

Research Article

Changing the Diversity of Tree-And-Shrub Species According To the Forest Inventory in Eastern Transbaikalia

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ABSTRACT:

The results of analyzing the changes in the species composition of the forest fund in the territory of Eastern Transbaikalia have been provided for the period between 1956 and 2016 with the aim of identifying trends in the spatiotemporal variability. For obtaining information about resources of the forests in the region, materials of the State Forest Inventories and State Forest Registers have been retrospectively studied, which contain information about the main forest-forming tree species with division into coniferous, hardwood and softwood plants, as well as about other tree species and shrubs. The total of 23 dominant tree and shrub categories involved in the forests formation in the Eastern Transbaikalia have been allocated, of which 11 categories have remained unchanged. As a result, it has been found that over the past 60 years, significant growth has been observed in the diversity of tree and shrub species, as well as the displacement of the zonal categories of trees and shrubs; the process of "green desertification" has been observed. Geographically, this process occurs unevenly, causing spatial diversity of changes in the areas. The most prosperous of all forest areas in the Eastern Transbaikalia is the Baikal mountain-forest district. The territory passed by the Trans-Siberian Railway – the Trans-Baikal mountain forest district – was significantly developed.

Keywords: Eastern Transbaikalia, biodiversity, trees and shrubs, Forest Fund, forest-covered area

[I] NTRODUCTION

Of the numerous issues that have been widely discussed lately, one of the priorities is the problem of studying global warming for predicting the response of the forest cover to climatic variability. Numerous studies predict further reduction of forests' sustainability on large areas and performing a variety of functions [1-5]. Despite the fact that there are many factors and several uncertainties in assessing the effect of

climate variability on the forests, there is also quite a reasonable assumption that forest transformation has started and boundaries of the forest vegetation are shifting [6, 7].

Eastern Transbaikalia (Zabaykalsky Krai) is one of the entities of the Russian Federation rich in forests. Its share in the category of the Russia's "wooded land" is 3.6 % [8]. Over the period from 1950 until present, intense climatic variability has

been observed in the territory of the Krai: the surface air temperature has increased by 1.9 °C, and in the changes in the annual amount of precipitation, clearly visible cyclicity has been observed: the period from 1965 to 1981 was a period of reduced humidity, from 1982 to 1998 – a period of increased humidity, from 1999 to 2009 – a period of reduced humidity, and from 2010 until present – again a period of increased humidity. An assumption has been made that if the temperature keeps rising, hard climatic conditions will be observed in the next period of low humidity. This will naturally affect the forest cover in the region. One of the real ways of obtaining regional information about forests is the forest inventory data from forest management. This paper was aimed at studying the trends of spatiotemporal variability of the species composition in the region over the period between 1956 and 2016.

[II] MATERIALS

The data of the State Inventories of Forest Resources (SIFR) and State Forest Registers (SFR) are generalized information for obtaining the information about forest resources in Eastern Transbaikalia. The very first data about SIFR in the region were published in 1956 in the Statistical Handbook on Forest Fund of Russia. Afterward, such data were published until 2003 in approximately five years' intervals. According to the Forest Code, the term "State Forest Fund" was replaced with "State Forest Register". Since 2008, SFR of the region has been updated annually.

This article is based on the information obtained from the databases of SIFR and SFR for the Zabaykalsky Krai as of first of January in years 1956, 1961, 1966, 1973, 1978, 1983, 1988, 1993, 1998, 2003, 2008 – 2016 [9, 10], and State reports for years 1995, 1997, 1999, 2002 – 2016 [11-15].

SIFR and SFR provide information about the main forest-forming tree species with division

into coniferous, hardwood and softwood plants, as well as about other tree and shrub species. Moreover, according to the data available, hardwood species were for the first time allocated in the SIFR dated 01.01.1998. The exact number of species in the forests of the region is very difficult to be determined since the forest inventory in the process of forest management indicates only the generic name in the plantations composition. According to the materials of SIFR and SFR, over the 60 year period, the total of 23 dominant tree and shrub categories involved in the formation of forests of Eastern Transbaikalia have been allocated. These include: "larch", "birch", "pine", "cedar", "aspen", "spruce", "poplar", "fir", "gray alder", "black alder", "willow tree", "elm", "apricot", "bird cherry", "apple tree", "shrub birch", "dwarf pine", "purple willow", "shrub willow", "shrub alder", "sea-buckthorn", "other tree species", "other shrubs". Given the fact that some categories have not been always allocated over this long period due to their scarcity, it turned necessary to join "poplar", "gray alder", "black alder", "elm and other elms", "apricot", "bird cherry", "apple tree", "shrub alder", "sea-buckthorn", and "other shrubs" into category "other tree species". Category "purple willow", which was allocated in the SIFR until 1966, has been called "shrub willows" from 1973 until the present, and category "dwarf birch" has been renamed to "birch shrubs". Category "elm" includes all elms in the region. As a result, an ordered series of data have been obtained about the areas of tree and shrub species prevailing in the region. In the end, 11 categories remained unchanged, which had been considered based on the List of Forest Zones of the Russian Federation and the List of Forest Areas of the Russian Federation [16] for the period between 2005 and 2016 (the available period).

[III] RESULTS

Over the 60-year period, the area covered with forest vegetation has increased significantly (by 20.3 %). This increase was uneven in terms of the

predominant species. The area covered by coniferous species (larch) has reduced, and the area covered by softwood species (birch), shrubs (shrub birch) has increased (Table 1). For the remaining categories, minor fluctuations have been noted.

Identification of the dependencies between changes in the acreage of the main species and the climate has revealed the presence of statistically significant correlations for several selected categories. A positive correlation (0.25 – 0.5) was observed for birch, cedar, shrub birch and shrub willow, dwarf pine, and other tree species, while negative correlation (0.1 – 0.4)

was observed for pine, larch, aspen, spruce, and fir.

Analysis of the dynamics of the areas covered by tree and shrub species across forest zones and regions of the Krai has revealed spatial variability in the number of species in the forests of the region. Over the 11-year period, 45 % of its area has undergone changes in the composition of the tree-and-shrub vegetation (Figure 1, Table 2).

In the Steppe zone that includes the forest-steppe Zabaykalsky region, slight growth was observed (by 0.015 %) in the diversity of shrub plantings in three categories: "shrub birch", "dwarf pine", and "other wood species", as well as decreased shares of larch, birch, and spruce.

[Table-1]. Dynamics of the areas with the species predominant in SIFR and SFR for Eastern Transbaikalia

Category name, % of the area covered with forest vegetation	Years of accounting																				Changes Over the 1956 – 2016 period. %
	1956	1961	1966	1973	1978	1983	1988	1993	1998	2003	2008	2009	2010	2011	2012	2013	2014	2015	2016		
larch	81.0	75.8	68.3	63.8	61.0	58.9	57.8	56.9	55.2	57.0	56.8	55.6	55.6	55.6	55.8	55.8	56.1	55.8	-25.2		
birch	3.1	6.1	12.2	14	14.5	14.8	15.2	15.5	16.0	16.3	16.6	18.0	18.1	18.0	18.0	18.0	17.9	18.0	+14.9		
pine	9.3	10.1	9.6	10.2	9.8	9.7	9.5	9.1	8.6	8.8	8.6	9.1	9.0	9.0	9.0	9.0	9.0	8.9	-0.4		
cedar	1.5	2.9	2.9	3.5	3.4	3.1	3.5	3.4	3.5	3.6	3.6	3.4	3.0	3.4	3.4	3.4	3.4	3.4	+1.9		
aspen	0.1	0.2	0.8	1.2	1.2	1.3	1.5	1.5	1.6	1.7	1.7	1.8	1.8	1.8	1.8	1.8	1.8	1.8	+1.7		
spruce	0.003	0.04	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03	+0.027		
fir	0.007	0.01	0.01	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	+0.003		
shrub birch	0.4	0.2	1.8	3.07	4.7	5.8	5.8	5.8	5.8	5.8	5.8	5.5	5.6	5.5	5.5	5.5	5.5	5.5	+5.1		
dwarf pine	4.2	4.3	3.8	3.8	4.7	5.8	5.8	5.8	5.8	5.8	5.8	5.5	5.5	5.5	5.5	5.5	5.5	5.5	+1.3		
shrub willow	0.002	0.0004	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.03	0.03	0.02	0.03	0.03	0.03	0.03	+0.028		
other tree species	0.01	0.05	0.09	0.1	0.1	0.1	0.3	0.4	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	+0.59		
Total area covered with forest vegetation	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100			

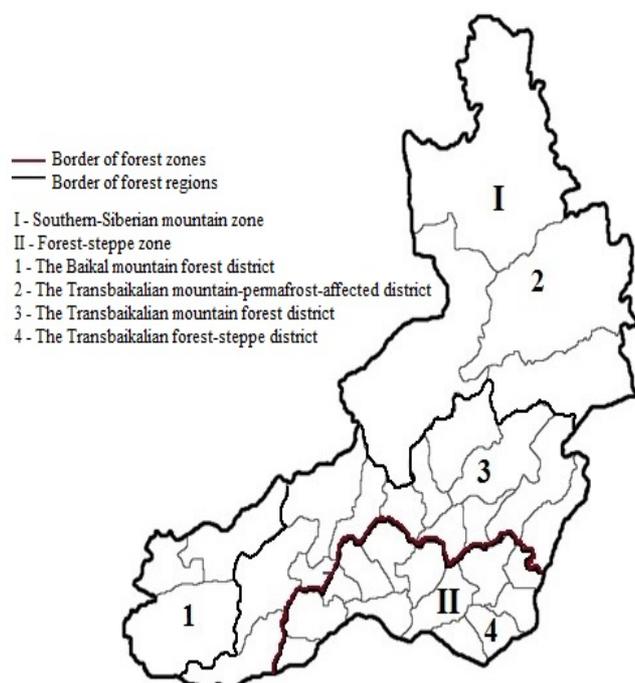


Fig. 1: Forest zones and forest areas layout in the territory of Eastern Transbaikalia

[Table-2]. Dynamics of the areas covered with the species predominant in SIFR and SFR for Eastern Transbaikalia

Forest division name	Changes over the period of 2005 – 2016, %										
	larch	birch	pine	cedar	aspen	spruce	fir	shrub birch	dwarf pine	shrub willow	other tree species
Aginskoye	0	0.02	0	0	0	-0.11	0.01	0	0	0	0
Akshinskoe	0.02	-0.08	0	0	0	0.06	0	0.03	0.01	0	0
Aleksandrovsko-Zavodskoye	0.005	0.03	0	0	0	0.11	0	0	0	0	0.02
Argunskoye	-0.01	-0.13	0	0	0	-0.18	-0.01	0.03	0	0	0
Badinskoye	0.5	0.33	0.15	0	0	0.13	0.05	0	0	0	0
Baleyskoye	0.02	0.28	0	0	0	0.46	0	0.01	0	0	0
Beklemishevskoye	-0.01	-0.09	0	0	0	-0.02	0	-0.02	0	0	0
Verkhne-Chitinskoye	-0.04	-0.15	0	0	0	-0.03	0	-0.01	0	0	0
Gazimuro-Zavodskoye	-0.03	2.32	0	0	0	1.02	0.14	0.12	0	0	0
Duldurginskoye	0.02	0.12	0	0	0	0.06	-0.01	0	0	0	0
Ingodinskoye	-0.09	-0.32	-0.07	0	0	-0.07	-0.01	-2.22	0.03	0	0
Karymskoe	0	-0.17	0	0	0	-0.02	0	-0.02	0	0	0
Krasnochikoyskoe	0.1	-0.54	0.42	0.01	0	-0.04	-0.01	-0.06	-0.01	0	0
Kyrinskoye	-0.08	-0.33	-0.04	0	0	0	-0.02	-0.03	-0.02	0	0
Mogochinskoye	1.11	9.36	0	0	0	1.62	0.01	10.2	1.93	0	0
Nerchinskoye	-0.02	-0.05	0	0	0	0.04	0	0	0	0	0
Olenguyskoe	-0.06	-0.09	0	0	0	-0.04	-0.01	0	0	0	0

Of all studied categories in the South Siberian mountain zone, the increased shares of larch, birch, pine, cedar, spruce, fir, shrub birch, dwarf pine, and other tree species were found (by 44.3 %). Among these, softwood species (birch) and shrubs (shrub birch) were dominating. For other categories, no changes have been noted in these zones.

In the forest areas within the South Iberian mountain zone, mixed trends in the dynamics of the forest cover have been noted.

Thus, in the Baikal mountain forest district, increased (by 1.16 %) areas covered with larch, pine, cedar, spruce, fir were observed, as well as decreased areas covered with birch, shrub birch, and dwarf pine. In this forest area, larch, spruce, and pine were dominating.

Ononskoye	-0.06	0	0	0	0	0.05	0.01	0	0	0	0
Petrovsk-Zabaykalskoye	0.23	0.19	0.07	0	0	0.05	0	0.04	0	0	0
Sretenskoye	-0.04	0.1	0	0	0	-0.42	0.02	0.03	0	0	0
Tungokochenskoye	-0.03	9.2	0	0	0	-0.021	-0.02	-0.17	-0.07	0	0.01
Khilokskoye	-0.07	-0.23	-0.04	0	0	-0.07	-0.01	-0.03	0	0	0
Charskoye	0.14	6.4	0	0.01	0	0.19	0	-0.06	2.88	0	0.67
Chernyshevskoye	-0.01	-0.24	0	0	0	-0.1	0.02	-0.05	0	0	0
Chitinskoye	0.04	0.03	0	0	0	-0.02	-0.01	0	0	0	0
Shilkinskoye	0	-0.05	0	0	0	0.12	0.48	0	0	0	0

In the Trans-Baikal mountain-permafrost area, positive changes (43.3 %) were observed for the following categories: "larch", "birch", "cedar", "spruce", "shrub birch", "dwarf pine" and "other tree species". Among these, the shares of birch, shrub birch, and dwarf pine were the greatest. A negative trend was noted for the "fir" category.

In the Trans-Baikal mountain-forest area, the areas of birch, spruce, fir, and dwarf pine increased slightly. These were dominated by category "birch". The areas covered with larch, pine and birch shrub, reduced. Moreover, these were dominated by "shrub birch". The Trans-Baikal mountain-forest district is the only district with a negative trend (0.14 %) in the species diversity of the tree-and-shrub vegetation.

[IV] DISCUSSION

The positive dynamics in the variation of the area of the lands in the Forest Fund territory covered with forest vegetation were associated with the handover of the lands unfit for agricultural use and abandoned lands, which have been gradually covered by coniferous, softwood species and shrubs.

A significant decrease in the share of larch and an insignificant one in that of pine have been related to numerous forest fires, industrial logging, and forest drying due to the spread of pests, diseases, and other reasons. The ongoing reforestation at forest departments, along with the good natural renewal of the coniferous species over the last 20 years have failed to rectify the trend.

Transformation of the area of the coniferous forests due to fires and breaking the rules of forest use and reaction to climate variability have resulted in increasing the share of early-sun-genetic species (birch).

The growth of shrubs (shrub birch) also indicated a catastrophic transformation of the forest environment, death of softwood species due to fires in these areas or drying up due to the changes in the hydrological regime, replacement of softwood species by shrubs, emergence of areas that for a long time have remained unfit for forest usage.

In other words, zonal categories of trees and shrubs shift, and the process of "green desertification" of the region is observed. Geographically, this process occurs unevenly, causing spatial diversity of changes in the areas.

In the Baikal mountain-forest area, an increased share of conifers was reflected in a decrease in the diversity of softwood species and shrubs. This is because conifers tend to form tree-stands with few other tree species. It is the most prosperous forest district in the entire territory of Eastern Transbaikalia, into which species that are unusual for this area do not penetrate.

The territory passed by the Trans-Siberian Railway – the Trans-Baikal mountain forest district – was the most developed one. The most significant reduction in the diversity of tree-and-shrub vegetation has been noted here.

[V] CONCLUSION

Summing up the aforesaid, it should be noted that a significant increase in the diversity of tree and shrub species has been observed in Eastern Transbaikalia over the past 60 years. This fact shows not only the influence of climatogenic factors but also the effect of the anthropogenic factor on the reduction of the indigenous coniferous biocoenoses and on the appearance of free ecological niches that are occupied by species unnatural for this area.

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