

Restoration of Degraded Forest Sites by Reintroduction of Ecologically Valuable Tree Species – An Amelioration Project Based on Ecological Site Analysis



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Objectives

Many forest ecosystems in Austria were heavily affected by historic land use, like litter raking, and by uniform forest management, which has led to a widespread establishment of spruce monocultures far beyond their ecological range. Consequently soil fertility in these man-made forests was reduced, due to the impoverishment of nutrients and to retarded nutrient turn-over rates. Sustainable amelioration of these sites can only be achieved by changing forest management, like conversion of these unstable plantations, by introduction of ecologically valuable tree species beneath the canopies of the old spruce trees. Because of the severity of the degradation, however, this kind of silvicultural restoration may be subject to ecological constraints.



Figure 1: Study site „Hirschenwies“

The amelioration area (50 ha) is located near Weitra, Lower Austria at 850 m a.s.l. and is managed by a private forest company. The bedrock is granite, prevailing soil types range from Humic Cambisol to Podzol. The potential natural vegetation is a *Galio hircynici-Piceetum*. In this uniform 100- to 120-year-old Norway spruce stand, the canopy closure was opened up to enhance the growth of the introduced tree species (Figure 1).

Based upon varying soil depth, relief form, soil type and different intensity of historic land-use three site units were classified (Table 1), which are to be managed in different ways.

The site units, especially site unit S3, have been heavily affected by litter raking and charcoal production. The intensive biomass depletion has led to considerable acidification of the top soil (pH-values [CaCl₂] range from 2.7 to 4.0), impoverishment of nutrients and a low cation exchange capacity (CEC). The concentration of acid-extractable calcium of the site units hardly exceeds the 10-percentile of 360 sample plots on non-calcaric substrates of the Austrian Forest Soil Monitoring System (FBVA 1992; see figure 3). The biogeochemical nutrient cycle is severely disturbed, the nutrients being accumulated in the ecto-humus layers. Nutrient analyses of mineral soil and needles indicate a lack of magnesium and calcium.

Table 1: Site units of the amelioration area

(growth region: 9.2 (Waldviertel), altitudinal zone: montane (Kilian et al. 1994))

site unit	soil water regime*	nutrient regime*	soil type (FAO-Unesco 1988)	potential natural forest community	relief	soil depth [cm]
S1	fresh	very poor	Humic Cambisol/ Cambic Podzol	Calamagrostio villosae-Fagetum	Ridge/ upper slope	0-15 (50)
S2	fresh – moist	very poor	Humic Cambisol/ Cambic Podzol	Calamagrostio villosae-Fagetum	slope	>120
S3	fresh	very poor	Cambic Podzol- Haplic Podzol	Calamagrostio villosae-Fagetum	plateau	60–120

* classified according to Pyatt (1995)

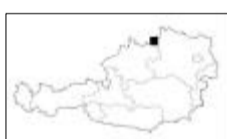
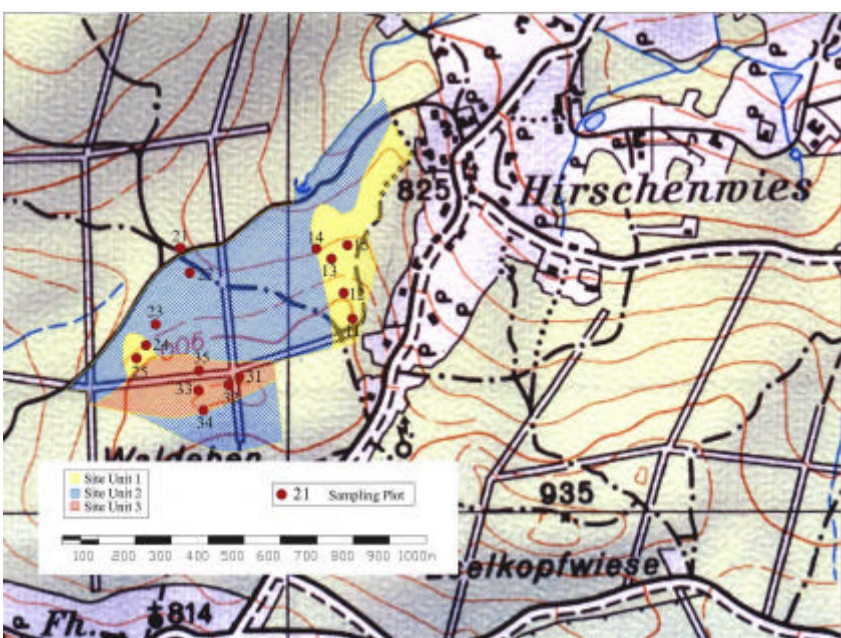


Figure 2:

Site units and sampling plots.

Map based on Österreichische Karte 1:50.000, Blatt 17, BA. f. Eich- und Vermessungswesen.

Silvicultural Restoration

The main objective is to stimulate the nutrient cycle of those sites by introduction of tree species with high amelioration potential (*Acer pseudoplatanus*, *Sorbus aucuparia*, *Fagus sylvatica*, *Abies alba*). These species are expected to exploit deeper soil horizons, thus gathering base cations and consequently increasing base saturation in the upper soil horizons (Nebe 1995, Weihs 1995). The site units are underplanted as follows (relative proportions) :

Site unit 1:

Acer pseudoplatanus (0,4), *Fagus sylvatica* (0,2), *Abies alba* (0,4), *Sorbus aucuparia*.

Site unit 2:

Acer pseudoplatanus (0,3), *Fagus sylvatica* (0,3), *Abies alba* (0,4). The broader ecological amplitude allows a larger liberty in forest management (e.g. a higher portion of natural regeneration of *Picea abies*) .

Site unit 3:

Acer pseudoplatanus (0,2), *Sorbus aucuparia* (0,2), *Fagus sylvatica* (0,3), *Abies alba* (0,3). For *Acer pseudoplatanus* and *Fagus sylvatica* plant hole preparation with a Mg-rich fertilizer is necessary.

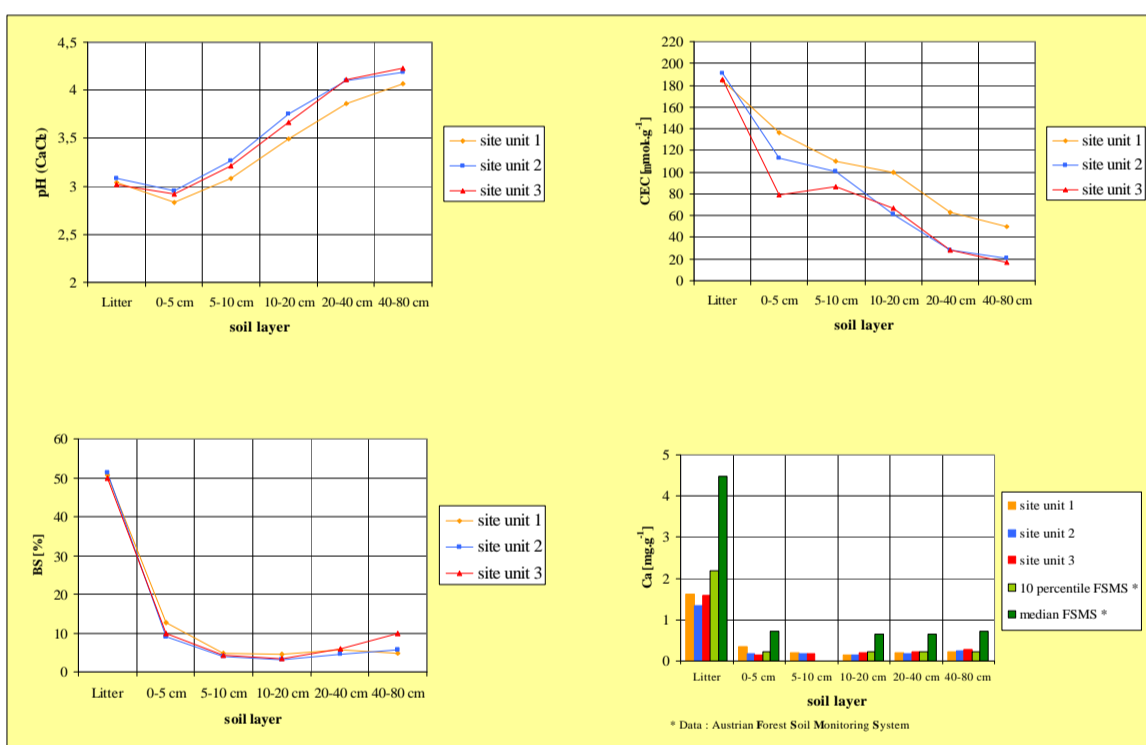


Figure 3: Main soil characteristics of the site units (pH: pH in CaCl₂, BS: Base Saturation, CEC: Cation Exchange Capacity, Ca: Concentration of acid-extractable Calcium)

Ongoing Research

In this study it is intended

- to investigate the performance of the introduced tree species under the prevailing environmental conditions, to quantify the influence of nutrition on growth under canopy closure, to generalise site requirements of ecologically valuable tree species (Weber, 1998) and ultimately to develop a management concept for a successful restoration on a regional scale;
- to study long term effects on soil fertility and production potential by monitoring the change in the soil nutrient regime, soil biology and ground vegetation.

Literature

- FAO-Unesco 1988. Soil map of the world. Revised legend. World Soil Resources Report 60, Rome, 119p.
- Forstliche Bundesversuchsanstalt 1992. Österreichische Waldboden-Zustandsinventur. Waldbodenbericht. Mitt. d. Forstl. Bundesversuchsanst. 168/I+II, 247p. Kilian W., Müller F. and Starlinger F. 1994. Die forstlichen Wuchsgebiete Österreichs. Eine Naturraumgliederung nach waldökologischen Gesichtspunkten. FBVA-Berichte 82: 1-60.
- Nebe W. 1998. Zur Ernährung von Birken-, Aspen-, Salweiden –und Ebereschenaufwüchsen im Erzgebirge. In : LÖBF (Hrsg.): Weichhölzer und Sukzessionsdynamik in der naturnahen Waldwirtschaft. Schriftenreihe der Landesanstalt für Ökologie, Bodenordnung und Forsten/Landesamt für Agrarordnung Nordrhein-Westfalen, S. 61-68, Bd. 4.
- Pyatt G. 1995. An ecological site classification for forestry in Great Britain. Research Information Note 260, Research Division of the Forest Authority, Edinburgh, 6 p.
- Weber G. 1998. Wachstum und Ernährungsstatus von jungen Eschen und Bergahornen in Abhängigkeit von der Basen und Aluminium Sättigung und vom Wasserhaushalt natürlicher Böden. Dissertation an der LMU München.
- Weihs U. 1995. Die Eberesche – eine ökologisch wertvolle Baumart bei der Walderneuerung auf Problemstandorten. In : LÖBF (Hrsg.): Weichhölzer und Sukzessionsdynamik in der naturnahen Waldwirtschaft. Schriftenreihe der Landesanstalt für Ökologie, Bodenordnung und Forsten/Landesamt für Agrarordnung.