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CONSERVATION OF BIODIVERSITY IN ECOSYSTEMS OF THE BOREAL FORESTS

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Abstract

Biodiversity in forest ecosystems is the main indicator of the stability and sustainability of the system. It is also a sign of ecological community orientation to a state of stable fluctuated equilibrium - homeostatic state. Implementation of any forest management activities must be accompanied by the trend of natural systems tending to a stable state. In Russia forest resources are mostly relates to a commercial forest (intended for logging). Important element of biodiversity conservation program in forest ecosystems is the preservation of the natural gene pool during all management activities. Long-term studies on stationary objects (since 1929) in the North-West Russia indicate that during harvesting with preservation of young retained undergrowth at the same time we preserve not only the undergrowth but the understory and ground cover also. Quantitative changes of biodiversity in forest ecosystems, as a consequence of any management activities, are just some of the intermediate indicator of changes in forest biogeocenosis, but do not explain their dynamics. Only perennial detailed observations of the dynamics of vegetation changes, at different stages of succession, provide a complete picture of nature and process of returning the system to homeostatic state.

Keywords: biodiversity, homeostasis, forest ecosystems, forest management activities, experimental objects with long-term observations

Introduction

The problem of biodiversity conservation is particularly acute in occasions of intense human impact on forest ecosystems. A large amount of forests, in the forest fund of Russia, belongs to a commercial forest. It means that there is allowed to carry out all types of logging operations, reforestation and water conservation. Important element of biodiversity conservation in forest ecosystems is to keep the original, natural gene pool, in the performance of any management activities. First of all it concerns the undergrowth - the young generation of main forest species.

Objects and methods

The experimental work was conducted since 1929, during 85 years, and it considered variety of experiments located inNorth-West of Russia.
The objects of research were mixed spruce-birch stands. In the various stages of their growth, different intensity of thinning cuttings was carried through. The studies covered four test sections and one control section, in witch there was no any forest management activities (Table 1).

Table 1. General characteristics of the objects of study “PP1”, 2012

General characteristics	Control section (A)	Test sections			
		B	C	D	E
The composition of the stand	**I** 10Б+Ос+С **II** 10E	9E1C	9E1C	8E2C	10E+C
Relative completeness	0,9	0,5	0.5	0,5	0,6
Timber volume, m3	**I** 348 **II** 148	301	331	321	432
Condition types	C2	C2	C2	C2	C2
The intensity of thinning cuts,%	-	15-24	25-34	35-45	over 45

(Б - Silver birch; Ос - Trembling aspen; E –Norway spruce; C – Scots pine; ***I*** *– first layer,* ***II*** *– second layer)*

Differentiation by the age, height, and diameter is typical for the mixed stands. And that is the reason of their horizontal and vertical differentiation [5].
Accounting of undergrowth, underbrush and ground cover was performed by selectively statistical method: the circular areas of 10 m^2 were placed one by one, touching each other, in three or more different rows, throughout the experimental objects. The sample magnitude must be at least 2% of the total subject area (Grjazkin, 1997), but because the studies were performed on stationary objects, some sections were enumerated completely. During that accounting procedure, special attention was paid to their qualitative and quantitative characteristics which directly, or indirectly, was the indicator of dynamic processes and the state of forest ecosystems.

Results and Discussion

Our results showed that not only the structure of forest communities were under the influence of thinning cuts, but also were the microclimate and the environmental conditions [1, 2, 3, 4, 5, 7, 8]. The main out come of the thinning cuts was releasing of a part of the soil resources, which resulted in the extra growth of ground cover, soil protection and resource-saving. Those structural changes of forest communities aimed to restore the homeostatic state of the system. This implies that those extra soil resources are fixed in the biological cycle throughout enhanced growth and development of the lower vegetation layers (ground cover).
Thinning cuts were conducted in different intensity from 1929 to 1973, at 4 of those 5 test sections. Accounting of the understorey vegetation barred 5 years after the last cycle of thinning cuts, showed that the implementation of a strong (35-45%) and very severe thinning cutts (over 45%) leads to an increase in the proportion of shrubs and subshrubs, compared to the control section. Also, at these facilities, there was noticed an increase in the proportion of ground cover, cranberries and raspberries, which in turn improves the habitat conditions (Belyaeva, 2011). Along with the development of the moss layer after strong and very strong thinning cut, active growth of heliophyte grass cover is also observed. This is the expected response of forest ecosystems to a strong anthropogenic influence, and it also indicates the increasing intensity of the biological cycle.
The results of observations made in the course of 15-20 years after the last cycle of thinning cuts show that the proportion of subshrubs, grasses and mosses, corresponds to parameters in the control section, and that prove that ecosystem has recovered and returned to a state of a stable fluctuated equilibrium.
Comparative quantitative analysis of biodiversity undergrowth, bushes and ground cover in the control section, and the sections in which thinning cuts of varying intensity was conducted, shows

that the medium and low intensity of thinning cut lead to a decrease in the number of species. In the other hand, their high intensity (of about 50%), generated their increase (Table 2).

Table 2. Biodiversity of understory vegetation on the experimental object “PP1”, 2012

Section	Intensity of Thinning cuts,%	Biodiversity, number		
		Undergrowth	Underbrush	Ground cover
A	Control section	3	1	29
B	15-24	2	2	24
C	25-34	3	2	24
D	35-45	3	1	21
E	>45	4	2	30

This is primarily due to the appearanceof ruderal species. At the same time, there is also a relatively high biodiversity of all structural elements of the understory vegetation on other sections. The reason for this is the fact that the last thinning cuts was carried out 40 years ago, and during that time all the sections have already come back to a state of homeostasis.
The structure and the biological characteristics of the control sections is the same as the original state of all the other sections was before starting thinning cuts in 1929. Consequently, the birch prevails in the main layer and spruce is present only in the second layer. After thinning cuts in sections B, C, D, E spruce become edificator, with the 80% participation in the first layer. This means that thinning cuts caused changes of the environmental conditions. It follows that the quantitative analysis of biodiversity cannot give a complete picture of the dynamic processes at these facilities.
Environmental changes that have occurred as a result of thinning led to qualitative and quantitative changes in ground cover. The study of ground cover was focused on identifying its species diversity, and the projective cover. After thinning cuts, the share of helophytes and shrubs, comparing to the control section, increased. But after 20 years that proportion came close to the original state of dynamic equilibrium (Belyaeva, 2011, 2006; Melnikov, 2006). The results of studies in 2012 showed that the total projective ground cover is the largest in section E *, and the smallest in section A (Table 3).

Table 3. Characteristics of the stand and ground cover on different sections of experimental object “PP1”, 2012

Section	Composition of stand	Completeness	Average age, age	Total projective cover of ground cover, %	Share of ruderal species of ground cover, %
A	10Б+Ос+С	0.9	123	110.8	18.9
B	9Е1С	0,5	123	142	5.6
C	9Е1С	0,5	123	137.8	8.9
D	8Е2С	0,6	123	140.6	3.8
E	10Е+С	0,7	123	161,4	4.3
E*	10Е+С	0,7	123	173.1	9.1

(Б - Silver birch; Ос - Trembling aspen; Е –Norway spruce; С – Scots pine)

The main reason for expansion of ground vegetation is the fact that the section E * was completely cleaned of underbrush in 1994, and also the thinning cut of high intensity (over 45%) was

performed. The reason for the relatively small projective ground cover in the control section, most likely, is a well-developed second layer of spruce, as well as the relatively high number of undergrowth of spruce that shade near-surface layers. An unexpected result was obtained in section A. The reason for those results was that the second layer of the undergrowth of spruce was clump (group) located. Therefore, the certain number of glades occurs in the canopy of birch, and they were the niches for ruderal species, which possessed 18,9% of all ground cover (Table 3.).
Dynamics of undergrowth and ground cover determined changes in the stand, and were responsible for the reforestation processes in the forest ecosystem. The success of the thinning cuts of varying intensity can be estimated by a large number of signs, such as changes in the stock and structure of forest stands, forest conditions, and the composition and morphological (qualitative and quantitative) characteristics of the forthcoming reforestration.
An important factor in that reforestration after thinning cuts is a competitive correlation between underbrush and undergrowth. Changes in environmental conditions after thinning cuts at some stage causes the appearance of the fast-growing underbrush, particularly rowan. According to the account in 2012, with an increase in the intensity of thinning cuts, rapidly increased the number of rowan, with the exception of section E, where the intensive thinning cuts of underbrush in 1994 was conducted as a measure to encourage natural regeneration (Table 4).

Table 4. Characteristics of understory vegetation on experimental object “PP1”, 2012

Section	Intensity of thinning cut, %	Strength, number/hectare		Share of a large, %		Total projective cover of ground cover, %
		Undergrowth of Spruce	Underbrush	Undergrowth of Norway spruce	Underbrush	
A	Control	3748	9729	31	37	110.8
B	15-24	6499	6884	3	72	142.0
C	25-34	3292	5666	9	64	137.8
D	35-45	9549	10350	1	97	140.6
E	>45	4520	4680	26	56	163.4

This study showed that the distribution by size categories - the underbrush on the one, and regrowthon the other hand, is inversely proportional. That is, the larger the underbrush is, the smaller regrowth is.
Researching results also indicate that the 35-45% intensive thinning cut provides the best spruce regeneration. It should be emphasized that it also encourages the widening of the underbrush to a large degree, resulting that large undergrowth is practically missing. On the other side on the section E, where the intensive thinning cutting of underbrush was conducted, a large amount of high quality spruce undergrowth appeared (Table 4).

Conclusion

Quantitative changes of biodiversity in forest ecosystems, as a consequence of any management activities, are just some of the intermediate indicator of changes in forest biogeocenosis, but do not explain their dynamics. Only perennial detailed observations of the dynamics of vegetation changes, at different stages of succession, provide a complete picture of the nature and process of returning the system to homeostatic state.
Conducting the thinning cuts of the medium intensity (30-40%), together with the subsequent regulation of the amount of underbrush, provides the growth of the high quality stands in the future. A predominance of commercially valuable species allows their subsequent successful natural

regeneration. The regular implementation of these activities does not contradict the ecological processes in the forest ecosystems, and the system stability (homeostatic state) will be rapidly achieved.

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