Conversion of pure Norway spruce stands into mixed stands: Impact of different felling types on understorey vegetation

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Introduction

The conversion of pure, even-aged coniferous stands into ecologically adapted mixed stands is a main goal of modern silvicultural practice in Central Europe. This conversion process will severely affect the biotic and abiotic conditions of forest ecosystems, what was mainly investigated by comparision of pure and mixed stands yet. Thus a large-scale long-term research before-after/control-impact experiment (BACI-type design after BENNETT & ADAMS 2004) with different felling types (single tree selection felling, clear felling) and planting systems (European beech, Douglas fir and natural regeneration of Norway spruce) was established in two Norway spruce stands to investigate the conversion process itself.

The present study focuses on the immediate response of the understorey vegetation to the different disturbance regimes in comparison with the initial state and unmanaged plots.

Results

The DCA-ordination diagram shows (Fig. 2) a site effect along the 1st axis. This effect can mainly be explained by different species dominating on both sites and a higher herb layer species diversity and coverage at study site 1. The 2nd axis represents a disturbance gradient. This is underlined by both the correlation of the 2nd axis with the disturbance gradient and the correlation with the tree layer coverage. Additionally some species (*Carex pilulifera*, *Juncus effusus*, *Epilobium angustifolium*) show a higher affection towards higher disturbance.

The disturbance also has an affect on the species diversity in the herb and shrub layer (Fig. 3). The clear cut plots show the highest diversity in both layers after overcoming the treatment effect in 2004. The higher species number can mainly be explained by the appearance of plants from open sites.

The cover values of both layers (Fig.3) in the manipulated plots exceed the initial ones indicating a higher productivity of the ground flora.

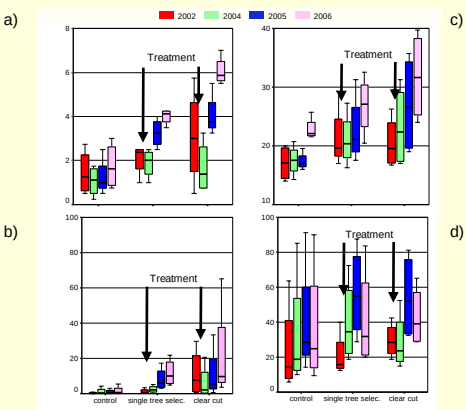

Fig. 3: Species numbers and cover values/100 m² in shrub (a,b) and herb (c,d) layer in the different years of sampling. Shown are mediane, quartile and dezile. Plot value represents mean of 4 control subplots with natural regeneration of Norway spruce. n =4. Observe different scales on the y-axis.

References

Bennett, L.T., Adams, M.A. (2004): Assessment of ecological effects due to forest harvesting: approaches and statistical issues. J. Appl, Ecol. 41: 585-598.

Ellenberg, H., Weber, H.E., Düll, R., Wirth, V., Werner, W. (2001): Zeigerwerte von Pflanzen in Mitteleuropa. Scripta Geobotanica 18. 262 S.

Fig. 1: Images of the differently treated plots: A unmanaged , B single tree selection felling C clear cut

Study site

The two Norway spruce stands are located in the Solling hills (Lower Saxony) between 280 and 500 m. They are characterized by high percipitation (900-1050 mm) and an annual mean temperature around 7 °C. Both sites are formed on Triassic sandstone with loess cover. The stand age varies between 89 and 108 years. The potential natural vegetation at both sites is the Luzulo-Fagetum.

Methods

1 ha plots were established in both stands treated either with clear felling or single tree selection system felling in 2003. The latter treatment resulted in a 7 to 10 % lower tree layer coverage. One plot was left unmanaged (Fig. 1). Each treatment was replicated once per study site. The plots are subdivided into 100 m² subplots. Most of these subplots were planted with different tree species. On unplanted controls (4 subplots per plot) with natural regeneration of Norway spruce vegetation relevées were made before the impact (2002) and after cutting (2004-2006). Vegetation survey was done by making a species list and recording species coverage within different stand layers.

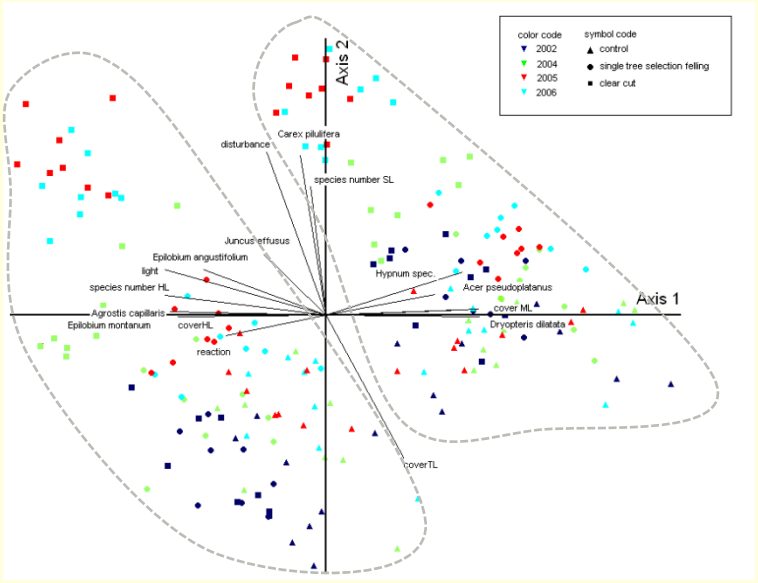

Fig. 2: DCA-ordination of the controls with natural regeneration of Norway spruce over the 4 years of vegetation sampling. Framed are the plots belonging to the different study sites. 1. Axis: length of gradient = 2,08, r² =, 0,25, 2. Axis: length of gradient = 1,64, r² = 0,14, parameter correlation cut off level: r² = 0,300, p ≤ 0,05. Disturbance gradient is defined as: 1 = unmanaged, 2 = single tree selection felling, 3 = clear cut. Parameter of light and reaction represent mean of Ellenberg's indicator values (ELLENBERG et al. 2001), TL = tree layer, SL = shrub layer, HL = herb layer, ML = moss layer

Summary and Conclusion

The different levels of disturbance had a clear immediate effect on composition, diversity and structure of the understorey vegetation. Species already present under closed canopy gained in coverage (e.g. *Carex pilulifera),* others typical of closed forests disappeared or remained on the plots but less abundant with increasing disturbance. Additionally more stress-tolerant species occured. This implicates a higher diversity especially on the clear cut plots but also a loss in naturalness. The species numbers of the shrub layer exceed the initial ones as well from 2005 on by the appearance of pioneer tree (*Sorbus aucuparia*, *Salix caprea*, *Betula pendula*) and shrub (*Rubus idaeus*, *R. fruticosus* agg.) species, whereas the shrub species dominate on the plots with single tree selection felling.

Both treatments result in higher cover values in both layers what points at the importance of the understorey vegetation concerning productivity and nutrient storage during the conversion process.