Assessment of living ground cover under the influence of logging activities in the taiga zone

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Abstract. The influence of logging activities on the taiga ecosystems of the North-West is ambiguous. As a result of clear felling, tree and shrub vegetation is destroyed, which subsequently, as a result of a sharp change in environmental factors, makes a fundamental change in the biodiversity of the living ground cover. There is a complete change of botanical forest species that are part of the living ground cover for the species diversity characteristic of open landscapes. The overgrowth of clearings with grasses and undergrowths occurs depending on the typological characteristics of the felled stand and the season of the felling year. The subsequent overgrowth of clearings with herbaceous vegetation depends not only on the species composition of reforestation species, but also on various natural conditions - the features of the relief, climatic, soil and hydrological conditions. Therefore, the process of restoration of felling areas is not always positive. In order to ensure rational, sustainable and sustainable forest management, it is necessary for timber industry organizations and specialists of the forestry complex to use various measures prescribed in the “Methodological Recommendations for the Conservation of Biological Diversity in Timber Harvesting in the Vologda Region”.

1. Introduction

Forest as a self-sufficient, self-regulating and self-restoring ecological system can exist for many centuries in the absence of the impact of forest-destructive anthropogenic factors (deforestation, fires, flooding of the territory, unregulated grazing, etc.). At present, almost all forest biogeocenoses and their constituent components have been changed to one degree or another by human economic activity. Any anthropogenic impact leads to a reduction in the diversity of the biocenosis. Logging activity, as one of the serious types of anthropogenic impact, makes a significant contribution to the change of ecosystems [1; 2; 3]. Deforestation with the use of heavy logging equipment in vast areas leads to a number of adverse consequences for forest ecosystems: disruption of the climatic and soil-hydrological regime, damage and death of undergrowth and undergrowth, change in the species composition and biodiversity of the ground cover, etc. [4].
2. Object and research methods
As test plots, areas after clearcutting were considered as having the most significant impact in comparison with other types of felling. A sharp change in natural conditions leads to the onset of long-term changes in all components of the forest biogeocenosis, including the structure and species composition of the ground cover and tree and shrub vegetation.

The selection, establishment and examination of test plots in order to assess the impact of logging activities on tree and shrub vegetation and living ground cover was carried out using the method of forest typological survey. On the area of the clearing (stand) and in the young stands, circular relasopic plots with an area of 10 m² (R = 1.78 m) were laid. Since the areas of felling are very large, and accounting for renewal should be linked to certain relief elements (forest types), an area of about 3 hectares is allocated in the felling area, tied to relief elements and one type of forest. 20 sites for renewal accounting are laid on it. In each circular area, a continuous enumeration of phytocenosis elements was carried out.

3. Results and discussion
Change in the ground cover under the influence of felling. Removal of the stand canopy leads to a sharp change in the ecological conditions for the existence of preserved and developing vegetation [5-11]. In felling areas, as a rule, there is a phase of herb-dwarf shrub associations, which settle in the cutting area in the first ten years after the felling of a mature forest. Depending on the typological characteristics of the stands, cut by felling, and the season of the year, when the felling was carried out, the cuttings are overgrown with grasses and undergrowth. Comparative analysis of the dynamics of structural changes and species composition of the undergrowth makes it possible to trace how changes occur in the processes in clearings and under the forest canopy.

There is a gradual change of biocenoses with the formation of herbaceous communities with a new complex of soil microflora and zoocenosis of open areas. The formation of new communities of phytocenosis of the living ground cover is dynamic. At the initial stages, after clearcutting, forest vegetation remains for some time, but over time, conditions appear for the formation of ecotopes [12]. The new floristic composition of “open” phytocenoses formed over time is more diverse than the original forest one. The species diversity of the living ground cover after forest felling increases due to a sharp and significant increase in illumination under the canopy of the stand, contributing to the appearance of a large number of light-loving species. For some time, the parallel existence of meadow and forest areas is possible, followed by a predominance of vegetation in open areas. As the felling area becomes overgrown with tree and shrub vegetation, a gradual return of forest species to the phytocenosis is observed. However, in each specific phytocenosis, the species composition can differ markedly. The floristic richness of felling areas depends on several factors - the scale of felling, the distance to farmland and villages, climatic conditions, etc. The living ground cover in the communities under consideration is characterized by structural heterogeneity within a particular forest type. Most of the plants in these areas are mesophytes and mesotrophs.

In the clearings of the North-West of Russia, which includes the Vologda region, significant changes in the integral characteristics of phytocenoses, that is, the species richness of vegetation in clearings, occurred on average over 25 years of succession, which does not contradict the data of N.G. Ulanova (1989) [5]. The species richness of vascular plants in the process of overgrowing increases by 4 times during the first 3 years in relation to the original type of forest. Subsequently, there is a gradual decrease in the total number of species, while there is a significant high correlation between the total number of species and age after cutting (r = −0.90). Examples of diverse plant communities after clearcutting are shown in figure 1 (from a to c).

It is known that herbaceous plants have retained and developed many adaptive qualities and, unlike woody ones, are more perfect in ecological and evolutionary terms when exposed to unfavorable conditions, primarily due to the ability to avoid the annual passage of the most vulnerable phases of seed germination and seedling formation.
So, for example, when considering individual species from the group of taiga large grasses typical of intact forests in the protected area of the Russian North National Park (Aconitum septentrionale, Athyrium filix-femina, Cacalia hastata, Cardamine macrophylla, Cicerbita uralensis, Cirsium heterophyllum, Cirspium olerace paludosa, Crepis sibirica, Diplazium sibiricum, Dryopteris carthusiana, Dryopteris expansa, Dryopteris filix-mas, Filipendula ulmaria, Geum rivale, Impatiens noli-tangere, Lathyrus gmelini, Matteuccia struthiopteris, Senecio nemorelvis, Struthiopteris, Senecio nemorelvis, Struthiopteris) there is a clear and unambiguous pattern in the preservation of both the total abundance and the occurrence of certain species.

In a 100-year-old forest formed at the site of felling, the number of large taiga species per sample plot is only about 30% compared to intact forest, with a significantly lower total abundance (about 35% of the initial). There is also a number of species that are not included in the group of large taiga grasses that react in a similar way to forest felling. This tendency of this group of species in the plant communities of clear-cut areas in comparison with intact forest is associated with a sharp change in environmental conditions, first of all, humidity and temperature regime of the upper soil horizons. So, in areas of clear cut areas, the amplitude of daily fluctuations in humidity and temperature of the surface air layer can be 2.0-2.5 times higher than under the forest canopy, and even reach temperatures of 15-20 °C and humidity of 50-60% in summer. At the same time, in summer, the average daily temperature in clearings is everywhere higher, and the average daily humidity is lower than under the canopy. This leads to the most rapid loss of precisely those species that require high soil moisture and surface air for their development.

For clear-cut areas with normally moistened soils, as a rule, the predominance of the herb-dwarf shrub layer over the moss layer is characteristic; on the waterlogged soil, the share of mosses increased by 35% compared to areas not affected by felling. The share of herbaceous vegetation has decreased by 35%. As a result of clear felling of the forest, the species characteristic of dark coniferous plantations, such as the two-leaved canyon and the forest horsetail, have almost disappeared from the grass and shrub cover. Plants appear - hygrophytes (for example, marsh horsetail). Felling has led to a change in the richness of the soil towards an increase in dryness or, conversely, moisture, which leads to the loss of humus, soil fertility and its poverty.

Also, the impact of clearcuts enhances transformation processes in the living ground cover. Forbs types are formed.

In the first year after felling, the species diversity of the living ground cover is observed. Non-clearcutting leads to a decrease in the proportion of megatrophic plants in comparison with closed areas of the forest, where their abundance is observed (dioecious nettle, common whitewash, European gingerbread). After clear felling without preserving undergrowth, the projective cover of the herbaceous cover is 100%, which indicates the development of, first of all, grasses and shrubs. At clearcut sites with preliminary regeneration (with preservation of undergrowth), the amount of undergrowth decreases, so there is an active growth of undergrowth, which creates competition for the young generation of undergrowth (especially coniferous) for light, moisture, and nutrients.
a. Grain and fireweed cover of fresh (up to 3 years old) felling on loamy intact soils (primary forest type E is oxalis).

b. Forbs (left) and willow-crimson (right) ground cover in 3-year clearings (the primary forest type E is oxalis.).

c. Intact lingonberry (left) and heather (right) ground cover of fresh one-year clearings on sandy loam soils (primary forest type - C bilberry).

Figure 1. Types of ground cover (a-c) in the territory after clearcutting during the initial recovery period (1 - 3 years) in the Vologda region.

4. Conclusion

The forest system has optimal environmental sustainability and is able to recover from certain disturbances. But in the case of the impact on the forest biogeocenosis of serious or large-scale disturbances, the natural ecosystem will be subject to degradation and even death. So, for example, due to the close location of groundwater to the day surface in the Vologda region, clear cuttings without observing the rules of timber harvesting often lead to swamping of vast territories and their subsequent loss to the forest fund. According to the legislation of the Russian Federation, in the process of nature management, it is necessary to take measures to preserve biological diversity, natural ecological systems, natural landscapes and natural complexes, sustainable forest management, and increase their potential. The same requirements are reflected in the new Forestry Code of the Russian Federation, as well as in forestry regulations. Biodiversity conservation implies the maintenance of historically formed landscapes and ecosystems in the forest fund, which are the habitats of various groups of living organisms.

In order to use the requirements of federal and regional legislation in the field of environmental protection in forestry, forest regulations, as well as to meet the requirements of voluntary forest certification (in particular, according to the FSC system) for the preservation of biological diversity,
"Methodological recommendations for the preservation of biological diversity in timber harvesting in the Vologda region" (2013). These methodological guidelines are used by forestry organizations and specialists of the forestry complex of the Vologda region and provide for a number of measures aimed at ensuring the rational and sustainable use of forests, their protection, protection and reproduction, based on the principles of sustainable forest management and conservation of biodiversity of forest ecosystems, increasing the ecological and resource potential of forests, meeting the needs of society in forest resources on the basis of scientifically grounded, multi-purpose forest management [13].

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