

Extended abstract No. 195

VEGETATION SUCCESSION IN PREPARED MICROSITES IN DRAINED PEATLAND
FOREST REGENERATION AREAS

Markku Saarinen*, Juha-Pekka Hotanen & Virpi Alenius

*Finnish Forest Research Institute, Parkano Unit, Kaironiementie 15, FI-39700 Parkano, Finland; tel. +358 50 391 4058, email: markku.saarinen@metla.fi

SUMMARY

In this study the aim behind monitoring vegetation changes was to deduce how quickly prepared microsites revegetate in drained peatland forest regeneration areas depending on their surface characteristics as well as their proximity to the water table. The depth of the water table in scalps was an essential environmental variable affecting vegetation succession. Likewise, the original composition of vegetation (prior to soil preparation) and scalp depth were integral factors in determining how vegetation proceeded to develop. In mounds vegetation succession progressed substantially slower. The height and soil composition of mounds were important in determining the successional pathway.

KEYWORDS: forest regeneration, soil preparation, drained peatland, vegetation succession

INTRODUCTION

The succession of vegetation catalyzed by peatland drainage can be distinguished as either drying or forest succession. In the former, mire species gradually disappear while in the latter case, plant species typical of upland forests colonize living space freed up by vacating mire vegetation (Saarinen & Hotanen 2000). Ecological factors (in the drained peatland forest environment) such as variation in the water table level in peat soil depend not only on weather conditions but also on the forest stand itself and the effectiveness of drainage; consequently, this creates variability in the manifestation of different successional stages as well as in the speed and direction toward which succession progresses. If drying of the peat soil in the drained area has progressed poorly, the direction of vegetation succession may also revert back towards a state of increasing abundance of mire vegetation (Laine et al. 1995, Saarinen & Hotanen 2000, Hotanen 2003).

Environmental factors dictating vegetation succession change radically upon regenerating the first post-drainage forest stand. In forest regeneration areas where the soil has been prepared, the microsites present consist of unprepared vegetated surfaces as well as different kinds of bare peat and peat-mineral soil surfaces from which vegetation has been removed (mounds, scalps). New plant communities colonize these surfaces, and as a result, the vegetation structure in drained areas develops along entirely new successional gradients (Moilanen et al. 1995).

In this study, vegetation succession in excavator-made scalps and mounds following regeneration of the first post-drainage forest stands in two old drainage areas was examined. The aim behind monitoring changes in vegetation has been to deduce how quickly prepared microsites revegetate in drained peatland forest regeneration areas depending on their surface characteristics as well as their proximity to the water table.

MATERIAL AND METHODS

Both experimental sites are situated in Parkano municipality in Western Finland, (N/lat: 62°, E/lon: 23°). The Uusikyttö experimental area was drained in the 1950s and clearcut in the summer of 1997. The site type ranged from lingonberry (*Vaccinium vitis-idaea*) to blueberry (*Vaccinium myrtillus*) drained peatland forest types (site types according to Laine & Vasander 2008), wherein mire vegetation had been almost completely replaced by upland species following drainage. In part of the field site, patches dominated by *Sphagnum* and *Polytrichum/Polytrichastrum* species, remained evident as drying succession within them was still in progress.

In the autumn 1998, the soil in the Uusikyttö regeneration site was prepared using an excavator resulting in scalped and mounded microsites. For vegetation monitoring (1999-2001), 150 scalps and 148 mounds were selected by sampling from all the prepared surfaces made. Scalped spots were classified as those covered by *Polytrichum* s.l. (either *Polytrichum commune* or *Polytrichastrum gracile*), *Sphagnum* spp. or drained peatland forest vegetation prior to soil preparation. The last mentioned were further grouped into scalps made by baring the surface peat and those distinguished by remnants of an undecomposed humus layer, which had accumulated post-drainage, left atop the surface peat.

The other experimental site, Haukilammenneva, was drained in 1912 and represents lingonberry drained peatland forest site type. The tree stand was clearcut in 1995 and soil preparation carried out in the autumn of 1996. The number of sampled plots incorporated into the monitoring scheme totalled 250 and 240 for mounds and scalps, respectively. Changes in the vegetation were monitored over five growing seasons during the years 1997-2001.

The vegetation structure within different data subsets, which was based on species-wise coverage measured during vegetation succession monitoring at the end of the final growing season, was analyzed and visualized via non-parametric multi-dimensional scaling (NMDS). Scaling was performed using the PC-ORD application (version 4.36), which utilizes the global multi-dimensional scaling technique (GNMDS) (McCune & Mefford 1999). Species and species group-wise probability of occurrence was modeled with a logistic regression (GENMOD procedure in SAS). In addition, generalized additive models (GAM procedure in SAS) were created, in which non-parametric methods and generalized linear modeling are incorporated.

RESULTS

The moss vegetation in scalps at Haukilammenneva had developed three-dimensionally (Table 1). Scalps colonized by moss vegetation dominated by *Polytrichum* s.l., *Sphagnum*

spp. or *Dicranella cerviculata* distinguished themselves from scalps which remained free of moss. At the Uusikyttö site, the variation amongst vegetation growing in scalps was particularly distinguished by those scalps previously dominated by a *Polytrichum commune* moss layer; in these, viable shoots of the species left intact on the bottom of the scalp quickly produced new moss growth from their buds. Another vegetation gradient was determined by the coverage of *Carex canescens*. This particular sedge species was commonly found in scalps at the *Vaccinium myrtillus* drained peatland forest site.

Table 1. Correlations (Pearson) of the Haukilammenneva site's ordination axis coordinates (gnmds 1-3) with plant species group coverages exceeding 5% and median water table depth (MedianGWT).

	gnmds1	gnmds2	gnmds3
Polys.l.	0.944	0.040	0.039
Sphaspp.	-0.038	0.925	0.005
Dicrcerv	-0.170	-0.322	0.881
Eriovagi	-0.114	0.304	-0.134
Careglob	-0.001	-0.091	0.049
MedianGWT	0.067	-0.615	-0.068

Polytrichum s.l. mosses were not identified down to the species in vegetation coverage assessments, but *Polytrichastrum gracile* was however found to be the most common species present in the drained peatland forest sites on scalped surfaces in which the decomposed peat layer lying beneath the undecomposed humus layer had been revealed. The probability of *Polytrichum s.l.* occurrence in scalps in *Vaccinium myrtillus* drained peatland forest was nearly double that of *Vaccinium vitis-idaea* drained peatland forest. *Polytrichum s.l.* mosses chiefly colonized scalped surfaces, as mounds became vegetated by mosses at a considerably slower pace even in the richer site, *Vaccinium myrtillus* drained peatland forest.

The depth of the water table in scalps was an essential environmental variable affecting vegetation succession. Likewise, the original composition of vegetation (prior to soil preparation) and scalp depth, i.e. the horizontal position of the scalp in respect to the surface peat layers, were also integral factors in determining how vegetation proceeded to develop. For the majority of plant species or plant species groups occurring in scalps, the optimal range of the water table level based on its depth variation could be determined. As expected, the coverage of *Sphagnum* mosses was greatest when the water table level approached the surface of the scalp (Figures 1 & 2) (Bragazza & Gerdol 1996, Tahvanainen & Tolonen 2004).

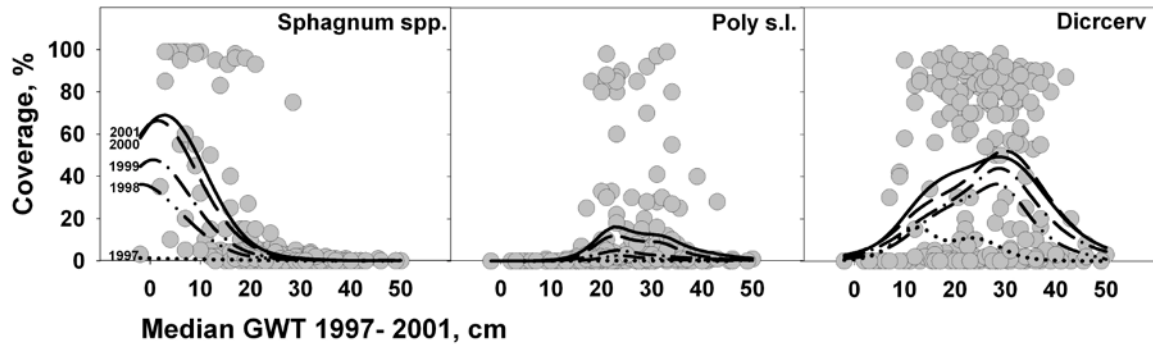


Fig.1. Dependence of *Sphagnum* spp., *Polytrichum* s.l., and *Dicranella cerviculata* coverages on the variation of the median water table depth (Median GWT) on scalped surfaces of the Haukilammenneva experimental site at the conclusion of the fifth growing season (scatter plot) and throughout the monitoring period as fitted nonparametric curves (GAM).

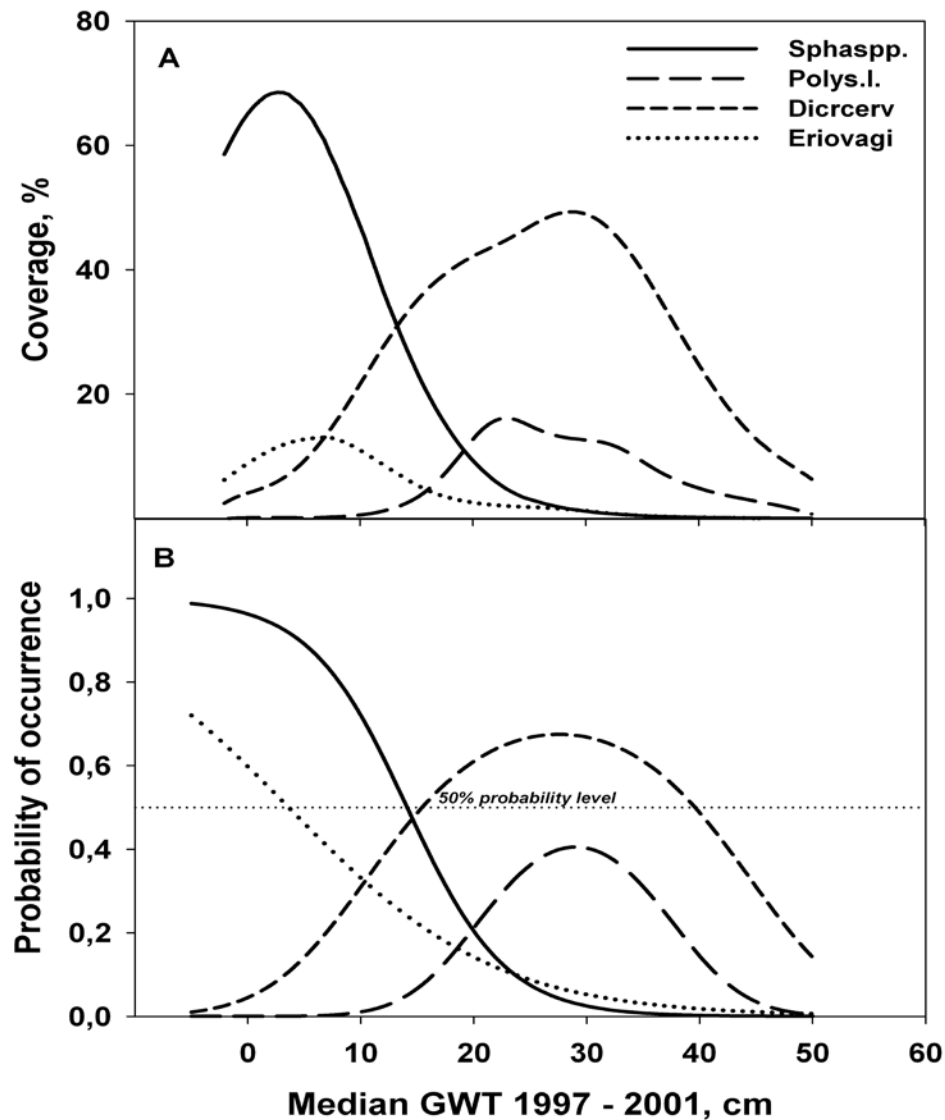


Fig. 2. Dependence of vegetation coverage in scalped surfaces during the fifth growing season on the variation of the median water table depth in peat soil (Median GWT) at the Haukilammenneva experimental site as nonparametric spline fits (A) and as probability of occurrence with over 5% coverage (B).

Of all the plant species present in the field layer of scalps, *Eriophorum vaginatum* spread the most aggressively. It emerged first in scalps with a high water table level. The maximum coverage of *Eriophorum vaginatum* was achieved when the water level in scalps was situated 5-10 cm below the scalp surface. If the vegetated surface had been dominated by *Sphagnum* mosses prior to scalping, then it enabled *Eriophorum vaginatum* to grow in abundance despite deeper water table levels (Figure 2). As for *Dicranella cerviculata* and *Polytrichum s.l.* mosses, the optimum water table level range in this study lied at a depth of 20-30 cm. With the optimal water level prevailing, low-growing *Dicranella cerviculata* colonizes bare peat scalps swiftly, already during the first two growing seasons (Figures 1 & 2).

Calluna vulgaris appeared on scalped surfaces already during the first monitoring year depending on the presence of an undecomposed humus layer (more or less intact). It emerged first in the wettest scalps, but differences in the median water table level evened out towards the end of the monitoring period. By then, the probability of *Calluna vulgaris* occurrence in scalps with an undecomposed humus surface was four times that of scalps with a bare peat surface.

In mounds, especially in high peat mounds, vegetation succession progressed substantially slower than in scalped surfaces (figure 3). Field layer vegetation in low mounds generally consisted of *Vaccinium vitis-idaea* and *V. myrtillus*. However, mound height was not always the primary factor affecting vegetation succession. Rather, more probably it was a question of excavation technique when mounding the sites. Most likely, the majority of low mounds were created from surface peat while high mounds contained a relatively higher proportion of deeply excavated peat. Surface peat includes some roots from dwarf shrubs and other field layer vegetation; thus, *Vaccinium vitis-idaea*, for instance, is capable of spreading rapidly vegetatively (Reinikainen & Salemaa 2000). Nevertheless, mound height does seemingly affect the physical properties of peat substrate, for the desiccation process in the surface portion of high peat mounds progresses more intensely than in low peat mounds.

Soil composition of mounds is also an important factor determining the path of vegetation succession: *Polytrichum s.l.* mosses were most prevalent in mounds composed of a peat-mineral soil mixture and least apparent in pure peat mounds. In the case of field layer species, *Carex globularis* and *C. canescens* occurred most commonly in peat-mineral soil mounds, although the latter-mentioned species did so chiefly due to the fertility of the *Vaccinium myrtillus* drained peatland forest site. *Eriophorum vaginatum*, *Rubus chamaemorus*, and *Vaccinium vitis-idaea* were typical species found growing in peat mounds.

CONCLUSIONS

To summarize regarding vegetation succession, total coverage in scalps decreased and vegetation development slowed down considerably as the median depth of the water table increased to more than 30 cm. In mounded areas, relatively large, over 25 cm high mounds remained free of vegetation for considerable time, particularly if they consisted of deeply dug, decomposed peat.

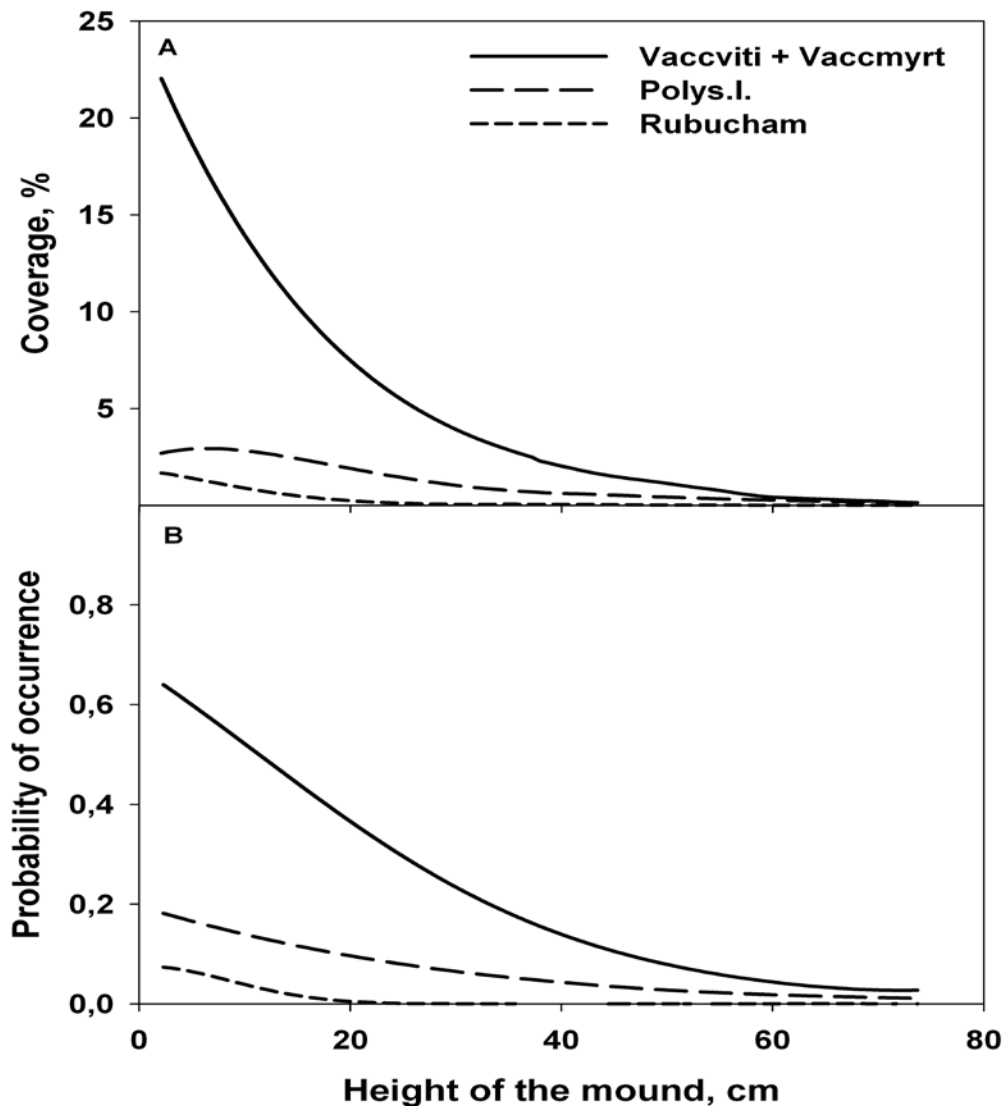


Fig. 3. Dependence of vegetation coverage in mounds during the fifth growing season on mound height variation at the Haukilammenneva experimental site as nonparametric spline fits (A) and as probability of occurrence with over 5% coverage (B).

REFERENCES

- Bragazza, L. & Gerdol, R. (1996). Response surfaces of plant species along water-table depth and pH gradients in a poor mire on the southern Alps (Italy). *Annales Botanici Fennici* **33**: 11–20.
- Hotanen, J.-P. (2003). Multidimensional site description of peatlands drained for forestry. *Silva Fennica* **37(1)**: 55–93.
- Laine, J., Vasander, H. & Laiho, R. (1995). Long-term effects of water level drawdown on the vegetation of drained pine mires in southern Finland. *Journal of Applied Ecology* **32**: 785–802.
- McCune, B. & Mefford, M. J. (1999). PC-ORD. *Multivariate Analysis of Ecological Data*, Version 4.0. Mjmm Software Design, Gleneden Beach, Oregon. 237 s.

- Moilanen, M., Ferm, A. & Issakainen, J. (1995). Kuusen- ja koivuntaimien alkukehitys korven uudistamisaloilla. *Folia Forestalia – Metsätieteen aikakauskirja* **1995(2)**: 115–130.
- Reinikainen, A. & Salemaa, M. (2000). Varvut. Teoksessa: Reinikainen, A., Mäkipää, R., Vanha-Majamaa, I. & Hotanen, J.-P. (toim.). *Kasvit muuttuvassa metsäluonnossa*. Tammi, Helsinki. s. 97–103.
- Saarinen, M. & Hotanen, J.-P. (2000). Raakahumuksen ja kasvillisuuden yhteisvaihtelu Pohjois-Hämeen vanhoilla ojitusalueilla. Covariation between raw humus layer and vegetation on peatlands drained for forestry in western Finland. *Suo-Mires and Peat* **51(4)**: 227-242.
- Tahvanainen, T. & Tolonen, K. (2004). Patterns of plant species responses to the water table depth gradients in Finnish mires. In: Päivänen, J. (ed.). *Wise use of Peatlands. Proceedings of the 12th International Peat Congress*, Tampere, Finland 6–11 June 2004. International Peat Society. **Vol 2**: 925–930.
- Vasander, H. & Laine, J. (2008). Site type classification on drained peatlands. In: Korhonen, R., Korpela, L. and Sarkkola, S. (eds.). *Finland – Fenland – Research and sustainable utilisation of mires and peat*. Finnish Peatland Society and Maahenki Ltd., Helsinki, Finland. Pp. 146-151.