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STAND STRUCTURE AND PRODUCTIVITY DYNAMICS IN A DRAINED TRANSITION BOG 50 YEARS AFTER

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SUMMARY

A considerable part of nowadays productive Latvian forests are drained former wetlands. The forest drainage has proved to be the most effective method for increasing the forest productivity during the last century. We studied the dynamics of stand composition and productivity in 30 permanent sample plots located in a drained transition bog that was initially dominated by Scots pine. The results confirm that the stand productivity gradually increases and the studied sites are also suitable for growing spruce which propagates naturally after the drainage. The total standing volume in the studied sites has increased on average by 250 m^3 ha^{-1} during the study period.

KEYWORDS: transition bog, forest drainage, stand productivity, Scots pine, Norway spruce

INTRODUCTION

According to the National Forest Inventory data, forests in Latvia take up 3 162 310 ha or 49% of the total country area. Considerable parts of this area are former wetlands that were transformed into productive forest during the 20th century. 19% of all forests are located on drained mineral soils and 14% - on drained peat soils. Wetland forests still occupy 18% of the total forest area (Results of the first NFI cycle, 2012).

Since the long term research data show that other factors then precipitation/transpiration rates influence the abundance of wetland forests in Latvia, the intercorrelations between the localization of confined aquifer water discharge areas and wetland forests have been analyzed. The analysis has shown that forests on wet peat soils are mainly (74% of the territory of Latvia) located on sites where the confined aquifer water level reaches the ground level (Fig.1).

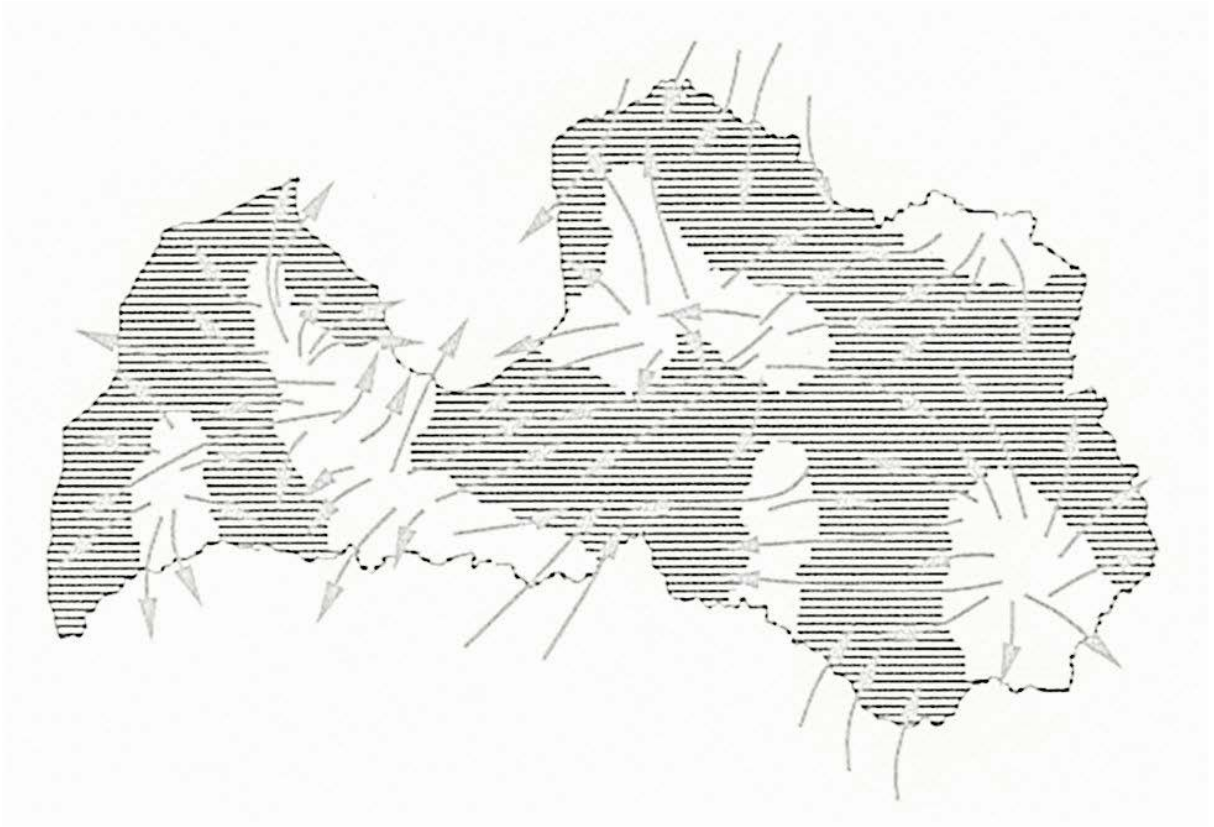

Fig.1. Abundance of wetland forests in relation to the localization of confined aquifer water discharge areas.

Forest drainage favours the discharge of confined aquifer water on drained areas and increases the amount of run-off water in neighbouring streams and rivers (Залитис, 1983; Zālītis, 2006).

In Latvia, forest drainage has been the most effective method for increasing forest productivity during the last century. Since 1939 the growing stock was judged to increase on average by 100 m^3ha^{-1}, mostly due to the forest drainage (Indriksons and Palejs, 2005; Zālītis, 2006). The best drainage effect can be observed in former bogs – the productivity increases up to 10 times (Odiņš, 1971). In less fertile site types, the influence of drainage can become apparent with a delay of 1-3 years (Odiņš *et.al*., 1960). Kaspars Bušs (1958) has stated that productivity of pine and spruce stands after drainage on average increases 3-4 times, that of birch stands – 2-3 times, and that of black alder – around 1.5 times. Even aspen and ash can establish high-productive stands. From all tree species in Latvia, spruce shows the most pronounced drainage effect. 85% of trees show increase of diameter during next 5 years after ditching, but maximal additional increment is reached 10-15 years after ditching (Столяров и Ананьев, 1986). Even 100 years old spruce and pine stands often react positively on drainage.

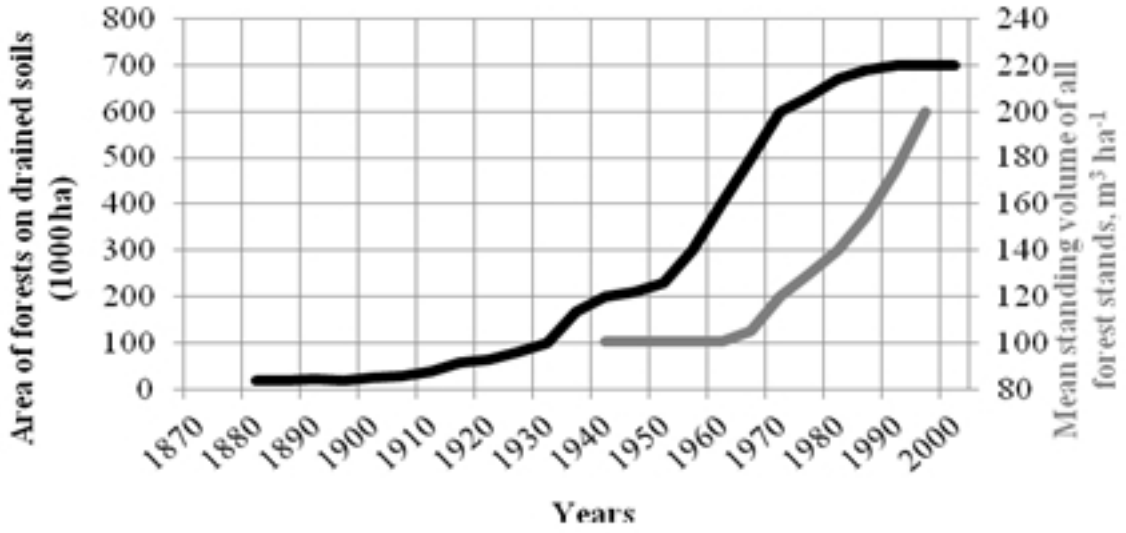

Fig.2. Changes in the area of forests on drained soils and mean standing volume.

Scots pine stands on eutrophic drained soils show high annual increment, but very low stem quality. Considering that, such stands should be converted to spruce stands (Буш 1968). However, sufficient soil aeration is a necessary precondition for the growth of highly productive spruce stands on drained sites. Even in stands on drained oligotrophic mineral and peat soils where the target species is Scots pine, vigorous Norway spruce biogroups in a 10-15 m wide belt along the ditches can usually be observed, even penetrating into the overstory, while further from the ditch spruce can be found only in the understory. The productivity of Norway spruce is more dependant on the soil aeration than that of Scots pine; and it decreases rapidly with an increasing distance from the drainage ditch.

We analyzed the dynamics of stand composition and productivity in a drained transition bog initially dominated by Scots pine.

MATERIAL AND METHODS

The stand structure and growth dynamics of pine stands on drained peat soils were studied using the data from 30 permanent sample plots in the Forest research station Kalsnava located in the central part of Latvia, Madona region , latitude 57° N, longitude 26° E, elevation 95 m above sea level. Main soil types are sod-podzolic soils and transitional mire soils, the sum of active temperatures reaches 1900-2100 °C, length of frost free period is 135 days, the duration of the vegetation period is 173 days, and average amount of the precipitation exceeds 590 mm.

Sample plots analyzed in this study were established in 1960 on drained peat soils of average fertility (*Myrtillosa turf.mel.*) with Scots pine as dominant tree species. Since 1970, seven re-measurements of stand parameters – species' composition, diameter, height, basal area and standing volume – were carried out.

In order to make the data comparable, the sample plots were divided into 3 groups according to the proportion of Scots pine in the initial stand composition: 1st group with the proportion

of Scots pine up to 50% (7 sample plots), 2nd group with the proportion of Scots pine between 51 and 80% (16 sample plots) and 3rd group with the proportion of Scots pine more than 80% (7 sample plots). The analysis was carried out with a special emphasis on the stand structure dynamics and changes of the standing volume of spruce over time.

Table 1. The dynamics of stand composition and standing volume in the analyzed sample plots

Year	Mean standing volume, $m^3 ha^{-1}$			
	Pine	Spruce	Birch	Total
1965	35	0	15	50
1970	67	10	19	96
1976	97	19	24	140
1981	114	29	27	170
1990	151	59	30	240
1999	173	96	22	291
2006	186	106	20	312
2011	181	121	11	313

Before the drainage, the mean standing volume was 50 $m^3 ha^{-1}$ in all plots included in this study. Therefore a transition bog with relatively constant standing volume similar to the initial one was used as a reference area in this study.

RESULTS AND DISCUSSION

The mean standing volume in all sample plots has increased from 50 $m^3 ha^{-1}$ in 1960 to 313 $m^3 ha^{-1}$ in 2011. In the transition bog that was retained as a reference area, the standing volume of Scots pine has not increased and still equals 50 m^3 ha^1.

In all three analyzed groups the proportion of Norway spruce in the stand composition has steadily increased, gradually outcompeting birch and thus confirming the improvement of growing conditions. In the first group stands the standing volume of Norway spruce has increased from 9 $m^3 ha^{-1}$ to 143 $m^3 ha^{-1}$, in the second group stands - from 3 $m^3 ha^{-1}$ to 150 $m^3 ha^{-1}$, but in the third group stands where no spruce admixture was initially recorded – to 78 $m^3 ha^{-1}$. The volume accumulation pattern is rather similar in 1st and 2nd group stands but different in the 3rd group stands (Fig. 3).

In the mixed pine stands the number of stems has decreased from 420 trees ha^{-1} to 280 trees ha^{-1} during the last 5 years, which also explains the slight decrease in the standing volume of pine. In the pure pine stands (3rd group) where the number of pines in 2011 is still 490 stems ha^{-1}, the standing volume has increased by 35 m^3 ha^{-1}, and the mean volume accumulation rate is 7 m^3 ha^{-1} a year. It can be predicted that at the end of the rotation period the standing volume of Scots pine will be around 320 m^3 ha^{-1}, but that of Norway spruce – 160 m^3 ha^{-1}.

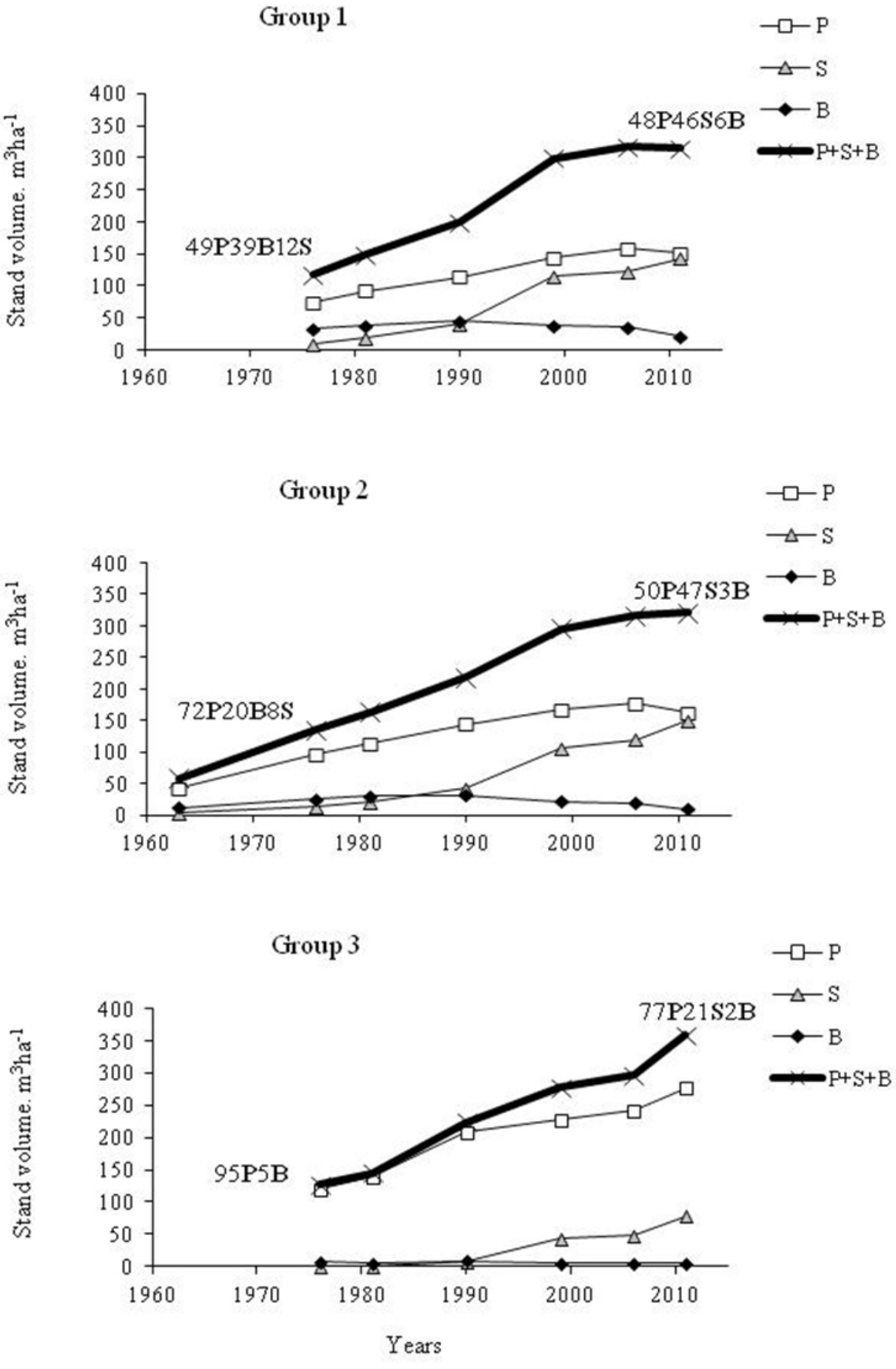

Fig.3. The volume accumulation pattern in three analyzed groups (P – pine, S – spruce, B – birch).

Changes in the stand structure dynamics clearly demonstrate the ecological processes after the drainage. As a result of improved aeration and nutrient availability the productivity of the trees rapidly increases and the former bog ecosystem was transformed into a forest ecosystem, where the main producer of the organic matter is the forest stand. The presence of downy birch that was necessary to ensure the survival of tree stand in the bog, has lost its importance after the ditching and gradually disappears from the ecosystem.

In all sample plots the mean volume difference over the time period of 50 years is greater than 250 m^3 ha^{-1}. The results confirm that site type *Myrtillosa turf.mel.*is suitable for growing spruce and are in accordance with the findings of other authors – Norway spruce steadily propagates in drained transition bogs (Матюшкин, Гаврилов, 2003).

CONCLUSIONS

1. Changes in the stand structure dynamics clearly demonstrate the ecological processes 50 years after the drainage of the former transition bog. It has resulted in notable increase in volume accumulation of the stand and in proportion of Norway spruce.
2. The presence of downy birch that was necessary to ensure the survival of tree stand in the bog, has lost its importance after the ditching and birch trees are gradually disappearing from the ecosystem.

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