

Bibliography, AUSTRIA**Georg Frank**

Frank G. (1991): The Primary Forest "Selkacher Teil" in the Karawanken Mountains - a Vegetational and Silvicultural Analysis. (Der Urwald "Selkacher Teil" in den Karawanken - Eine vegetationskundliche und waldbauliche Analyse) In: Naturschutz in Kärnten Vol. 12. Edited by Amt der Kärntner Landesregierung.

Abstract: In the rest of primary forest "Selkacher Teil" on the north side of the Kahlkogel in the mountain range "Karawanken" seven clearly differentiated mountain forest communities could be identified, mapped and studied. *Lamias troflavidi-* (*Abieti*) *Fagetum petasiticosum*, *Anemone trifoliae-* (*Abieti*) *Fagetum* with the sub-associations *petasiticosum*, *typicum* (*Cardamine trifoliae*, *Helleborus niger-* and *Adenostyles glabra* types) *calamagrostietosum varia* and *ericetosum*. Stand types range from almost pure closed beech stands of the close stand forest communities, types with a high number of firs to incomplete wooded perpetual communities characterized by a limited growth with beeches not being able to compete with the admixed tree species anymore. A combined analysis of regeneration and damage by game was carried out. Just like in other rests of primary forests in Central Europe the continuity of the primary forest dynamics is not given anymore due to the severe damage caused by game. Fencing of the reserve is the only safe method taking immediate effect to preserve it for future generations in an undisturbed state.

Key-words: Stand characteristics, diameter distribution, natural regeneration, species composition, forest structure, game-damage

Frank G. (1998): Forest Reserves and Biological Diversity (Naturwaldreservate und biologische Diversität) In: Geburek Th., Heinze B. (ed.): Erhaltung genetischer Ressourcen im Wald - Normen, Programme, Maßnahmen. Ecomed-Verlagsgesellschaft, Landsberg, 205 - 238.

Abstract: A critical view on how forest reserves can contribute to maintaining biodiversity is presented. The experience gained in the planning and implementing phase of the Austrian Forest Reserves Programme has been taken into consideration. A series of international conventions, resolutions and political commitments under international law are intended for the *in situ* maintenance strategies. As far as the extension of the Austrian forest reserves network is concerned, the agreements of the Ministerial Conference on the Protection of Forests in Europe (particularly the Helsinki Resolution H2 "General Guidelines for the Conservation of the Biodiversity of European Forests") are of crucial significance. The following criteria will be decisive for the success of a forest reserves network: minimum size, number and distribution, representativity, and several other quality features. The determination of area according to exclusively zoological criteria has been proven to be ineffective. For the conception of the network the minimum structural area (Koop 1982, 1989) - since this parameter is exclusively dependent on natural forest communities - has been chosen as the basis for the determination of the minimum size. The assessment of the minimum area of forest reserves on the basis of genetically effective population size of forest trees leads to a minimum area a bit larger than the above one. This minimum areas are largely dependent on the tree species of the natural forest communities. Objective of a conservation strategy cannot be the protection of the entire biodiversity in some areas by completely protecting the areas, but the maintenance of threshold values of biodiversity in the forest area in total. Forest reserves form an essential part of the coherent strategy for the maintenance of biodiversity of forests. However, they must not be regarded as isolated islands but as embedded in managed forests and other vegetational formations by a close-to-nature management. Maintaining biodiversity by the use of forest reserves and other protection areas is an important short-time step but will not be sufficient to solve the problem of biodiversity conservation. In addition to these measures, a management strategy is required which considers biodiversity apart from other components equally important for forest sustainability.

Key-words: Biodiversity of forests, strict forest reserves, minimum area, development phases, genetical diversity, networks

Fröhlich J. (1951): Praxis of virgin forests. Experiences and conclusions of 40 years (Urwaldpraxis. 40jährige Erfahrungen und Lehren) Neumann Verlag. Radebühl and Berlin.

Abstract: For over 40 years the author was involved in the drawing up of forest management schemes which have been the basis of assessment of expected yield of former southeastern European virgin forests. He got to know and documented most of the still existing virgin forests of the Balkans and Carpathians as well as Abyssinia and Northwestern Anatolia. This report we owe the most detailed authentic description of exploitation of the southeastern European virgin forests still in this century, as well as a large number of hints e.g. original game population density, but also serious data of composition and structure and even dynamics of the former virgin forests.

Key-words: Virgin forests, forest exploitation, forest history, game population, natural regeneration, forest dynamics.

Grabherr G., Koch G., Kirchmeir H., Reiter K. (1998): Hemeroby of Austrian Forest Ecosystems (Hemerobie österreichischer Waldökosysteme) Österreichische Akademie der Wissenschaften. Veröffentlichungen des Österreichischen MaB-Programms 17, 493 pp.

Abstract: Austria is a Central European forest land whose forests cover nearly 50 % of its territory. Regional studies and experience gained from Austria's long tradition in nature conservation and silviculture led to the assumption that a relatively large proportion of the country's forests are in a seminatural state and that these ecosystems represent one of the most wide-ranging and valuable natural habitats in Central Europe. From the silvicultural and nature conservation perspective, the following question has become increasingly acute: To what degree or in what intensity have human beings influenced the forest ecosystems and how natural are Austria's forests today? The MAB project "Hemeroby of Austrian forest ecosystems" was designed to provide a survey of the naturalness of the Austrian forest as a whole, as well as of particular regions. In order to determine the hemeroby or naturalness of native forests, the effect of forest cropping, forest grazing, game management, tourism and other forms of forest use were analysed. A special catalogue of criteria was developed for this evaluation. It includes individual features such as current and potential tree composition, ground vegetation coverage taking disturbance indicators into consideration, amount and quality of dead wood, intensity of utilisation and others. Using the method of logical combination the single characters are aggregated to a synoptic value referring to the degree of hemeroby of the site. The results of the hemeroby study were extrapolated from the subsamples to the forest surface based on statistical procedures and a Geographic Information System (GIS). As it's clearly shown in the results, more than 20 % of the Austrian forests can be classified as seminatural or natural. Such natural forests are mostly located in the Inner Alps as well as in the Northern and Southern Limestone Alps. "Moderately altered" forests make up a distinctly larger proportion of 41 %. These forests are all commercially exploited, yet the potential natural vegetation is at least partly present. 27 % of the forests were classified as being "altered" and 7 % as "artificial". These stands are subject to intensive exploitation and the tree species composition does not reflect the original natural conditions. This study confirmed the assumption that the degree of naturalness of Austria's forests is still relatively high. Nonetheless, the proportion of primeval forests is low. On the other hand, the contribution of hemerobic forests in sites favourable to agriculture and forestry is high. However, stands which still retain features of the Potential Natural Forest Vegetation can be found in every part of the country.

Key-words: Hemeroby, naturalness, ecoregions, potential natural vegetation, forest classification, species composition

Kilian W., Müller F., Starlinger F. (1994): The Forest Ecoregions of Austria. A Landclassification based on Forest Ecology (Die forstlichen Wuchsgebiete Österreichs. Eine Naturraumgliederung nach waldökologischen Gesichtspunkten) Austrian Forest Research Center Vienna, Report 82/1994.

Abstract: In order to standardise several different systems of land units which have so far been used side by side in the Austrian forestry a new classification is presented. As highest ranking site units the ecoregions are to serve as a basis of regional planning, statistical forestry inventory, monitoring networks, of an ecologically oriented silviculture and a delimitation of the provenance areas of forestry seeds. 22 ecoregions are distinguished, with special regard to the regional climate and to the woodland communities that prevail due to these climatic conditions and combined to form 9 principal ecoregions. Within the ecoregions 7 altitudinal zones, representing three the altitudinal belts, are distinguished from phytocoenological and climatical points of view. The descriptions of the individual ecoregions include information on the old classification system, about locations and altitudinal extension, limit values of the borderline of the altitudinal zones as well as chapters dealing with climate, geomorphology, soils and natural woodland communities.

Key-words: Ecoregions, altitudinal zones, climate, forest soils, natural woodland communities, forest landscape

Koch G., Wallnöfer S. (1997): (Vegetationskundliches Monitoring in Waldökosystemen) In: Traxler A. (1997), Handbuch des Vegetationsökologischen Monitorings. Methoden, Praxis, angewandte Projekte, Teil A: Methoden. UBA-Monographien Vol. 89A, Wien, 280-320.

Abstract: In this article the methods, i.e. the tools, of vegetation monitoring will be described with the aim of standardising the methods used and giving new momentum to the various activities carried out in this field. Comprehensive description and discussion of the most commonly applied monitoring methods, and the establishing of the Austrian Register of Permanent Plots shall help achieve this goal. The study is intended for scientists and experts an applied ecology with little experience on how to carry out vegetation monitoring projects. In describing the methods special emphasis was laid on the practical aspects of their application, a topic which is hardly ever treated to the necessary extent in the relevant publications. Monitoring in forests allows representative statements on the environmental conditions and their alterations, as forests are well balanced and natural ecosystems. Therefore, many monitoring programmes in forests deal with the observation of the environment and forest damages. The Austrian Forest Inventory (Österreichische Waldinventur), a programme with over 10.000 permanent plots, performed by the Federal Forest Research Centre Vienna (Forstliche Bundesversuchsanstalt) since 1961, deals with research on forest management. Besides, there are experiments on soil fertilisation and investigations of forest regeneration. Another point of interest are vegetation dynamics, which are mainly investigated in forests no longer managed (Strict Forest Reserves). The "Naturraum-Stichprobeninventur" in the National Park "Limestone Alps" (Nationalpark Kalkalpen) and the Man and the Biosphere-Project "The Hemeroby of Austrian Forest Ecosystems" deal with aspects of nature conservation. Among the parameters investigated, the emphasis was placed on woody plants, which determine the structure, growth rate and regeneration of the forest and show the extent of forest damage. The ground vegetation reflects, for instance, the amount of pollutants and direct human impact. Epiphytic mosses and lichens are good indicators for air pollutants. Furthermore structural parameters (e.g. structure of forests, dead wood) and parameters concerning the site (e.g. soil) are recorded. Sampling is carried out either by means of regular grid, a method for stratification or according to subjective criteria. The design of permanent plots depends on the investigation method. In determining the frequency of recordings it should be considered that changes in the canopy take much more time than changes in the ground vegetation.

Key-words: Vegetation monitoring, monitoring methods, sample plot, monitoring handbook, vegetation ecology, forest inventory

Kral F., Mayer H. (1968): Evaluation of virgin forest character of the strict forest reserves Rothwald and Neuwald (Lower Austrian limestone Alps). (Pollenanalytische Überprüfung des Urwaldcharakters in den Naturwaldreservaten Rothwald und Neuwald [Niederösterreichische Kalkalpen]). Forstwissenschaftliches Centralblatt 87/3, 129-192.

Abstract: Using methods of pollen analysis the characteristics of both virgin forest have been checked by a reconstruction of its compositional and structural development. Profiles of raw humus and bogs reflect in many details the development of the local forest community over the post glacial period. Their interpretation assumes a serious knowledge of ecology of forest communities, a critical assessment of the proportions of pollen local resp. regional origin as well as detailed knowledge of local proportions of climax tree species. The local pollen profiles don't show - contrary to the regional human influenced forest history - an abrupt successional break of the climax tree species. *Abies* shows a fine scaled indicator for anthropogenic influence. In the immediate vicinity of the stands no historic exploitation could be shown by using pollen analysis. Considering archival investigations and the recent structure of stands one might conclude that both stands are primeval untouched virgin forests in the coser sense.

Key-words: Pollen analysis, forest history, forest succession, naturalness, virgin forest, species composition

Mayer H., Neumann M. (1981): Stand structure and dynamics in the virgin forests of Rothwald/Lower Austria and in Corkova Uvala/Croatia. (Struktureller und entwicklungsdynamischer Vergleich der Fichten-Tannen-Buchen-Urwälder Rothwald/Niederösterreich und Corcova Uvala/Kroatien) Forstwissenschaftliches Centralblatt 100/2, 111-132.

Abstract: The thrifty mountainous *Abies alba*-*Picea abies*-*Fagus sylvatica* virgin forest reserves of Rothwald/Lower Austria and Corcova Uvala/Plitvicka Jezera - Yugoslavia are situated in limestone mountains, characterized by annual precipitations of over 1750 mm. In both reserves, as a result of similar ecological and sociological conditions, *Asperulo-Abieti-Fagetum cardaminetosum trifoliae* is the typical forest association with subalpine *Piceetum* species in Rothwald and illyric vegetation elements in Corcova Uvala. The "Waldtextur" (distribution of development phases) is nearly balanced in Corkova Uvala, whereas in the Rothwald forest - as a result of its wind-exposed position - this balance has been more strongly disturbed. For these reasons the regeneration phase is the dominant one and the role of natural regeneration is more important than under the rather closed canopy in Corkova Uvala. Nevertheless there is a close analogy in structural and dynamic conditions. Another problem in the Rothwald forest is its large population of game. In spite of sufficient natural regeneration only Beech stands show an uninhibited development; there is much browsing on young spruce trees and nibbling on silver fir is so intensive that especially *Abies alba* has been eliminated for the last 100 years. In Corcova Uvala on the contrary, only a natural game population exists on a size according to the special ecological conditions in this forest. As a consequence, there is only little browsing with varying intensity. In this balanced ecological system natural regeneration is not endangered or even interrupted. According to these facts, virgin forests and natural forest reserves will lose their typical structure and texture, if their excessive hunting-game population cannot be reduced to an ecologically adequate size.

Key words: Stand dynamics, stand structure, natural regeneration, forest disturbances, forest development phases, game population

Mayer H., Schenker, S., Zukrigl K. (1972): The virgin forest Neuwald near Lahnsattel. (Der Urwaldrest Neuwald beim Lahnsattel) Centralblatt f. d. ges. Forstwesen 89/3, 147-190.

Abstract: The wilderness area "Neuwald am Lahnsattel" in Lower Austria may, on the basis of pollenanalytical investigations, be regarded as virgin forest in its strict sense even through the natural vegetational dynamics is today disturbed because of the small size of the area and because of an overly high game population during the last decades. Five sociologically-ecologically clearly differentiated forest associations (*Abieti-Fagetum adenostyletosum glabrae*, *Abieti-Fagetum cardaminetosum trifoliae*, *Abietetum equisetetosum sylvaticae*, *Adenostylo glabrae-Piceetum montanum asplenetosum*, *Oxali-Piceetum montanum alnetosum incanae*) comprise the reservation which is thus characteristic of the spruce-fir-beech forests of the northeastern outskirts of the Alps. The vegetational associations are diverse with regard to tree species composition, growth potential, growth relations, tree-number distribution, structure of growing stock, stratification, form and development dynamics and therefore the sociological-ecological characterization of the associations distinguishes at the same time differentiated silvicultural treatment units. As the early to late terminal phases dominate in the reservation and regenerative and initial phases are almost completely absent, no continuous developmental dynamic prevails. Only after a suitable solution of the game question the differentiated natural regeneration of the various sites may be secured and the reservation preserved for extended periods. The reservation is to be considered a unique natural laboratory where insight into the natural automatization of production may be gained by repeated observations and by comparison with other reservations. A closer insight into the natural development dynamics will allow to realize the combined productive and social functions in our managed forests with a minimum of regulating measures.

Key-words: Natural regeneration, stand structure, stand dynamics, forest communities, pollenanalysis, game population

Mayer H., Reimoser F. (1978): Effects of elm disease in the beech virgin forest of Dobra. (Die Auswirkungen des Ulmensterbens im Buchen-Naturwaldreservat Dobra [Niederösterreichisches Waldviertel]) Forstwissenschaftliches Centralblatt 97/6, 314-321.

Abstract: The predominant plant society in the virgin forest of Dobra (Lower Austria) is formed by extremely well-growing *Dentario bulbiferae-Fagetum*, whereas *Aceri-Tiliatum* only occupies a small area on a rocky site. According to inventory results of 1970, the dominant terminal- and disintegration-phases were characterized by a low number of stems (209/ha) combined with a high growing stock (700 Vfm) due to excellent height growth and radial increment (- 150 cm diameter, - 43 m high) of *Fagus sylvatica*, *Ulmus glabra* and *Tilia platyphyllos*. All elms exceeding 38 cm DBH died till autumn 1977, attacked since 1974 by the more aggressive race of *Ceratocystis ulmi*, which first appeared in England since 1972. Owing to the loss of *Ulmus glabra* as admixed tree species and an important decrease of growing stock (189 Vfm = 28 %) the natural reserve's decay will be accelerated. Thick shrub vegetation with *Sambucus nigra* develops in the opened up stand which cannot be colonized by *Fagus sylvatica* for ecological conditions. *Ulmus glabra* as a specialist for regeneration in the "Hochstauden"-vegetation had developed pioneer stands. Under the canopy of elm overwood climax stands of *Fagus sylvatica* had been enabled to grow very well. For this reason phases of open field will dominate for some time. The present epidemic elm disease affects even virgin forests with natural stands of high vitality and excellent growth capacity.

Key-words: *Ceratocystis ulmi*, dutch elm disease, natural regeneration, mortality, forest development phases, forest dynamics

Mayer H., Tichy, K. (1979): The oak-nature conservation area Johannser Kogel in the game park of Lainz in the Vienna-forests. (Das Eichen-Naturschutzgebiet Johannser Kogel im Lainzer Tiergarten, Wienerwald) Centralblatt ges. Forstwesen 96, 193-226.

Abstract: Several subassociations of *Quercus-Carpinetum* (European oak hornbeam-association)

dominate in the nature conservation area Johannser Kogel in the Vienna forests. An analysis of the stand structure showed an advanced development stage with terminal and disintegration phases to be typical. The 200-400 years old oak trees in the overstorey are overmature with reduced vitality and increasing mortality. Young growth of hornbeam begins to reach the middle and upper story in most of the area. The different phases in the preserve illustrate the conversion of the oak climax forest into a hornbeam association. There is no natural regeneration of *Quercus petraea* and only little of *Quercus cerris* due to high game population. 200 years ago, at the time when the old oak trees grew up, the Lainzer Tiergarten was not fenced and game population was lower, whereas today natural regeneration of oak stands is impossible without fence.

Key-words: *Quercus petraea*, *Quercus cerris*, natural regeneration, forest development phases, game population, forest history

Mayer H. (1969): Structure and silvicultural assessment of the forest reserve Freyensteiner Donauwald (Aufbau und waldbauliche Beurteilung des Naturwaldreservates Freyensteiner Donauwald) Centralblatt. ges. Forstwesen 86, 161-183, 219-253.

Abstract: Within the natural forest reserve there are, on a relatively limited area, ten silvicultural treatment units well differentiated both sociologically and ecologically. Apart from the leading community rich in beech there are remarkable: heavily mixed transitional stands near to climax, multifarious forests of valuable broad-leaved species, a relict spruce-firewood community, and a natural larch stand at the point of being extinguished. Pollen analysis of raw humus profiles gave evidence of twice-repeated exploitation, thus the present standing crop represents second growth after natural forest, having arisen by natural regeneration. The various stand types are described as to structure of growing stock, and stands, special quality characteristics (stratification, vitality, crown and bole quality), growth production, mortality, and distribution. There upon is based a local silvicultural assessment of the most important tree-species characterizing the stands. The inventory of the natural forest reservation gives instructive insights into the natural development tendency of forest communities rich in broad-leaved species. Considering the local productivity and yielding power of stands, it allows at the same time to assess the decline in volume and financial yields caused by omitted tending of woods. For the silvicultural treatment of commercial and productive forests on comparable sites the observation of permanent plots will give valuable hints. Considering the manifold importance of natural forest reservations, a systematic establishment of forest reservations for all important site units and forest communities of the Austrian forest would be desirable.

Key-words: Species composition, forest association, stand types, pollen analysis, forest dynamics, silviculture

Mayer H. (1975): The influence of game on the natural regeneration and maintenance of natural forest reserves. (Der Einfluß des Schalenwildes auf die Verjüngung und Erhaltung von Naturwaldreservaten). Forstwiss. Centralbl. 94, 209-244.

Abstract: The natural alteration of generations can be reached by a surprisingly low number of individual trees if there is an ecological balance and a natural wood structure. The natural number of game does not influence the process of regeneration to a high degree. An unnaturally high number of game, the optimum from the hunter's point of view, has an immediate and extreme effect on the process of regeneration by exerting a high selective influence on the regeneration which may even reach a degree that entails the complete elimination of the natural reproductive ability. Therefore a mere passive protection of natural forest reserves is not enough. In the Central European land cultivated by man as a consequence of one-sided game keeping the unnatural game factor has to be compensated by a considerable reduction of game (or fencing of the reserves) in order to counteract the slow and continuous loss of ecological substance of the reserves. If the damage caused by game is not eliminated not only the existence of the few rests of natural forests will be endangered or even destroyed, but also, on top of that, in the mountains

large areas of protection forests will collapse within a short period of time as a consequence of the elimination of natural regeneration. Damage caused by erosion, avalanches, rock fall, or mud flows can develop to catastrophes, so that every effort has to be made to find a solution to this question (Leibundgut 1961, 1973; Mayer 1973, 1975). Waiting inactively in this matter not only endangers nature, but is also threatening life in mountainous countries.

Key-words: Game population, natural regeneration, browsing, forest dynamics

Mayer H., Zukrigl K., Schrempf W., Schlager G. (eds.): (1987): Natural Forests in Austria (Naturwälder in Österreich) Institut für Waldbau, Universität für Bodenkultur, Wien.

Abstract: The catalogue of virgin forests, strict forest reserves and protectible natural forests is the result of three decades of regorous work. Already during the inventory of the most important forest communities (Mayer 1973) the idea was born to develop forest reserves, representative of all mayor forest communities, both to preserve unic nature monuments as well as to establish compareable areas to be used for the assessment of environmental influences and silvicultural treatments. In this compendium all research papers about reserves published until 1987 are collected in a clear form. This collective account represents the outcome of natural forest research in Austria up to 1987.

Key-words: Virgin forests, forest reserves, nature protection, silviculture, forest dynamics, forest structure

Schrempf W. (1978): Analysis of natural regeneration in the mixed spruce-fir-beech virgin forest Rothwald in Lower Austria (Analyse der Verjüngung im Fichten-Tannen-Buchen-Urwald Rothwald in Niederösterreich) Centralblatt f. d. gesamte Forstwesen 95/4, 217-245.

Abstract: On one part of the primary forest Rothwald with carbonate-spruce-fir-beech forests a regeneration inventory and an analysis of the damage by deer were carried out. The prerequisites for regeneration continuity are met by the abundantly fructifying old trees, the differentiated structure and ecological diversity in terms of regeneration as well as the fact that there are no especially extreme ecological conditions. Approximately 2000 (individual trees/ha) are sufficient for the regeneration, with beeches being overrepresented in comparison to the old forest, and the occurrence of firs, and to some extent also spruces, being below average. Small sites with a variety of ecological conditions (e.g. mixed herb type) reach the highest rates of regeneration (32000/ha). Between the phases of stand development minor differences in young natural reproduction are registered. The optimum of regeneration lies at medium degree of sheltering (0,5 - 0,7). As regeneration is developing, considerable selective damage by game occurs, entailing that the mixed forest is becoming a more or less pure forest. While beeches are hardly affected by damage caused by game and also firs are capable of penetrating the lower stratum, the damage caused by game is so severe that no fir exceeding a height of 50 cm could be registered (see picture 12). According to the quantitive development of trees, especially as far as the lower stratum is concerned, in terms of age analysis in primary forests firs have not formed part of the development dynamics of the natural forest for about 100 years. Only an adequate reduction of the hoofed game could restore the development ability of firs, as above all due to the considerable depth of snow in winter fencing is out of question.

Key-words: Natural regeneration, game population, virgin forest, forest dynamics

Zukrigl K., Nather J., Eckhart G. (1963): Ecological and Silvicultural Studies in Virgin Forest Relicts of the Lower Austrian Calcareous Alps (Standortliche und waldbauliche Untersuchungen in Urwaldresten der niederösterreichischen Kalkalpen) Mitteilungen der Forstlichen Bundesversuchsanstalt Mariabrunn 62. Wien.

Abstract: The plant sociology and the site conditions of two relicts of the virgin forests formerly covering the Calcareous Alps of Lower Austria have been studied and compared with those of adjacent managed forests. One of the relicts, the so called "Rothwald", is the largest virgin forest

in Central Europe covering about 300 ha, not coherently but in two parcels of different size. The other one is situated in the "Neuwald" and covers 21 ha.

The climate belongs to that of the humid northern rim of the Alps, having very high precipitation (exceeding 2000 mm) and a mean annual temperature of 3.5°C. Microclimatical measurements were made within the virgin forest, the managed forest and open places.

The parent rock is formed mainly by Dachstein-limestone, in the "Neuwald" also "Werfener Schichten" are present. Among the soils, terra fusca is predominant. At level sites, it is frequently gleyed by rain-water, heavily acidified and podzolized, but it is passing to mould colluvials at slopes.

The natural forest association is the beech-fir-spruce-forest of the high-montane zone of the Northeastern alps (*Abieto-Fagetum austriacum*), with a very variable stand structure. Fir is predominant in volume, producing like spruce enormous dimensions. Beech dominates in the number of trees and in regeneration, representing mainly the understory. Spruce regenerates well on fallen trunks and on raw humus.

Fir regeneration is abundant but almost completely destroyed by deer browsing. Pure spruce stands as a climax forest type grow only close to the timberline and on extreme sites such as block fields, screens and rocks. At high altitudes up to about 1400 m beech is more abundant than in the low basin.

There is no essential difference in plant sociology between the virgin forest and the comparable forests under management.

Using a "combined procedure" forest site unites were separated. In most cases, soil and vegetation form in mosaics. The vegetation units, characterized by local ecological groups of species and obtained by table analysis, can be assigned directly to site units. Substitute plant associations as arising after clear cutting have been described.

The influence of individual tree species upon the soil has been studied in the virgin forest as well as in the managed spruce forest on hand of thoroughly analysed soil profiles. Even in the virgin forest, most unfavourable soil conditions were found on some places as a dynamic balance. On the whole however, optimal conditions were present. The individual tree species differ in their ability to lift nutrients and to produce humus. Beech seems to be the most favourable species in this respect, spruce the least favourable one. Fir appears but little superior to spruce in lifting nutrients, but it is more able to grow on compact and water logged soils.

Under the first generation of a managed spruce forest, about 90 years old and still healthy, there was to observe a marked enforcement of podzolic dynamics, caused by the enforced pressure on the upper soil with the result of increasing water stagnation, by an essential poorer lifting of nutrients, and, above all, by a notable change of the humus conditions for the worse.

In the "Kleiner Urwald", the smaller part of the Rothwald, stand conditions were analysed by means of a sampling inventory. About 2400 trees were sampled on 237 plots, each 400 m² in size.

No relation could be found between "site" (ground vegetation) and state of regeneration. Spruce and fir show an irregular distribution of the number of stems within the small diameter classes (14, 18 cm DBH). The growing stock is ca. 630 cubic meters per ha, all three tree species represented at almost equal portions. The rate of growth is only 0.75 per cent.

The structure of the size was analysed in details by a separate strip survey. From the different phases of development occurring in the stand, attention is focused to the phases of regeneration, selection, formation of crown layers, and disintegration. Apart from the predominating storied stand structure, some other possibilities of development can be recognized, such as regeneration - selection - disintegration. The characteristics of the stand structure are explained by dividing the stand into three storeys. Characteristics of the tree species are: the distribution of the number of stems among storeys and diameter classes, the number of suppressed trees within storeys and diameter classes, the passing over into the next following storey from a certain diameter class on, and the overlapping of storeys within certain diameter classes. The average current diameter-

increment of spruce and fir has been determined for the period of 1950-1959. Between comparable trees of different storeys there are only slight differences in increment, they are, however, very clearly between suppressed trees and those which are free on all sides.

In the study of regeneration, light measurements were of primary interest. Daily light sums, light maximi, and duration of the different light intensities were recorded on five plots. With additional series of measurements made by hand on several points, it was possible to get an overall view of the plane distribution of light intensity within the stand.

Next it was tried to show correlations between the disintegration and the regeneration of the forest, on the basis of its course of life. Discourses about the regeneration of beech, fir, and spruce point out the differing requirements of this species. It is supposed, that under this cool and moist climate with a short growing period, a considerable amount of light intensity and heat is found in openings. Here, also the conifer seedlings are able to maintain against abundant undergrowth of beech.

As far as stem quality is concerned: no selection of stem forms according to economical aspects takes place. Only the "species" or the "race" resp. with its specific qualities is responsible for the portion of well formed stems.

An investigation of the increment within the three stand-storeys shows that trees with large crowns are superior to those with small ones, even among the dominant trees

An annual ring analysis, carried out on 114 firs, is currently under evaluation. Details will be published later.

Key-words: Natural forest association, stand structure, forest dynamics, natural regeneration, forest development phases, light conditions

Zukrigl K. (1990): Natural forest reserves in Austria. (Naturwaldreservate in Österreich. Stand und neu aufgenommene Flächen) Umweltbundesamt, Monographien 21, 232. Wien.

Abstract: Natural forest reserves are defined as "those areas of a forest which by the composition of the tree species and stand structure represent the original state of vegetation particularly well or which are likely to fulfill these conditions in the foreseeable future and where changes of any kind have to be prevented on principle".

In the first place, such reserves serve forest research, which deducts the composition and development of forest untouched by man as guidelines for natural silviculture. They are also of use to other branches of scientific field observation. As complete forest ecosystems (including "dead wood") they are of great value to the task of nature protection. They also serve as subjects for instruction and observation.

For approximately 25 years the Institute of Silviculture at the University of Agriculture and Forestry of Vienna and later also the author of this study have worked on the development of a network of natural forest reserves (resp. natural forest "cells") in Austria. This network is intended to represent all forest communities that are considered to be important as natural forest reserves. The ecological conditions of these stands are also very variable, from real virgin forests to forests which have developed naturally after an initial complete deforestation ("secondary virgin forest") down to hitherto cultivated forest and heavily pastured land. (The latter are of value as natural reserves only when it becomes possible to protect parts of them from grazing.) In most cases natural regeneration suffers because of browsing by game. Consequently, the preservation of reserves appears to be endangered in the long run and a real natural forest development can only take place behind fences or after drastic regulations of deer numbers. The fencing in of partial areas at least is an important requirement which would justify the use of public means. In many cases (e.g. steep slopes with thick snow cover) it is technically almost impossible. Naturally reserves are not exempt from immission either.

Existing or specifically projected reserves are listed with a short description and a specific bibliography, and their distribution is shown on a map. 15 natural forest "cells" in the Tyrol and 6 natural forest reserves from other federal states are described in varying detail and at different

lengths mainly concerning their flora and stand structure. Most areas in the Tyrol comprise the transitional zones from the lower to the high subalpine regions, that is, from spruce to stone pine (*Pinus cembra*) and larch forests.

Key-words: Forest reserves network, strict forest reserves, nature protection