

# Management options in mixed mountain forests of the Bavarian Alps

Hany El Kateb, Christian Ammer, Joachim Schmerbeck and Reinhard Mosandl

*Chair of Silviculture and Forest Management, Technische Universität München, Am Hochanger 13, 85354 Freising, Germany, email: mosandl@wbfe.forst.tu-muenchen.de*

---

A comprehensive study on management of mixed mountain forests was initiated 27 years ago in the eastern Bavarian Alps. The main tree species of these forests are spruce, fir, beech, and maple. The study included 25 permanent plots of 0,5 ha in size. These were located in blocks, which differed in geology (Hauptdolomit and Fylsch formations), altitude (800 - 1250 m), and aspect (northwest, north, south, and west). The age of the stands investigated ranged from 100 to 150 years. Based on the reduction of the initial-stand basal area, five different management options were practiced. These were: control (non-intervention), light shelterwood cut (30% reduction of the basal area), heavy shelterwood cut (50% reduction of the basal area), clear cut (removing 100% of the mature stand), and group selection (removing 100% of the mature stand within a circular of 30 m diameter). Further management options pertaining to the regeneration were involved, including fencing, and soil cultivation. Two-thirds of the area of each plot were permanently fenced in order to investigate the impact of game browsing on the regeneration. One-third of the plot within the fenced area received soil cultivation to advance germination.

A wide range of data was collected from each plot including measurements on soil, bioclimatic conditions, stand characteristics, seed and litter fall, regeneration, and competing ground vegetation. Information on litter and seed fall was gained from installed 30 litter traps on each plot. Measurements related to the regeneration and ground vegetation were based on 96 circular plots of 1 m<sup>2</sup> in size. The data was collected over several years of observation. The most recent was in autumn 2003, which was followed by a second reduction of the basal area of the shelterwood plots. The acquired information was used to judge the different silvicultural management-options.

Plots received the management option "non-intervention" was at disadvantage. The survival as well as the relative growth rate of the mature stands on the control plots were lower than those on the shelterwood plots. The mortality of the understory trees was high in the control plots, resulting in less structured stands as the age increased. Stability was substantial for stands receiving slight intervention. Stands on the heavy shelterwood plots were at higher risk for windthrow.

Gaps resulting from the death of individual trees in the dense control plots were too small to improve the light environment at a level, at which the survival of regeneration

can proceed. Only shade tolerant species could survive. In contrast, opening up the canopy improved the establishment of the regeneration with tree species composition analogous to that of the mature stand. The survival, density, growth, and biomass production of the regeneration were dependent on the degree of opening up the crown layer. The same was valid for the biodiversity. However, opening up the canopy improves the condition for the establishment of the competing ground vegetation. The time for intervention to take place is therefore meaningful, particularly when a clear cut or a group selection technique is employed. To avoid the dominance of undesired ground vegetation and the subsequent long regeneration period, an intervention should only be carried out when sufficient density of the regeneration on the forest floor is available or when fructification is indicated for the species of interest. A safe technique is a slight opening up of the canopy with the goal of improving the light conditions for the survival of regeneration. When the regeneration is established, a further intervention can be carried out to improve the growth of the regeneration. Using such goal-directed interventions, the long regeneration period can be considerably curtailed. In addition, income can be generated from harvested trees. Felling and skidding did not significantly affect the regeneration. Irrespective of the intensity of an intervention, a limiting factor, which hampers the regeneration development in the investigated forests, is game browsing. Successful management depends on the control of this factor. Contrarily, soil cultivation proved to be superfluous.

Depending on the management goal, diverse management options in mixed mountain forests can be practiced. Silvicultural systems, which focus on stand stability and vitality as well as securing adequate regeneration, are appropriate for the management of mixed mountain forests. Non-intervention or preservation as an option in these forests should only be considered when a decisive rationale, whether ecological or economical, is given.