Changes in Undergrowth on Drained Forested Fens in Lithuania

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Abstract

Overall area of fens occupies 143.6 thousand hectares in Lithuania, including 79.3 thousand ha or 55.2% of drained fens. The influence of drainage on undergrowth formation regularities was studied in meso-eutrophic and eutrophic fens of the Panevėžys and Biržai forests using transects, from 100 to 300 m long, perpendicular to the ditch axes or to the longest edge of the fen. Sixty-one water wells were dug along each transect for ground water level measurements. The same number of sampling plots (10×10 m) was delineated for investigating the forest vegetation. Furthermore, data from all forest enterprises of Lithuania (34,855 plots) on the species composition of the undergrowth in drained and undrained forest fens were analysed. Results from this analysis indicated that intensive drainage of fens (*i.e.* lowering of the level of ground water table ($H_{V.1}$) up to 40 cm and more) increased the number of european ash seedlings and decreased the number of black alder, downy birch and partially Norway spruce seedlings. The highest number of spruce seedlings was found in extensively drained fens ($H_{V.1}$ = 11-30 cm) characterized by forest stands with average (0.7) and lower stocking level.

Results from our sampling design indicated that drainage in mature birch stands on meso-eutrophic fens and in black alder stands on meso-eutrophic and eutrophic fens increased undergrowth densities as well as the areas of stands with second tree layers. Moreover, stands with dense undergrowth (3,000 trees ha^{-1} and more) expanded from 3.2 to 4.0%. However, the undergrowth density under mature spruce stands on drained meso-eutrophic fens decreased by 255±39 trees ha^{-1} ($p < 0.05$). It was attributed to the fact that the stocking level of drained spruce stands was higher and that the undergrowth was shaded more considerably in comparison to undrained spruce stands. Draining of birch and black alder stands had essentially changed species composition of their undergrowth. For instance, the proportion of spruce in undergrowth decreased from 10.6 to 35.6% ($p < 0.05$) while that of ash increased from 10.6 to 41.5% ($p < 0.05$). Moreover, a tendency of a decrease in the proportion of black alder was observed in the undergrowth of drained fens. Lowering the ground water level due to drainage had led to an increased number of ash seedlings (up to 3000-4400 trees ha^{-1}) and weakened natural regeneration of black alder.

Key words: fens, the ground water level, undergrowth density, mature stands

Introduction

Currently, clear fellings prevail in Lithuania which comprise 80-90% of the total harvesting of forest stands (Juodvalkis 2007). This does not correspond to the guidelines of forest policy of the European Union which promotes the extent of non-clear fellings and gives the priority to nature-regeneration of stands. Thus forest biodiversity is preserved and increased. The quantity of undergrowth or the second storey trees under the cover of mature stands has indeed been and will remain as the main criterion for planning and carrying out non-clear fellings (The regulations of forest final cutting, 2005). The importance of undergrowth for forest regeneration is pointed out by many other authors (Rowe 1956, Seppälä and Keltikangas 1978, Isomäki 1979, Kuuluvainen 1994, Hörnberg, Ohlson and Zackrisson 1995, Örlander and Karlsson 2000, Korpela 2002, Hotanen et al. 2006). Moreover, undergrowth can be successfully applied to assess site quality, to study forest succession tendencies, to evaluate biological diversity and the structure of different canopy layers (Leemans 1991, Segerström, Bradshaw, Hörnberg and Bohlin 1994, Uuttera, Maltamo and Hotanen 1996).

In foreign countries, researchers (e.g., Rowe 1956, Seppälä and Keltikangas 1978, Hökkä and Laine 1988, Saarinen 1989, Laiho et al. 1997, Ефремов 1972, Сабо et al. 1981, Красильников 1988, Тараканов 2008, Дружинин and Старунская 2008) studied the effect of drainage of fens on the composition of undergrowth and less frequently on the second storey of trees. They have shown that essential changes occur in stand structure, stocking level, and in the abundance and species composition of undergrowth following drainage. Furthermore, the number of shade tolerating tree species usually increase in the undergrowth and in the second storey due to the increase in the stocking level. However, due to the differences in methodologies used by various authors, draining intensity and duration, soil fertility as well as duration and classification of site quality, results are ambiguous, hardly comparable and sometimes even contradictory. Therefore a thorough knowledge of forming undergrowth and tree storey is needed (Hotanen et al. 2006).

Natural regeneration of stands was studied by several Lithuanian scientists in the past (Kairiūkštis 1973, Karazija 1994, Kapustinskaitė 1995, Juodvalkis 2007). However, most of the research was assigned to self-regulation on mineral soils or in the clear-cut areas of fen sites. Recently, Juodvalkis (2007) investigated regeneration by seedlings, but paid no attention to the influence of drainage on changes in site conditions. Despite being rather important, such studies cannot completely characterize the features of undergrowth in forest swamps. Thus, the aim of our work was to assess the effect of fen draining on the regularities of formation of undergrowth and the second storey of trees.

Methods

To study regeneration under stand cover, we selected stands of the main forest tree species (downy (*Betula pubescens* Ehrh.) or silver birch (*B. pendula* Roth), black alder (*Alnus glutinosa* (L.) Gaertn.), Scots pine (*Pinus sylvestris* L.) and Norway spruce (*Picea abies* (L.) H. Karst.)) growing on the meso-eutrophic (Pc, Pc^{n} forest sites) and eutrophic (Pd, Pd^{n} forest sites) fens (Vaičys *et al.* 2006). In these stands no thinnings or other logging operations were performed after drainage. Sixty-one experimental plots (including 18 plots in undrained and 43 in drained areas about 35 years ago) were established in mature and maturing stands of different stocking level. They were located in transects every 20-50 metres (depending upon the area of plot) perpendicularly to the longest edge of the fen. On the drained fens the experimental plots were located at the distance of 20, 50, 70, 100 and 150 m from the ditch (Figure 1). Since differences existed in vegetation community's composition, areas with homogenous vegetation were chosen.

In the centre of each experimental plot, water well was installed. Wells consisted of fenestrated pipe of

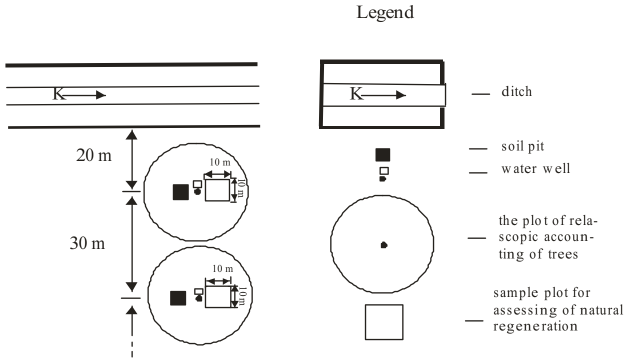


Figure 1. Experimental design showing allocation of sample plots, water wells, soil sampling profiles and sub-plots for assessment of natural regeneration under the cover of stands

5 cm in diameter and 1.5 m long. During the study period (2003-2008), the ground water level was measured every year in the first decade of May as well as two other times in dry and wet periods of the growing season. May was chosen for regular measurements of the ground water level because, according to our previous results (Ruseckas 2002), it was during that period that the level of ground water showed the highest correlation with the intensity of drainage and productivity of forest stands. Moreover, a pit was dug up to 1 m depth in each experimental plot to determine the thickness of soil profile horizons. Deeper layers were bored at the bottom of each pit down to 2 m depth.

A 10×10 m sampling plot has been also delineated in every experimental plot near the water well to assess vegetation. Vegetation cover in all experimental plots has been assessed in June-July (spring efemeroids were recorded at the beginning of the growing season). Ground and bottom layers have been evaluated by estimating the cover of grasses, shrubs, semi shrubs and mosses (projection coverage in %). The layers of vegetation have been estimated by assessing the mean height and projectional coverage (%).

The undergrowth was assessed in the sampling plots (10x10 m) by determining tree species, age, mean height and viability by describing its distribution and location in terms of micro relief. According to age, the undergrowth was grouped as follows: seedlings, trees aged 2-5, 6-10, 11-20 years and older than 20 years. In accordance with vitality, the trees in undergrowth were grouped into viable, nonviable and dead. For every group the mean height of all seedlings was measured.

Characteristics of forest stands have been calculated by conventional methods used in the Forest inventory (Kuliešis 1989).

We analyzed the quantity of undergrowth of different tree species as well as the factors crucially affecting undergrowth. For this purpose, the data of forest management from all Lithuanian forest enterprises were applied (34,855 plots). While carrying out forest inventory, the undergrowth was assessed in each mature and maturing stand by establishing the circular temporary sample plots as follows: on the inventory site up to 1 ha – 10 sample plots, 1.1-3 ha – 15 and on that of 3.1 ha and larger ones – 20 sample plots. Sample plots were distributed on the site systematically and evenly over the whole area. In the stands with sparse undergrowth, seedling inventory was simplified measuring height and distances between individual saplings. While carrying out forest inventory, the undergrowth was divided into three size groups of different tree species: small-sized undergrowth up to 0.5 m, medium 0.6-1.5 m and large-sized – over 1.5 m.

Analysis was conducted using the data from forest management. A characteristic of forests growing on peatlands is presented in Table 1. Mature and maturing stands with the second tree layer were assigned to a separate group. The second tree layer was excluded in cases when tree height constituted <75% of the dominant tree height, and they were higher than 4 m. The relationship of undergrowth quantity between stand species composition and age as well as site fertility and soil moisture was computed. For this purpose, not only the quantity of undergrowth but also its species composition were analyzed.

Statistical analysis of the data has been computed using STATISTICA for WINDOWS 4.3.

Results and discussion

The influence of drainage on formation of the second layer in mature stands

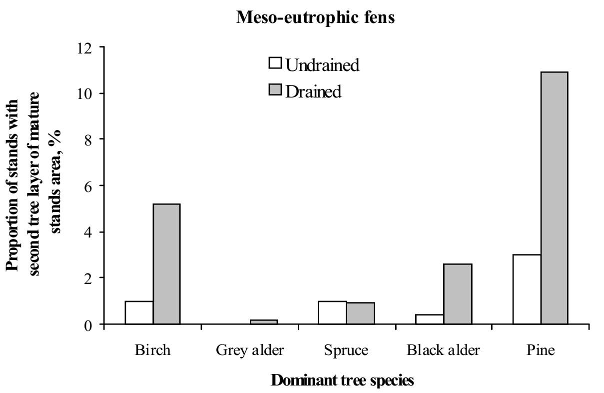
In accordance with the analysis (Table 1) of data on forest inventory in undrained fens (Pc, Pd sites) in Lithuania, absolute majority (97-99%) of mature stands had no second layer. Most of such stands were found in black alder forests (99.9%), while the least appearance of them was in pine stands (57.0%). It essentially coincides with the conclusion by Juodvalkis (2007) that the second storey rarely occurs in the black and grey alder stands. Drainage of birch, black alder and pine stands increased the quantity of mature stands with the second storey by 3.6-6.2 times as compared to the undrained stands. However, even on drained fen sites in Lithuania the quantity of two-storey stands was relatively insignificant, i.e. they made up just 1.8-10.9% (Figure 2).

Drainage of grey alder and spruce stands practically did not create favourable conditions for the formation of the second tree layer. Therefore, both the mature spruce and grey alder stands with the second layer on drained fen sites comprised only 0.2-1.4% (Figure 2).

Kairiūkštis (1973) and Juodvalkis (2007) have pointed out that in spruce stands on mineral soils the second tree layer is formed rarely. Despite draining of fens enhances the formation of the second layers in birch,

Table 1. Distribution of drained and undrained stands growing on the fens according to dominant tree species (forest inventory data of 1995)

Dominant tree species	Overall area of forests, ha,	The area of drained forests, %	The area of mature stands		The area of undrained mature stands with the second layer, %	The area of mature stands in which the undergrowth density exceeds 3000 trees ha^{-1} and more, %	
			ha	%		drained	undrained
Scots pine	7136	67	932	13	3.0	14.9	9.8
Norway spruce	15625	67	5921	38	0.8	10.8	11.2
Birch	72436	51	22028	30	1.0	11.3	7.3
Black alder	45223	39	16107	36	0.5	10.3	7.1
Grey alder	2100	60	1558	74	0.1	6.0	6.0
In total:	142521	55	46545	33	1.2	10.8	7.5



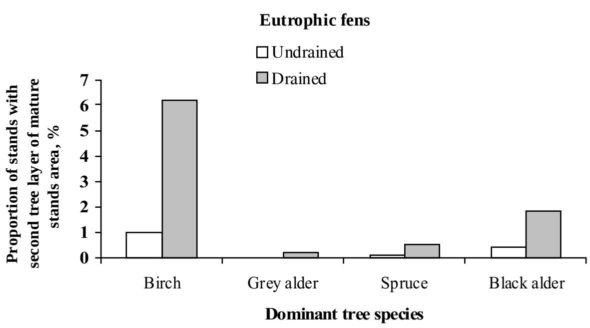


Figure 2. Proportion of mature stands with second tree layer growing in meso-eutrophic (Pc) and eutrophic (Pd) fens (Forest inventory data of 1995)

black alder and pine stands, it has negligible economic significance. Due to stand drainage, formation of the second tree layer occurs on a comparatively small territory constituting 2.4% of the area of mature stands.

The influence of drainage on undergrowth forming in mature and maturing stands

Lithuanian forest inventory data have showen that the influence of drainage on formation of the undergrowth in mature and maturing stands in peatlands is not univocal (Table 2). After drainage, the undergrowth density increased most for black alder stands (139±26; $p<0.05$) on meso-eutrophic fens (Pc^n forest site) and aspen (*Populus tremula* L.) stands (1,009±420 trees ha^{-1}; $p<0.05$) on eutrophic fens (Pd^n forest site). The most insignificant increase (80±19 trees ha^{-1}; $p< 0.05$) in understorey development was observed in the birch stands on meso-eutrophic fens. Black alder stands on the eutrophic fens were intermediate, where the undergrowth density following drainage on average increased 116±32 trees ha^{-1} ($p<0.05$). Other authors (Lukkala 1946, Saarinen 1989, Hotanen et al. 2006) also noted that after draining of forest mires the abundance of undergrowth had augmented. However, in spruce stands as expected, undergrowth density did not increase after drainage. On the contrary, on the meso-eutrophic fens spruce undergrowth density was significantly (255±39 trees ha^{-1}) reduced and on the eutrophic fens it slightly decreased (22±139 trees ha^{-1}). This can be attributed to significant increase in the stocking level of spruce stands after drainage (Table 3) as well as to shading at the same time. Researchers from Finland (Hotanen et al. 2006) have indicated a decrease in the number of downy birch seedlings in spruce stands after drainage.

In grey alder (Pc^n and Pd^n forest sites) and birch stands (Pd^n forest site), no significant influence of ditches on the undergrowth density was found. The reason for this finding could be a very high variation (coefficient of variation V = 72-86%) in the data and relatively minor effect (undergrowth density after drainage changed only 5-11%) of drainage. In these stands only a slight tendency of an increase (19-58 trees ha^{-1}) in the undergrowth due to drainage of peatlands was ascertained (Table 2).

Special attention needs to be paid to the influence of drainage on formation of mature stands where 3,000 and more trees per hectare grow in the undergrowth. In such stands simplified fellings could be used. Moreover, in case of clear felling, a new generation of stands might be formed by preserving undergrowth (Juodvalkis 2007).

In stands, where the undergrowth density attains 3,000 and more trees per hectare drainage resulted in an increase in the undergrowth from 3.2 to 5.1%, excluding spruce and grey alder stands. The area of stands with dense undergrowth after drainage enlarged most (5.1%) in pine stands and least (3.2%) in black alder stands (Table 1). In birch stands (Pc^n and Pd^n forest sites), following drainage, the amount of stands with dense undergrowth had increased by 4%. In contrast to the stands of pine, birch and black alder, a tendency of decrease in the area with dense undergrowth by 0.4% was observed in spruce stands. As mentioned earlier, this can be explained by a higher stand stocking level in the drained spruce stands and a consequent reduction of the undergrowth density.

Table 2. The mean density (T) of undergrowth in drained and undrained mature and maturing forest stands on fens, trees ha^{-1}

Dominant tree species	Drained forest stands				Undrained forest stands				T_d-T	$m_{(Td-T)}$	t	p
	T_d	m_d(±)	N_d	V_d,%	T	m(±)	N	V,%				
Meso-eutrophic fens (Pc forest site)												
Birch	939	14	5951	87	860	13	5955	87	80	19	4.20	0.0001
Black alder	967	22	1986	98	828	13	4635	95	139	26	5.43	0.0001
Spruce	823	14	4784	86	1078	36	946	97	-255	39	-6.61	0.0001
Grey alder	391	32	260	75	334	18	464	86	58	37	1.37	0.1170
Eutrophic fens (Pd forest site)												
Birch	1012	23	3112	79	981	37	945	86	31	43	0.72	0.4720
Black alder	1049	23	2744	86	933	23	2176	89	116	32	3.60	0.0003
Spruce	1001	77	273	78	1022	116	101	88	-22	139	-0.16	0.8730
Aspen	1778	297	54	82	769	298	13	72	1009	420	2.40	0.0340
Grey alder	411	36	257	72	393	39	199	71	19	53	0.35	0.7270

Note: T_d, T – the mean density of undergrowth, m_d, m – the mean error of undergrowth density, N_d, N – the number of inventory plots, V_d, V – coefficient of variation; t – Student test, p – probability of Student test (testing the effect of drainage on the undergrowth density)

Table 3. Correlation between the factors conditioning the undergrowth density

Factors and indexes of phytocoenoses components	r	r^2	t	p
Correlation between the ground water level at the beginning of vegetation season and:				
The stocking level of the first tree layer of stand	-0.37	0.14	-3.03	0.0037
The density of vital seedlings in undergrowth	0.40	0.16	3.30	0.0017
Grass projectional coverage	-0.34	0.12	-2.74	0.0083
Projectional coverage of high grasses shading undergrowth	-0.41	0.17	-3.44	0.0011
Correlation between the stocking level of the first tree layer:				
The density of vital seedlings in undergrowth	-0.38	0.15	-3.12	0.0028
The density of live seedlings in undergrowth	-0.28	0.08	-2.18	0.0335
Correlation between the grass projectional coverage and:				
The density of vital seedlings in undergrowth	-0.31	0.10	-2.47	0.0164
The density of live seedlings in undergrowth	-0.45	0.20	-3.79	0.0004

Species composition of undergrowth

With the aid of the material of 1995 inventory and the data of our experimental plots, we observed that spruce was dominant in the undergrowth of drained and undrained mature and maturing black alder and birch stands (Figure 3). In undrained stands it made up 70-92 % of the undergrowth while in drained 53-81 %. It coincides with the data obtained by Laiho et al. (1997) and Juodvalkis (2007). After drainage of peatlands of the fen the proportion of spruce in the undergrowth decreased by 11-23 % (± 3.7-4.2), as the proportion of European ash (*Fraxinus excelsior* L.) undergrowth had increased markedly. According to the number of seedlings in birch and black alder stands, ash was ranked second. However, in the drained stands it occurred 2.6 times more frequently as in undrained stands it was found to be 1.6-22.8% (±2.1-3.1) and in drained 14-42% (±2.2-2.9). There was particularly abundant ash undergrowth in the drained black alder and birch stands on the eutrophic fens prior to the beginning (1996) of mass dieback of ash stands in Lithuania. Currently, ash undergrowth is infected by unknown diseases and its vitality is low. The proportion of other tree species (downy and silver birch, black alder, scots pine, pedunculate oak (*Quercus robur* L.), wych elm (*Ulmus glabra* Huds.), Norway maple (*Acer platanoides* L.) in the total quantity of undergrowth is low. In birch stands it makes up nearly 5.8-10.0% and in black alder stands 6.3-7.6% of the total number of young trees. After drainage of fens there was a tendency of a slight increase in the proportion (0.1-0.6%) of aspen and a decrease in the proportion (0.4-1.6%) of black alder in the total amount of undergrowth. Kapustinskaite (1960) had also pointed out in her studies that aspen seedlings occurred in the undergrowth after draining of fens.

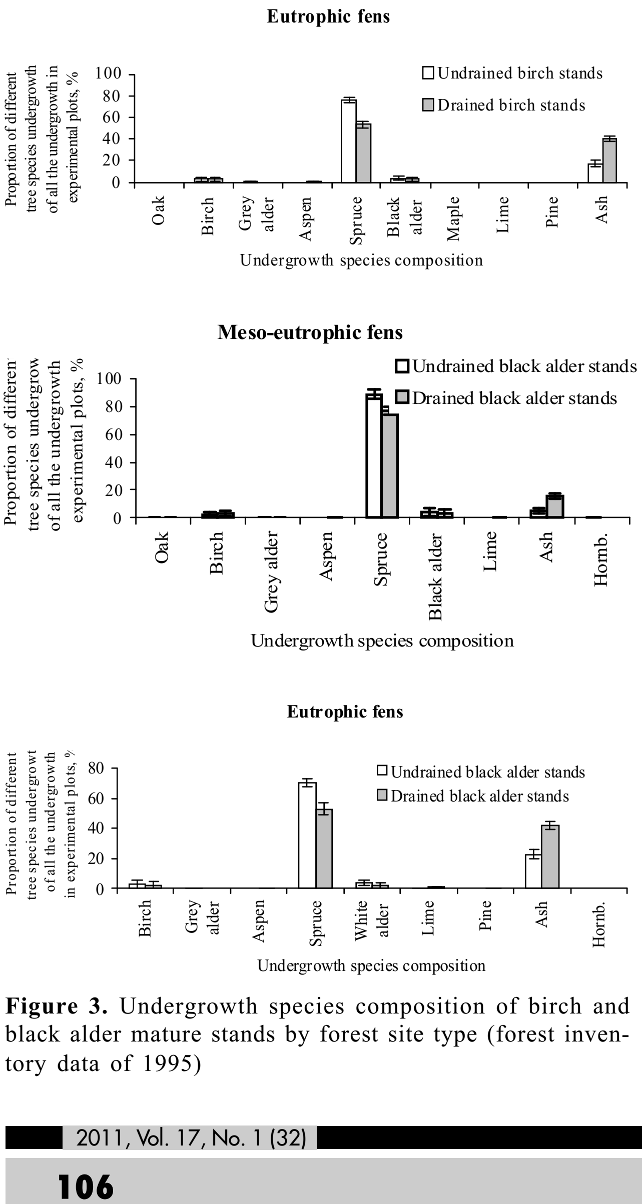


Figure 3. Undergrowth species composition of birch and black alder mature stands by forest site type (forest inventory data of 1995)

Factors that significantly affected undergrowth density

The variation in the undergrowth density was very high and reached 72-80% both in drained and undrained stands growing on fen peatlands (Table 2). Identification of factors significantly affecting undergrowth density would allow to determine the reason for such a great variation in the undergrowth density. A negative moderately significant correlation (coefficient was -0.60) was found between ash undergrowth density and the ground water level at the beginning of the vegetation season (Figure 4). In the stands where the ground water level was lower by 0-10 cm at the beginning of the vegetation period, these trees grew more densely than in the plots with higher ground water level.

Our results have shown that in the undergrowth of stands growing on fens ash seedlings regenerated at the density of 3,000-4,400 seedlings per hectare and

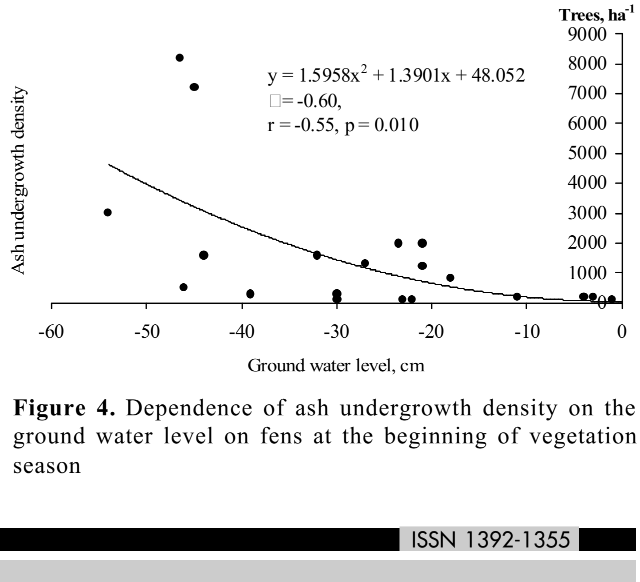


Figure 4. Dependence of ash undergrowth density on the ground water level on fens at the beginning of vegetation season

they dominate in the undergrowth of the stands where the ground water level is at 41-50 cm depth and deeper at the beginning of the vegetation period (Figure 5). Norway spruce prevailed in the undergrowth of the stands where the ground water level is at 11-30 cm depth in spring.

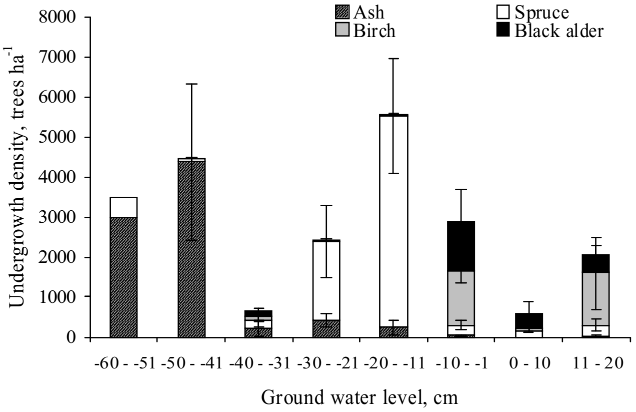


Figure 5. Distribution of average density of tree species in undergrowth and dependence of the ground water level on the fens

Black alder and downy birch seedlings mostly regenerated in the openings that appeared after the trees had fallen, on the sun-lighted parts of humps and on other small swells of the ground. A slightly more abundant (1,000 trees ha^{-1} and over) downy birch and black alder undergrowth was detected in the stands where the ground water level was over the soil surface or at 10 cm depth at the beginning of the vegetation period (Figure 5). Density of black alder and downy birch seedlings could reach up to 10,500 trees ha^{-1} and up to 3,800 trees ha^{-1}, respectively. However, these small trees grew more abundantly in the groups, therefore, only a small part of them would survive even under favourable conditions. In these stands black alder, small-leaved lime (*Tilia cordata* Mill.) and aspen sprouts were found. For various reasons weakened black alders tried to regenerate by weak sprouts from the lower parts of stems. Sometimes such sprouts even reached the second tree layer.

The different conditions for seedling regeneration exist under the canopy of stands on fen sites. A reliable *possible* conversely proportional correlation of the average strength has been determined between the stocking level of the first tree layer and density (η = -0.40) of the viable undergrowth (Figure 6). A density higher than 3,000 seedlings ha^{-1} has been found only in the stands where the stocking level of the first tree layer does not exceed 0.7. This finding supports the results by the other authors (Kapustinskaitė 1960, 1983,

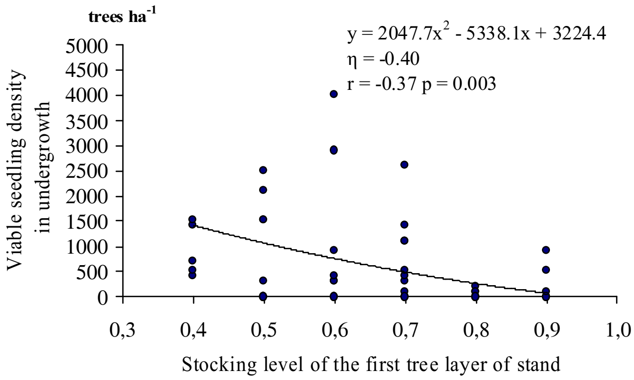


Figure 6. Dependence of viable undergrowth density on the overall stocking level of the first tree layer of undermature and mature black alder and birch stands

Кундзиньш 1969, Поджаров, Степанчик 1988) who have studied regeneration stimulating measures under the canopy of stands. Kapustinskaitė has found that it is not purposeful to apply enhancing measures for undergrowth formation in the stands where the stocking level is 0.7 and higher since the black alder seedlings die during the first period of vegetation under the crowns of trees.

Seedling regeneration seemed also to be affected by the herbal projectional coverage under the canopy of stands (Table 3). Weak, conversely proportional reliable correlation (r = -0.45; p = 0.0004) was found between the grass projectional coverage and undergrowth density. High, densely growing herbal plants probably had a negative influence on undergrowth by shading it as well as by competing for light and nutrients under the cover of stands.

We observed that the herb distribution shaded by undergrowth and the level of ground water were associated by weak but reliable conversely proportional correlation (r = -0.41; p = 0.0011) (Table 3). Weak correlation (r = -0.37; p = 0.0037) was found between the stocking level of mother stand and the ground water level at the beginning of vegetation season.

The density of vital undergrowth of all tree species (except for the ash undergrowth which due to diseases and game damage is not vital currently) and the ground water level at the beginning of vegetation were related by positive correlation (r = 0.40 p = 0.0017) (Table 3).

Applying the model of multifactor regression it has been found that the formation of vital undergrowth on fens is significantly affected by two major components " the ground water level at the beginning of the vegetation season ($H_{V.01}$) and stand stocking level (S).

A following linear multiple regression equation between density (N) of vital undergrowth seedlings and values $H_{V.01}$, S was computed:

$$N = 2643.27 + 22.23 \cdot H_{V.01} - 2301.29 \cdot S \quad (1)$$
$R^2 = 0.22$; $F = 8.06$; $p < 0.0008$;

The results of dispersion analysis confirmed it. They showed that both ground water level and the stocking level of the first tree layer in the stand had a great influence on the undergrowth's density (F = 5.10-12.37; p = 0.0005-0.0093).

Conclusions

1. The ash undergrowth formed denser on intensively drained fens in which at the beginning of vegetation period the depth of the ground water table was 40 cm, and deeper than on undrained and extensively drained fens. However, the quantity of black alder, birch and spruce seedlings in undergrowth on such fens was less than on fens where the water table at the beginning of the vegetation period was nearer to the soil surface. The largest number of spruce seedlings under stand cover was determined on extensively drained fens (water table 11-30 cm) in stands of mean and lower stocking level.
2. Due to drainage the undergrowth density of mature birch on meso-eutrophic fens and black alder stands on meso-eutrophic and eutrophic fens slightly augmented. The areas of stands with the second tree layer and areas with dense (3,000 trees ha^{-1} and more) undergrowth enlarged after drainage of fens from 3.0 to 6.0 times and 3.2-4.0% respectively.
3. In comparison to undrained stands, the undergrowth density in drained spruce stands was lower on meso-eutrophic fens, since drained spruce stands attain a higher stocking level.
4. Drainage of birch and black alder stands on fens essentially changed species composition of the undergrowth. In comparison to undrained stands, the proportion of spruce in undergrowth of drained stands is 11-36% less whereas that of ash is 11-42% larger. Besides, on drained fens a tendency of a decrease in the proportion of black alder in the undergrowth was revealed.

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ИЗМЕНЕНИЯ ЕСТЕСТВЕННОГО ВОЗОБНОВЛЕНИЯ ПОД ПОЛОГОМ ЛЕСА НА НИЗИННЫХ БОЛОТАХ

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Резюме

Объектом наших исследований явились как осушенные, так и неосушенные, осоковые (C_5), осокого-касатиковые ($Д_5$) черноольшаники, березняки и ельники. Осушение низинных лесных болот было проведено в 1956-1980 г., в большинстве случаев, одиночными канавами 0,8-1,3 м глубины.

Учет естественного возобновления под пологом леса проводился в 43 пробных площадях (10x10 м), размещенных через 20-50 м в трансектах 100-300 м длины, проходящих перпендикулярно осям канав. Еще 18 пробных площадей было заложено в естественных (неосушенных) осоковых и крапивных березняках и черноольшаниках. Возле каждой пробной площади для наблюдения за стоянием уровня грунтовых вод были оборудованы колодцы (всего 61 шт.). Дополнительно процессы изменения хода естественного возобновления под влиянием осушения низинных болот установлены путем использования материалов лесоустройства (всего было использовано 34,85 тыс. таксационных выделов, в том числе 19,23 тыс. осушенных).

Установлено, что интенсивное осушение низинных болот (т.е. понижение уровня грунтовых вод ($H_{V.1}$) на начало вегетационного периода до 40 см и глубже) увеличивает количество самосева ясеня под пологом древостоев, но уменьшает количество самосева ольхи черной, березы и частично ели. Наибольшее количество самосева ели под пологом древостоев было установлено на экстенсивно осушенных ($H_{V.1}$ = 11-30 см) низинных болотах, в древостоях средней (0,7) и меньше полноты.

В целом по Литве осушение осоковых березняков и черноольшаников и осоково-касатиковых черноольшаников не только увеличило густоту подроста на (80-139)±(19-32) шт./га ($p < 0,05$) но и в 3,0-6,0 раз увеличилось площадь лесов, имеющих второй ярус, и на 3,2-4,0% площади древостоев, имеющих густой (3000 шт./га и более) подрост. Однако в осушенных осоковых ельниках густота подроста под пологом спелых древостоев уменьшилась на 255±39 шт./га ($p < 0,05$). Этот факт объясняем тем, что под влиянием осушения ельников существенно увеличилась полнота древостоев, тем же самым и интенсивность затенения подроста под пологом леса. Под влиянием осушения осоковых и осоково-касатиковых березняков и черноольшаников на 10,6-35,56% ($p < 0,05$) уменьшилась часть самосева ели в составе подроста и на 10,6-41,5% ($p < 0,05$) увеличилась часть самосева ясеня. Кроме того, на осушенных низинных болотах замечена тенденция уменьшения части самосева ольхи черной.

Ключевые слова: низинные болота, уровень грунтовой воды, количество подроста, спелые древостои