The dynamics of forest ground cover vegetation following drainage

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The ground cover vegetation is of extraordinary importance in evaluating forest growing conditions. The research on the ground cover vegetation (vascular plants and bryophites) dynamics must be considered an important part of science about forest amelioration.

The data used in this work were collected at the Forest Ecological Laboratory *Vesetnieki* with the Forest Research Station *Kalsnava*. The forest lands of the Laborarory comprise drained peatland and drained mineral soil forests as well as undrained areas and originally dry sites. The aim of the Forest Ecological Laboratory *Vesetnieki* established 35 years ago was to investigate forest hydrological processes and work out the theoretical basis of forest amelioration in Latvia. In order to study the dynamics of ground cover vegetation, a number of sample plots were set up. The related studies were started and are still continued by Prof. Dr. A. Āboliņa. In 1975 the counting of vegetation, using the points-squares method, was done by Prof. Dr. P. Zālītis. In 1994 the counting was repeated by the author of this article, using identical methods. The data obtained 19 years later allow us to analyse the dynamics of vegetation over this period of time.

At *Vesetnieki* 103 species of flowering plants and ferns, belonging to 43 families and 89 genera were found with 31 species of 16 families and 24 genera common.

The nature of flora is not uniform. There were some dominant species encountered in different regions of the *Vesetnieki* forests, some species were rare in 1975, but were found to be common in 1994 (*Oxalis acetosella* L., *Urtica dioica* L.).

The ground cover vegetation may act as an indicator of forest growing conditions. The dynamics of vegetation reflects an increase in soil fertility and the stabilisation of soil moisture conditions. For the describtion of the biological diversity the Shanon's index was used. The biodiversity in drained forests is higher than on wet areas. The diversity increases if the drainage is done in one part of a wet forest site, but the other part remains undrained. This action helps conserve some hygrophite species.

Over 19 years the share of Norway spruce (*Picea abies* (L.) Karst.) increased, resulting in the less favourable light conditions under the canopy. This process negatively affects the diversity of ground cover vegetation in these forests.

Key words: drained forests, ground cover vegetation, biodiversity, biological similarity

Introduction

In forest management the modern approach involves a synthesis of the ecological and socio-economical and social aspects of forest. The forest stand is the main producer of wood, but apart of trees every forest site comprises also a great variety of other plant and animal species. The forest is one of the main renewable natural resources Latvia has. Therefore, the main goal of forest management in Latvia is to increase the volume and improve the quality of stemwood, while at the same time it is of great importance in identifying the response of other forest ecosystem components to the management practices aimed at increasing wood production.

In Latvia, a number of methods are used to increase the forest productivity and quality. Forest drainage is one of the most effective ones. Along with the increment of wood, which can be measured by annual rings, other forest components undergo changes, too.

The ground cover vegetation is considered a typical indicator of forest growing conditions. Forest amelioration is generally followed by rapid changes in ground cover vegetation. Dr. K. Bušs (1974) describes these changes by 3 stages of succession. At the first stage some hygrophyte species lose their vitality, the second stage is distiguished by the mesophyte species tending to increase, while at the third stage the changes in vegetation occur. This process is called a phytocenological convergence of drained forests with those of originally dry site types. After drainage the projective cover of some retreating species decreases, the cover of advancing species increases, while that of species indifferent to changes underway remaining virtually intact.

The scientists often demand to stop or reduce the intensity of forest exploitation in different regions of the world. The main reason for concern is an uncontrolled cutting of forest for improving the economical situation of one or another country, actually resulting in the destruction of unique forest biotopes. The conservation and enhancement of forest biological diversity is proclaimed as the main goal of forest management in the forest policy documents of many countries. The UN

Conference on the Environment and Development (1994, Rio) identified the necessity to conserve and enhance the biodiversity at three levels: ecosystem biodiversity, genetic diversity and species diversity. The research and conservation of biodiversity has become an important topic of discussions in Latvia.

Forest drainage is frequently considered an interference with the natural processes in the forest and an action diminishing its biodiversity. Unfortunately, these arguments are often declaratory without a substantial research back-up about the structure and dynamics of vegetation in forests after drainage. In order to speak about the dynamics of biodiversity, the data on the impact of forest reclamation on the ecosystems, and on the vegetation cover are necessary, in particular. This issue was studied at the Forest Ecological Laboratory *Vesetnieki* with the Forest Research Station *Kalsnava* by evaluating the ground cover vegetation in drained forests 15 and 35 years after amelioration and comparing it with similar undrained areas used as a control.

The answers to 4 main questions were sought:

1. What is the nature of the flora dynamics after the drainage?
2. How does the dynamics of ground cover vegetation reflect the changes in forest growing conditions (soil fertility, regimes of moisture)?
3. How to describe the biodiversity of vegetation and of what nature is its dynamics?
4. What is the dynamics of forest tree stand and how does it affect the composition of ground cover vegetation?

Material and methods

The field data on the ground cover vegetation were collected in 5 basins of the *Vesetnieki* laboratory forests. The laboratory was set up by Dr. K. Bušs and Dr. P. Zālītis about 35 years ago. The objective was to collect field data to investigate forest hydrological processes and work out the theoretical basis of forest amelioration in Latvia. The continuous measurements of water level in ditches and wells, and as well as the on-site meteorological observations are by now 35 years old. Besides this direction of research, a concurrent follow-up of the ground cover vegetation dynamics was conducted by Dr. A. Āboliņa, using permanent sample plots. This effort has resulted in a field data supported knowledge of the post-drainage changes in the projective cover for individual species or groups of species of the ground cover flora.

The ground cover vegetation at *Vesetnieki* was counted in 1975 by Dr. P. Zālītis with the aid of the points-squares method. Before counting a set of sample plots was established, which were evenly distributed on the area under study. The number of sample plots depended on the size of every basin (Table 1). In these basins (except Basin 5) the sample plots were located on both drained forests and originally dry sites.

Table 1. The number of sample plots in the *Vesetnieki* laboratory forests

Basin	The number of sample plots
I	46
II	95
III	101
IV	60
V	46

On every sample plot the vegetation was counted in 10 points, using an iron stick (3 mm in diameter, 1.5 m long) pierced into the soil. An individual representing a definite species was included in the count, if its leaves, flowers or stems touched the stick. In 1994 the author of this article repeated the counting by using identical methods on the same set of sample plots. At the same time the parameters of the tree stand were recorded too.

For the control, the ground cover vegetation in a virgin moss swamp representing the situation at *Vesetnieki* before amelioration was counted. The vegetation in this swamp was counted only in 1994. No forest management took place on this swamp, nor did changes uccur in the stand – the stock volume was constant – 40 m^3/ ha.

The dynamics of flora at *Vesetnieki*

The variations in the total amount of species remained unclear: in 1975 85 species of vascular plants and ferns were counted, while in 1994 – 86. In the joint list of both in 1975 and 1994 the species number 103. However, the number of species is not a universal index to describe the processes affecting ground cover vegetation after drainage. Some species wither away, while others appear instead. So, it appears that the points – squares method fails to give information on the unique species, which normally have a very small projective cover. Therefore, it may be concluded that the absolute amount of species at *Vesetnieki* is larger. At the same time the rare species are of little importance for describing the normal processes in ground cover vegetation.

The analysis of flora is the first step in the work on the ground cover vegetation dynamics. The species recorded belong to 43 families and 89 genera. All of them are common in Latvia, and the list does not contain any rare or unique species (Tabaka and etc., 1988). To evaluate the distribution of species, arbitrary indices describing the frequency of occurrence of every species were used : RO – rare occurrence (the species is rare, 1-2 specimens in some basins); AO – average occurrence (approximately 10 specimens in some basins); CO – common occurrence (species is widely spread in all the basins or is a dominant one in some of them) (Table 2).

The species defined AO are of great importance from the biodiversity point of view. They make up the greatest part of all recorded species. However, in some basins the dynamics of dominating species have special characteristics.

At *Vesetnieki*, 31 species belonging to 24 genera are found to be widespread (Table 3). Some species are numerous in all basins (*Rubus idaeus* L., *Rubus saxatilis* L.), the amount of other species has rapidly enlarged

Table 2. The families of flowering plants and ferns identified at *Vesetnieki*

Nr.	Family	The number of genera		The frequency of families		
		in family	at *Vesetnieki*	drained forests	dry sites	swamp
1.	*LYCOPODIACEAE*4	4	1	RO	AO	-
2.	*EQUISETACEAE*	1	1	AO	-	RO
3.	*HYPOLEPIDACEAE*	1	1	RO	AO	-
4.	*THELYPTERIDACEAE*	2	1	RO	-	RO
5.	*ATHYRIACEAE*	2	1	RO	-	-
6.	*ASPIDIACEAE*	3	2	AO	RO	
7.	*URTICACEAE*	1	1	CO	RO	
8.	*POLYGONACEAE*	4	1	RO	RO	
9.	*CARYOPHYLLACEAE*	23	1	RO	-	
10.	*RANUNCULACEAE*	17	3	RO	-	RO
11.	*DROSERACEAE*	1	1		-	RO
12.	*SAXIFRAGACEAE*	2	1	RO	-	-
13.	*PARNASSIACEAE*	1	1	-	-	RO
14.	*ROSACEAE*	23	6	CO	AO	-
15.	*FABACEAE*	12	1	RO	-	RO
16.	*OXALIDACEAE*	1	1	CO	AO	-
17.	*GERANIACEAE*	2	1	RO	-	-
18.	*EUPHORBIACEAE*	2	1	CO	RO	-
19.	*BALSAMINACEAE*	1	1	AO		
20.	*HYPERICACEAE*	1	1	RO		
21.	*VIOLACEAE*	1	1	AO	AO	RO
22.	*ONAGRACEAE*	4	2	CO	-	-
23.	*APIACEAE*	34	3	CO	-	RO
24.	*PYROLACEAE*	5	3	CO	-	-
25.	*EMPETRACEAE*	1	1	RO	-	RO
26.	*ERICACEAE*	8	5	CO	CO	CO
27.	*PRIMULACEAE*	9	3	CO	RO	-
28.	*MENYANTHACEAE*	1	1	-	-	CO
29.	*RUBIACEAE*	4	1	AO	-	RO
30.	*BORAGINACEAE*	13	1	RO		
31.	*LAMIACEAE*	26	3	CO	-	-
32.	*SCROPHULARIACEAE*	15	3	RO	CO	-
33.	*LENTIBULARIACEAE*	2	1	-	-	RO
34.	*VALERIANACEAE*	1	1	RO	-	-
35.	*DIPSACACEAE*	5	1	-	-	RO
36.	*CAMPANULACEAE*	3	1	RO	-	-
37.	*ASTERACEAE*	62	9	CO	AO	-
38.	*LILIACEAE*	13	3	AO	AO	-
39.	*IRIDACEAE*	3	1	RO	-	-
40.	*JUNCACEAE*	2	2	CO	AO	-
41.	*POACEAE*	67	9	CO	CO	RO
42.	*CYPERACEAE*	12	4	CO	AO	CO
43.	*ORCHIDACEAE*	19	2	RO	-	RO

RO – species of rare occurrence
AO – species of average occurrence
CO – species of common occurrence

(*Oxalis acetosella* L., *Urtica dioica* L.). At the same time, the projective cover of some species has decreased (*Carex appropinquata* Schum., *Pyrola rotundifolia* L.). There are no species dominating in all basins simultaneously, which attests to the diversity of dominating species in separate areas. The dominating species of some basins are not found in other basins (*Mercurialis perennis* L. in Basin III 1994 , *Calamagrostis canescens* (Web.) Roth in Basin V 1994 etc.). An invasion of some species is observed there – for example, *Oxalis acetosella* L. was not found in Basin I in 1975, but in 1994 it was a dominanting species. It must be pointed out that the dominating species of moss swamp (except *Oxycoccus palustris* Pers) are not encountered in drained forests.

It is possible to characterize the dynamics of ground cover vegetation using the Tchecanovsky's similarity index K(s). By comparing absolutely identical objects, the value of this index is 1. On the the other hand, if all components of the objects compared differ, the value of the similarity index is 0. The value of index is higher if the objects show greater similarity. At *Vesetnieki* the indices of similarity which describe the similarity of drained peatland vegetation with virgin undrained swamp (the initial ecosystem of drained forests) are very small – the value of this index in 1975 was 0.05, but in 1994 – 0.028. These values affirm the swamp ecosystem to have been totally transformed into forest. The value of similarity index between the vegetation of drained peatland forests in 1975 and 1994 was 0.55. This value confirms the dynamics of vegetation that has taken place over a period of 15 and 24 years after drainage.

The dynamics of ground cover vegetation as an indicator of forest growing conditions

The analysis of post-drainage dynamics of forest ground cover vegetation shows rapid spread of separate species and groups of species. Similar conclusions are true for other aspects of the forest ecosystems under drainage (Bušs, 1964; Āboliņa, 1977; Bušs, Āboliņa, 1968). The lowering of groundwater due to drainage by 10-20 cm is believed to be the main reason for changes, as the root system of trees is no more in an immediate contact with groundwater. At the same time the root system of most of the vascular plants lies mainly at the above mentioned depth and the resulting changes in moisture conditions favour a decline or remarkable reduction of the hygrophyte species. However, the diminishing of projective cover of hygrophytes is also observed in dry summers, when the lowering of ground water level resembles the effect of drainage (Āboliņa, 1977).

The fertility of the soil enhanced by the mineralization of peat is another factor affecting the ground cover vegetation. This process results in an increase in the amount of mineral nutrients in the soil, which stimulates the growth of vegetation favouring fertile soil. After the mineralization of peat is completed, rapid invasion of the drained peatland by Norway spruce (*Picea abies* (L.) Karst.) is also observed.

The presence of separate vascular plant species precisely characterizes the growing conditions on the corresponding site. For example, the presence of *Urtica dioica* L. in large amount attests to a high level of nytrogen in the soil, but some species characterize an acid (*Rumex acetosella* L.) or alkaline reaction (*Asperula odorata* L.) of the soil. The conditions of soil moisture are usually characterized with greater precision.

In order to describe the dynamics of growing conditions for the vegetation, we used phytocenological groups of plants, where the plants are classified considering their need in soil fertility, acidity, moisture regime and light conditions (Bušs, Āboliņa, 1968). There is a close correlation between the stand productivity and amount of phytocenological groups found on the corresponding forest site. The ground cover vegetation is arranged into 34 phytocenological groups of flowering plants and ferns. At *Vesetnieki* 32 of these groups were found. We analysed the amount of the groups by using a joint list of the evaluation data collected in 1975 and 1994.

The plants of every group have specific need in soil fertility. We designated the gradation in soil fertility by the following coefficients: 1 – oligotrophic plants growing only in very poor soils rich in mineral nitrogen; 2 – oligomesotrophic plants found mostly in poor soils; 3 – mesotrophic plants growing mostly in intermediate soils; 4 – mesoeutrophic plants growing mostly in soils rich in mineral nitrogen; 5 – eutrophic plants, only in soils rich in mineral nitrogen. The corresponding index for every gradation was calculated proceeding from the list for species in every basin and the projective cover of every species (Table 4). The average index of fertility for every basin was calculated for demonstrating the dynamics of soil fertility more clearly.

An increase in soil fertility was observed on the areas where the drained peatlands are dominanting (Basins I-III). The amount of Gradation 3 (mesotrophic plants) diminished while that of both Gradations 4 and

Table 3. Dominating genera and species at *Vesetnieki*

Nr.	Name of genera	Nr.	Dominating species at *Vesetnieki*	Drained forests					
				Basin I		Basin II		Basin III	
				1975	1994	1975	1994	1975	1994
1.	*URTICA* L.	1.	*U.dioica* L.	11	31	2	43	39	48
2.	*FILIPENDULA* MILL.	2.	*F.ulmaria* (L.) Maxim.	10	7	1	5	8	33
3.	*GEUM* L.	3.	*G. rivale* L.	-	-	-	-	3	26
4.	*RUBUS*	4.	*R. idaeus* L.	26	44	13	38	9	45
		5.	*R. saxatilis* L.	16	22	11	8	16	5
5.	*OXALIS* L.	6.	*O. acetosella* L.	-	60	27	150	38	79
6.	*MERCURIALIS* L.	7.	*M. perennis* L.	1	2	-	2	17	70
7.	*CHAMAENERION* RAFIN.	8.	*Ch. angustifolium* (L.) Scop.	1	-	1	-	1	20
8.	*ANGELICA* L.	9.	*A. sylvestris* L.	13	2	10	3	18	16
9.	*ANTHRISCUS* PERS.	10.	*A. sylvestris* L.	-	-	-	-	1	22
10.	*PYROLA* L.	11.	*P. rotundifolia* L.	16	1	19	2	2	-
11.	*CALLUNA* SALISB.	12.	*C. vulgaris* (L.) Hull	-	-	-	1	-	-
12.	*OXYCOCCUS* HILL.	13.	*O. palustris* Pers	-	-	8	2	-	-
13.	*VACCINIUM* L.	14.	*V. myrtillus* L.	-	4	18	20	14	8
		15.	*V. vitis - idaea* L.	-	-	12	-	8	6
14.	*LYSIMACHIA* L.	16.	*L. vulgaris* L.	3	16	3	10	11	12
15.	*MENYANTHES* L.	17.	*M. trifoliata* L.	-	-	-	-	-	-
16.	*GALEOPSIS* L.	18.	*G. tetrahit* L.	5	-	2	-	10	3
17.	*MELAMPYRUM* L.	19.	*M. pratense* L.	-	-	-	-	-	1
18.	*CIRSIUM* MILL.	20.	*C. oleraceum* (L.) Scop.	2	-	1	1	25	30
19.	*LUZULA* DC.	21.	*L. pilosa* L.	1	5	11	9	5	1
20.	*CALAMAGROSTIS* POANS.	22.	*C. arundinacea* (L.) Roth	-	7	1	-	16	86
		23.	*C. canescens* (Web.) Roth	30	5	13	-	34	17
21.	*DESCHAMPSIA* BEAUV.	24.	*D. caespitosa* (L.) Beauv.	-	8	3	3	4	38
22.	*MOLINIA* SCHRANK	25.	*M. caerulea* (L.) Moench	4	2	14	6	1	19
23.	*CAREX* L.	26.	*C. appropinquata* Schum.	15	-	31	-	33	41
		27.	*C. diandra* Schrank.						
		28.	*C. lasiocarpa* Ehrh.						
		29.	*C. limosa* L.						
		30.	*C. rostrata* Stokes						
24.	*TRICHOPHORUM*	31.	*T. alpinum* (L.) Pers						

Table 4. The dynamics of ground cover vegetation against soil fertility

Gradation of fertility	Basin I		Basin II		Basin III		Basin IV		Swamp
	1975	1994	1975	1994	1975	1994	1975	1994	
1	0.4	0.3	11.8	0.8	1.7	0.7	30.7	15.5	8.4
2	8.2	9.7	19.8	12.8	8.8	8.7	12.9	32.1	86.6
3	46.8	29.5	41.5	11.7	31.3	30.5	26.1	19.1	1.6
4	23.2	40.9	18.3	56.1	27.6	26.7	18.7	29.3	2.8
5	21.5	19.5	8.5	18.4	30.7	33.3	11.6	4.1	0.6
Average indices	3.57	3.69	3.65	3.78	3.77	3.82	2.57	2.74	2.01

5 increased. The process observed was similar in forests in drained mineral soils (Basins IV-V). However, in the originally moss swamp the index of fertility is significantly lower as compared with the drained forests. In the swamp Gradation 2 (poor soil vegetation) is dominanting. After drainage the fertility of the swamp soil increases. This process still continues for 35 years after drainage.

				Originally dry sites								Bog
Basin IV		Basin V		Basin I		Basin II		Basin III		Basin IV		
1975	1994	1975	1994	1975	1994	1975	1994	1975	1994	1975	1994	
9	1	7	5	-	-	-	-	-	-	-	-	
5	-	10	12	2	-	-	-	1	1	-	-	
2	-	9	6	1	-	-	-	-	-	-	-	
13	20	44	43	-	1	2	4	14	1	-	1	
6	12	13	9	-	1	-	-	7	3	-	-	
4	57	460	41	5	5	-	4	3	7	-	-	
-	-	-	-			-	-	-	-	-	-	
2	7	29	19			-	3	3	3	-	-	
1	-	4	9			-	-	2				
	-	2	-			-	-	-	-	-	-	
	-	-	-	-	-	-	-	-	-	-	-	
	23	-	-	1	-	39	24	7	7	7	18	
						-	-	-	-	-	-	78
12	65	3	13	10	11	29	46	17	35	5	17	
27	24	9	3	4	1	44	15	36	36	6	9	
8	10	7	9	-	-	-	-	1	-	-	-	
-						-	-	-	-	-	-	86
7	-	11	-			-	-	1	1	-	-	
1	6	-	-	1	1	5	10	-	8	-	3	
6	-	5	14	-	1	-	-	2	1	-	-	
2	12	1	2	-	2	1	1	3	-	-	-	
10	12	11	26	2	4	-	17	14	15	-	1	
15	10	5	79			-	-	3	13	-	-	
16	18	11	111	-	-	-	4	2	1	-	-	
12	40	-	11	1	-	5	1	6	5	7	3	6
1	1	12	1			-	-	3	-	-	-	3
						-	-	-	-	-	-	19
						-	-	-	-	-	-	40
						-	-	-	-	-	-	10
						-	-	-	-	-	-	13
						-	-	-	-	-	-	59

The dynamics of moisture regime was analysed in a similar way. Here 6 gradations were used : 1 – psyhrophytes (in extremely dry soils); 2 – mesopsyhrophytes (in dry soils); 3 – mesophytes (in fresh soils); 4 – mezohygrophytes (in moderately wet soils), 5 – hygrophytes (in wet soils); 6 – hygrohydrophytes (in extremely wet soils, sometimes in water) (Table 5).

The moisture regime has stabilized in the drained peatland forests of *Vesetnieki*. The average indices describing the moisture regime tend to decrease. The indices calculated show an increase in mezophytes in ground cover vegetation after drainage. At the same time the amount of hygrophytes and hygrohydrophytes diminishes in these forests but they do not become extinct. The difference between the moisture regime of the forest and swamp is very sharp and the effect of drainage was noticed before 1975 when the first counting was done. Over 19 years the moisture regime has undergone no essential changes.

Table 5. The dynamics of ground cover vegetation's moisture regime

The gradation of soil moisture regime	Basin I		Basin II		Basin III		Swamp
	1975	1994	1975	1994	1975	1994	
1	0.4	0.3	0.7	0.3	0	0	1.2
2	0	0	3.9	0	1.6	0.7	0
4	25.8	49.7	24.2	58.9	31.6	33.2	0.4
5	43.3	35.2	40.5	33.5	45.3	44.9	5.0
6	16.7	8.1	20.2	6.1	17.8	17.5	59.3
7	13.8	6.7	10.5	1.2	3.7	3.7	34.1
The average indices	5.16	4.70	5.03	4.48	4.91	4.90	6.22

The diversity of ground cover vegetation in drained forests

It is purposeful to analyse the biological diversity on the basis of definite territories. That allows us: 1) to compare the diversity between separate territories; 2) to trace the changes in biodiversity indices of one definite territory over a period of time. Thus it is possible to compare, in terms of biodiversity, the drained peatlands with forests growing in drained mineral soil on the territories where both drained and undrained forests are next to each other, or also between drained and undrained forests of the same site type.

To evaluate the biodiversity the Shannon's the index was used (Stugren, 1972). The value of this index is calculated for every basin of drained forests. The results indicate a slight decrease in the diversity of vegetation in drained forests over a period of 19 years (Fig. 1). The diversity of ground cover vegetation has been higher 15 years after drainage as compared with the situation 35 years after it. It is obvious that we must use other indices to characterize the biodiversity following drainage. For example, in virgin moss swamp, which corresponds to the original situation of the *Vesetnieki* forests before drainage the value of Shannon's index was less than for every basin of drained forests (H(s) = 3.331). At the same time the territory contiguous to both the drained forests and an undrained swamp shows the highest value of biodiversity (6.61 and 5.25 in 1975 and 1994, respectively). So, on the territories where drained forests and undrained areas interact the biodiversity is higher than on drained or completely undrained areas. Following the analysis of Latvia's forest sites in terms of ecosystem diversity similar conclusions were made (Zālītis, 1996).

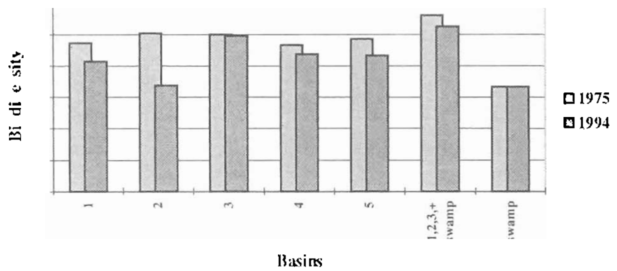

Fig. 1. The dynamics of ground cover vegetation diversity

To find out the specific reasons for biodiversity decrease in drained forests we analysed the dynamics of forest tree stand over a period of 19 years.

The dynamics of tree stand and its impact on the diversity of the ground cover vegetation

The tree stands of the Forest Ecological Laboratory at *Vesetnieki* are made up essentially of 4 tree species: *Pinus sylvestris* L., *Picea abies* (L.) Karst., *Betula pendula* Roth and *Betula pubescens* Ehrh., with *Alnus glutinosa* (L.) Gaertn. and *Populus tremula* L. met in rare cases. The aging of forest and projection of the tree crowns influence the projective cover and diversity of ground cover vegetation. The emergence of trees (artificial or natural) in clearings affects the light conditions for the ground cover vegetation resulting in the disappearance of the sun-loving plants. The natural succession changes the flora of clearings, too (Āboliņa, 1971). While over the period of our research the Norway spruce stands have become older by one age class (20 years), the light conditions for flowering plants and ferns have aggravated since 1975. The invasion of Norway spruce in drained forests is often due to an increase in soil fertility.

During our work we evaluated an increase in the amount of spruce, using the evaluation data for stands in every sample plot. Over 19 years the amount of mixed stands with the share of Norway spruce up to 30 % decreased while the amount of stands where the spruce accounts for 70-100% increased (Table 6).

Table 6. The distribution of tree stands (%) following the share of Norway spruce (*Picea abies* (L.) Karst.).

Basins	Years	The share of Norway spruce (%)		
		10-30	40-60	70-100
I	1975	81.8	18.2	0.0
	1994	53.3	26.7	20.0
II	1975	66.7	8.3	25.3
	1994	51.2	17.1	31.7
III	1975	38.9	25.0	36.1
	1994	26.3	21.1	52.6
IV	1975	50.0	9.1	40.9
	1994	33.3	20.0	46.7
V	1975	58.6	24.1	17.3
	1994	20.7	24.1	55.2

The diminishing of light conditions may also be described by the data on an increase in tree crown projections on the sample plots (Table 7). In all basins the projective cover of pine and birch decreases, but that for Norway spruce increases.

In order to characterize the changes in light conditions, we used the phytocenological groups described

Table 7. The projection of tree crowns on the sample plots

Basins	Scots pine *Pinus sylvestris* L.		Norway spruce *Picea abies* (L.) Karst.		Birch *Betula sp.*	
	1975	1994	1975	1994	1975	1994
1	55	43	16	105	120	111
2	181	131	122	226	120	62
3	20	10	128	167	153	96
4	69	104	81	168	65	48
5	7	2	98	120	132	91

above. Every group of plants has its specific need in light intensity. In this respect the plants are grouped in 3 gradations: 1 – light loving plants; 2 – half-shade tolerant plants; 3 – shade tolerant plants. We used a 4th gradation – light-loving *and* half-shade-tolerant plants as some plants can be included in both groups. So, the plants were arranged following the 4 indices and the average light intensity index was calculated (Table 8).

Table 8. The dynamics of light intensity index (%)

Gradation of light intensity	Basin I 1975	Basin I 1994	Basin II 1975	Basin II 1994	Basin III 1975	Basin III 1994	Basin IV 1975	Basin IV 1994
4	67.0	56.7	44.1	36.0	63.0	63.3	58.5	42.0
3	9.0	6.4	15.7	1.7	2.3	4.1	4.6	2.5
2	17.6	5.4	15.7	4.7	7.1	3.1	20.7	10.4
1	6.4	31.5	24.5	57.5	27.6	29.5	16.2	45.0
The averaga indices	3.36	2.88	2.79	2.16	3.01	3.01	3.05	2.41

Gradations: 1 – shade tolerant plants; 2 – half-shade tolerant plants; 3 – light and half-shade tolerant plants; 4 – light loving plants.

The diminishing of the average light intensity index reflects an increase in shading of the ground cover vegetation. It may be concluded that the intensity of light over a period of 19 years decreased. In some basins the changes in light index are not very considerable while in all basins the amount of shade-tolerant plants has increased. It confirms the diminishing of light in drained forests as a result of the wood increment. The number of light loving species decreases, however that of shade tolerant plants increases.

Conclusions

1. The ground cover vegetation of forests shows a prompt response to any management activities, in the given case – forest drainage. The cover of hygrophyte species diminishes while the mesophytes appear instead.

2. In the forests of the Ecological Laboratory *Vesetnieki* 103 species of flowering plants and ferns belonging to 89 genera and 43 families were recorded. The frequency of 31 species of 24 genera and 16 families was high.

3. There are differences in the distribution of dominant species in forests. In drained forests the species typical of undrained areas were not recorded. The similarity of originally undrained areas with the drained forests is very low (Tchecanovsky's similarity index K(s) in 1975 and 1994 was 0.05 and 0.028, respectively).

4. The dynamics of ground cover vegetation describes the changes in forest growing conditions after drainage. The dynamics of vegetation reflects an increase in soil fertility and the stabilisation of moisture regime. The increment of Norway spruce stands influences the light conditions of ground cover vegetation. As a result, the cover of shade tolerant plants increases, however, that of light loving and half-shade tolerant plants diminishes.

5. It is purposeful to analyse the biological diversity on the basis of definite territories. In the drained forests analysed the Shanon's diversity index lies between H(s) = 3.337 and 5.029. These values are higher than on undrained areas – (H(s) = 3.331). Over the last 19 years a slight decrease in biodiversity in drained forests was observed along with increasing wood increment.

6. The drainage of wetland forests intermittently with areas left undrained enhances the biodiversity. The value of Shanon's diversity index H(s) on these areas was 5.61 and 5.25 in 1975 and 1994, respectively.

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ДИНАМИКА ФЛОРИСТИЧЕСКОГО СОСТАВА И РАЗНООБРАЗИИ ЖИВОГО НАПОЧВЕННОГО ПОКРОВА ПОСЛЕ ЛЕСООСУШЕНИЯ

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Резюме

После лесоосушения происходят значительные изменения в живом напочвенном покрове леса. Гигрофитов и мезо-гидрофитов заменяют мезофиты. В стационаре Весетниеки Лесной опытной станции "Калснава" выявлено 103 вида цветковых растений и папоротников, которые принадлежат к 89 родам и 43 семействам. В осушенных лесах чаще всего встречается 31 вид, принадлежащий к 24 родам и 16 семействам.

В осушенных лесах не встречаются виды доминирующие на переходном болоте, которые характерны для лесов стационара до осушения. Сходство переходных болот и осушенных лесов характеризуют незначительные по величине коэффициенты сходства Чекановского (К(с) 1975 и 1994 г.- 0,05 и 0,028).

Динамика живого напочвенного покрова характеризует изменение условий произрастания растений леса после осушения. Изменения живого напочвенного покрова указывают на увеличение плодородия почвы и стабилизацию гидрологического режима. На освещение растительности влияет увеличение покрытия крон ели, в результате чего понижается жизнеспособность светолюбивых пород.

Биоразнообразие природы целесообразно изучить на основе конкретных территорий. Для характеристики разнообразия живого напочвенного покрова во всех осушенных лесах стационара использованный индекс Шенона Х(с) колеблется в пределах 3.373 - 5.029. Эти показатели намного выше по сравнению с неосушенным переходным болотом (Х(с) - 3.331). Биологическое разнообразие выше на территориях, где встречаются как осушенные, так и неосушенные площади (Х(с) 5.25-5.61).

Ключевые слова: осушенные леса, живой напочвенный покровь, биологическое разнообразие, биологическое сходство.