Forest regeneration in cutovers on drained fens in Lithuania

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Summary

The objective of this study is to identify direct and indirect factors causing weak forest regeneration and poor growth of young trees on cutovers in drained fens, and suggest measures to improve forest regeneration on wetland. Forest regeneration success was assessed in fresh and 10-years-old cutovers on undrained and drained fens by the aid of a network of 10 × 10 m sample plots (172 sample plots in total). The results showed that during the years of normal humidity, high water table depth, which at the beginning of the growth period lies at a depth of 30 cm or more, is one of the main factors inhibiting natural regeneration of forest on peat soils of drained fens. Forest regeneration in fens is also affected by coverage of grass vegetation (r = –0.60), hydrolytic acidity of the upper soil layer (r = –0.34). Variation in these factors explained 56% of the variation in the density of natural regeneration.

Key index words: forest regeneration, cutovers, drainage, fen, water table

Introduction

To increase wood yield of the wetland forests, large areas of forest were dried out in the 20th century in Lithuania (ca. 130 000 ha). The draining increased wood yield of the wetland forests for 0.2 to 1.1 of the bonitet class (Ruseckas and Grigaliunas, 2003, 2007; Grigaliunas and Ruseckas, 2005). However, presently, due to warm and dry springs and summers, lowering of water table and drying of soils and other unknown factors, many forest companies face problems with forest regeneration on intensively drained forest sites. According to R.Volskis *et al.* (1999) after water table depth in fens drops below 60 cm, we may loose the ecotope of fen and in the newly formed ecotope only plant communities of low commercial value usually develop. After draining of forest wetland and clear cutting, a disbalance of nitrogen and potassium occurs (Saarinen, 1966; Saarinen and Sarjala, 1999).

According to Kaunisto and Paavilainen (1988), a shortage of potassium in deep peatland drained long time ago, is the main factor inhibiting growth of forest stands.

The above mentioned problems were not studied in detail in Lithuania. The objective of this study is to identify direct and indirect factors causing weak forest regeneration and poor growth of young trees on cutovers in drained fens and suggest measures to improve forest regeneration on wetland.

Materials and methods

To assess the effect of the water table depth and other related factors on forest regeneration success in cutovers, the following forest site types on low moor soils were selected Carico-iridosa and Caricosa site type indexes. Forest regeneration in cutovers was studied in 172 sample plots in total, 17 sample plots in mesotrophic fens and 11 in eutrophic fens were not drained, 51 sample plots were on drained mesotrophic and 93 were established in eutrophic fens.

In the parts of the undrained sites, the sample plots were established along the transects located from 20 to 50 m each other perpendicularly to the edge of the fen. On the drained sites and on the sites affected by beaver damming, the sample plots were also established in transects located perpendicularly to the closest ditch at the distance of 20, 50, 70, 100 m (and more if possible) from the ditch. For the sample plots, the sites with homogenic vegetation were selected by considering the variation in the species structure.

In the transects established in the cutovers selected for this study, 1 m deep soil profile pits were dug beside each sample plot and the water-wells were drilled and the soil sample rods were used to assess the soil properties until the depth of 2 m. The same assessments were made as in the soil profile pits and water-wells in forest stands.

The ground vegetation in the sample plots were assessed with the aid of 10x10 m squares at the water wells. In each sample plot, the number of viable, not viable and dead seedlings was assessed for each tree species, age class, and type of regeneration, height and growth place, the dominant species composition of the ground vegetation and shrub layer was evaluated by assessing the mean height and the coverage (%). To assess the natural regeneration of deciduous trees by vegetative sprouting, the number of stumps and stump sprouts were counted and stump condition was described. When assessing the natural regeneration, the

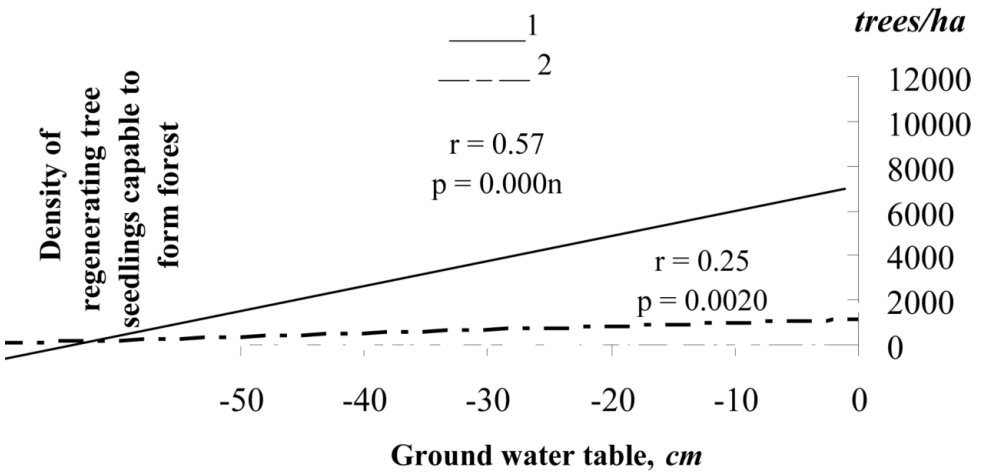

Figure 1. The dependence of the number of naturally regenerating young tree seedlings capable to form new forest on the ground water table at the beginning of the growth period in fens (1- seedlings, 2- sprouts)

position against the forest edge and the distance from the forest edge and the damming ditch were considered. The number of seedlings per ha was used in the analyses.

In laboratory of the Lithuanian Agrochemistry Centre, the pH_{KCl}, hydrolytic acidity, sum of bases were determined in the samples of the upper soil layer (0 - 20 cm) from 43 sample plots and amounts of nitrogen, phosphorus, potassium, magnesium, calcium were determined in 30 samples of downy birch and 34 samples of black alder leaves.

Results and discussion

Effect of the water table depth on natural regeneration of forest.

At the beginning of the growth period, the water table depth ($H_{V.01}$) in drained cutovers on peat soils in fens depended on drainage intensity (R^2 = 0.57; $p < 0.0001$). Therefore, the water table depth at the beginning of the growth period may be used as a criterion to determine the intensity of drainage.

In the cutovers with the sufficient and insufficient natural regeneration, the water table depth at the beginning of the growth period was 11.3±1.5 cm and 38.5±2.2 cm, respectively. This indicates that some cutovers are drained too intensively, because in the cutovers with very weak regeneration, the water table depth was 27.2±2.7 cm higher than on the cutovers with good natural regeneration.

The dependency of the natural regeneration of seedlings or sprouts and the ground water table at the beginning of the growth period was a positive correlation (Fig. 1), when the ground water lies under the soil surface (r equals 0.57 and 0.25; $p < 0.01$, respectively), and when the ground water is above the surface, the significant correlations between these variables are not determined, but in this case a tendency of negative correlations was observed.

There was a weak negative correlation between the grass vegetation coverage or total grass and moss coverage and water table depth (r = –0.37 – (–0.38); t = 4.97 – 5.31) (Table 1).

The effect of soil properties on natural regeneration of forest.

The effect of the following soil properties on natural regeneration was assessed: thickness of the peat layer, subsoil texture, pH, hydrolytic acidity, base saturation, ash content in the upper peat soil layer (0-20 cm). The results of this study showed that black alder and downy birch trees are sufficiently provided with macro (N, P, K) and microelements (Fe, B, Mn, Pb, Zn) content in the foliage. It shows that the trees provision with nutrition is not an essentially limiting factor of forest regeneration in the fens.

However, a weak negative dependency of the number of good quality naturally regenerating seedlings on hydrolytic acidity of the upper peat layer (0 - 20 cm) was observed. The number of naturally regenerating seedlings

Table 1. Correlation coefficients between the water table and the natural regeneration of forest as well as the grass cover indexes

Variables for natural regeneration and grass cover indexes	*r*	R^2	*t*	*p*
Number of viable young trees	0.42	0.17	5.96	<0.0001
Number of living young trees	0.46	0.21	6.78	<0.0001
Number of seed-derived young trees capable to form forest	0.48	0.23	7.19	<0.0001
Number of sprout-derived young trees capable to form forest	0.30	0.09	4.07	0.0001
Total number of young trees capable to form forest	0.54	0.30	8.45	<0.0001
Percentage of area covered by grass	–0.38	0.15	–5.38	<0.0001
Percentage of area covered by grass and moss	–0.37	0.14	–5.15	<0.0001

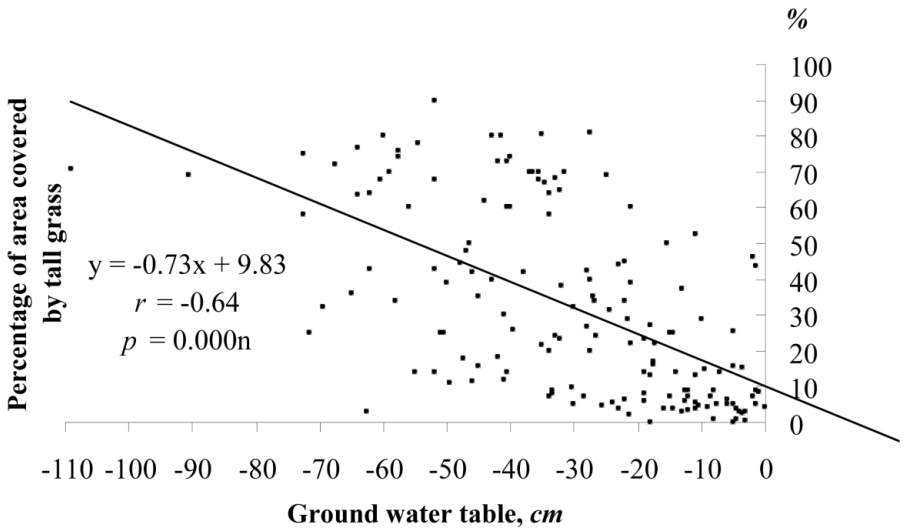

Figure 2. The dependence of the percentage of area covered by tall grass on the ground water table at the beginning of the growth period in fens

was also dependent on the pH_{KCl} (r = 0.37; p = 0.0118) and base saturation (r = 0.33; p = 0.0254) of the upper peat layer (0-20 cm). In the fens with the pH_{KCl} value of top-soil layer (20 cm and up) less than 5 and the hydrolytic acidity value greater than 1000 meq./kg, natural regeneration of sufficient density was rare (only in 22% of all sites). On such sites, only natural regeneration of downy birch and aspen was of sufficient quantity to form a new stand.

Thus, too high potential exchangeable and hydrolytic soil acidity negatively affects natural regeneration of the main forest tree species. To increase the success of natural regeneration of black alder and ash on such sites with the pH_{KCl} value of the top soil layer less than 5 or hydrolytic acidity higher than 1000 meq./kg, alkaline enrichment may be needed.

Effect of grass vegetation on natural regeneration.

There was a significant negative correlation between the proportion of the area covered by grass vegetation or covered by grass and mosses vegetation and the ground water table (r equals –0.38 and –0.37, respectively).

Abundance of tall grass species, which suppress young regenerating seedlings, was mainly dependent on the water table depth (r = –0,64; p < 0,0001) (Fig. 2).

There was significant negative correlation (p < 0.0001) between the proportion of the area covered by grass vegetation or covered by tall grass vegetation and the number of naturally regenerating seedlings (r equals –0.41 and –0.48, respectively). Additionally, the effect of grass vegetation cover was analysed in these sample plots, where the ground water table at the beginning of the growth period lies not deeper than 30 cm below the surface. It was determined that there was a significant negative correlation between these indices too (r equals –0.40 and –0.52, respectively; p < 0.0001).

On the basis of two-way ANOVA results it is possibly to say, that both the ground water table at the beginning of the growth period (F = 5.42; p = 0.0213) and the coverage of tall grasses (F = 8.27; p = 0.0004) differ and both these factors in interaction (F = 4.56; p = 0.0119) essentially affect the number of naturally regenerating seedlings.

Conclusion

During the years of normal humidity, high water table depth, which at the beginning of the growth period lays at the depth of 30 cm and deeper, is one of the main factors inhibiting natural regeneration of forest on peat soils of drained fens. Forest regeneration in fens is also negatively affected by coverage of grass vegetation and hydrolytic acidity of the upper soil layer. Variation in these factors explained 56% of the variation in the density of natural regeneration.

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