest managers to provide them. This is important for public owners, too. They must be able to show the public what portion of the expenditures went into noncommercial activities, what values were gained, and what the economic results would have been without these activities.

One big item will be the improvement of recreational facilities. I am deeply impressed by the outstanding work you are doing here in the United States. We have nothing comparable in our country. Certainly, the intensively utilized forest under a shelterwood or a group-strip-cut management has a higher recreational value than a virgin forest under clearcutting. But that is only one side of the picture and only one stage of development. What I admire so much in your country is the fine variety of recreational facilities you offer the public in so many places and under so many different conditions. I am convinced that we will have to follow you along this line—transformed to meet our own conditions.

Our need for recreation seems to be most pressing in the vicinities of our metropolitan areas. The Forest of the city of Frankfurt am Main is a public park combined with intensive commercial management. This combination is a very important point. I cannot see why intensive recreational use could not be combined with intensive commercial management in our country (where no wilderness areas are left). Both are existing already. We just have to lead them in the right direction and to offer more and better facilities, such as trails, picnic grounds, rest areas, playgrounds for children and grownups, and parking lots. Emphasis must be on structures and arrangements to prevent the damage that is done now—not from bad habits or malice but from lack of proper facilities.

Our forestry is in the middle of a revolutionary period. Struck by an economic crisis, in the process of becoming part of the European Economic Union, and under heavy stress for more and better social benefits, it tries to find its way into an unknown future. The line of approach is clear: we must find the means to make forestry pay its way and at the same time provide all the goods and services which a stable and sound forest can offer to society. This concept is one of true multiple use for all of our forests. The goal we strive for is high and it will not be easy to reach, but I hope we will attain it.

Bibliography

FOREST HISTORY

BERTSCH, K., 1951. "Geschichte des deutschen Waldes," Jena.

FIRBAS, F., 1952. "Waldgeschichte Mitteleuropas." Jena.

HORNSTEIN, F. v., 1958. "Wald und Mensch," Ravensburg.

MANTEL, W., 1961. "Wald und Forst," Reinbeck.

PLOCHMANN, R., 1961. "150 Jahre Waldbau im Staatswaldgebiet zwischen Osser und Dreisessel," Hamburg u. Berlin.

FOREST LEGISLATION

MANTEL, K., 1964. "Forstliche Rechtslehre," Neudamm.

FOREST POLICY

DIETERICH, V., 1953. "Forstwirtschaftspolitik," Hamburg u. Berlin.

LEMMEL, H., 1956. "Forstliche Holzmarktpolitik," Frankfurt/Main.

ORGANIZATION

"Neudammer Forstliches Lehrbuch," Herausgeber: K. Rubner; Radebeul u. Berlin, 1955.

"Wald und Forstwirtschaft in Bayern," Herausgeber: Bay. Staatsministerium f. Ernahr. Landw. u. Forsten; München, Basel, Wien, 1963.

FOREST PROTECTION

SCHWERTFEGER, F., 1957. "Waldkrankheiten," Hamburg und Berlin.

MANAGEMENT PLANNING AND INVENTORY

BAADER, G., 1942. "Die Forsteinrichtung als Nachhaltige Betriebsführung und Betriebsplanung," Frankfurt/Main.

KNUCHEL, H., 1950. "Planung und Kontrolle im Forstbetrieb," Aarau.

LOETSCH und HALLER, 1964. "Forest Inventory," München, Basel, Wien.

MANTEL, W., 1959. "Forsteinrichtung" 2. Aufl., Frankfurt/Main.

RICHTER, A., 1962. "Einführung in die Forsteinrichtung," Radebeul.

YIELD AND MENSURATION

ASSMANN, E., 1961. "Waldertragskunde," München, Basel, Wien.

ERTELD, W., 1952. "Vorratsbehandlung und Ertrang im Wald," Berlin.

PRODAN, M., 1961. "Forstliche Biometrie," München, Basel, Wien.

PRODAN, M., 1965. "Holzmesslehre," Frankfurt/Main.

WIEDEMANN, E., 1955. "Ertragskundliche und Waldbauliche Grundlagen der Forstwirtschaft," Frankfurt/Main.

SILVICULTURE

BAULE und FRICKER, 1966. "Die Düngung von Waldbäumen," München, Basel, Wien.

DENGLER, A., 1944. "Waldbau," Berlin.

KÖSTLER, J. N., 1950 (2. Aufl. 1954). "Waldbau," Berlin u. Hamburg; "Silviculture," 1956, Edinburgh u. London.

LEIBUNDGUT, H., 1951. "Der Wald, eine Lebensgemeinschaft," Zürich.

LOYCKE, H. J., 1963. "Die Technik der Forstkultur," München, Basel, Wien.

ROHMEDER und SCHÖNBACH, 1959. "Genetik und Zuchtung der Waldbäume," Hamburg und Berlin.

SCHADELIN, W., 1942. 3. Aufl. "Die Durchforstung als Auslese- und Veredelungsbetrieb höchster Wertleistung," Bern.

SCHOENBORN, A. v., 1964. "Die Aufbewahrung des Saatgutes der Waldbäume," München.

TSCHERMAK, L., 1950. "Waldbau auf pflanzengeographisch-okologischer Grundlage," Wien.

WAGENKNECHT, E., 1960. "Die Walderneuerung" Berlin.

WAGENKNECHT, E., 1961. "Rationelle Dickungspflege," Neumann.

FOREST UTILIZATION AND LUMBER TRANSPORT PLANNING

HAFNER, F., 1964. "Der Holztransport," Wien.

KNIGGE und SCHULZ, 1966. "Grundriss der Forstbenutzung," Hamburg u. Berlin.

MATYAS, K., 1964. "Oekonomische Plannung von Waldwegen," München, Basel, Wien.

TRENDELENBURG, R. und MAYER-WEGELIN, H., 1955. "Das Holz als Rohstoff," München.

MANAGEMENT ECONOMICS

DIETERICH, V., 1939, 1940, 1941. "Forstliche Betriebswirtschaftslehre," Berlin.

ENDRES, M., 1923. "Waldwertrechnung und Forststatistik," Berlin.

KÖSTLER, J. N., 1943. "Wirtschaftslehre des Forstwesens," Berlin.

LEMMEL, H., 1956. "Forstliche Vermögens- und Erfolgsrechnung," Schriftenr. d. Forstl. Fak. d. Univ., Göttingen.

MANTEL, W., 1962. "Waldbewertung," München.

MISCELLANEOUS

"Fortschritte in der Forstwirtschaft," Herausgeber: F. Bauer; München, Basel, Wien, 1960.

"Grundlagen der Forstwirtschaft," Herausgeber: H. Muller; Hannover, 1959.