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FOREST-USE ISSUES IN MOSCOW REGION AT THE BEGINNING OF THE 21ST CENTURY

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Abstract: *This paper reflects the forest-cover dynamics in Moscow area for more than a 300-year period and the factors which influence the forest cover. It assesses the current state of the region's forests and emphasizes the anthropogenic impact on the forest, as well as its possible associated risks. The work considers various approaches to the issue of determining maturity age. The necessity of developing silvicultural systems for protection forests, which allow the use of wood before stand decomposition was stressed.*

Key words: *forest cover, forest maturity, forest road network, spruce forests.*

1. Introduction

Assessing the current status of the environment should take into consideration the prodigious anthropogenic influence of Moscow, along with the natural aspects. Moscow, together with the Moscow Region, form an elaborate complex – the Moscow area. The Moscow area is the main consumer of forest products in the Russian Federation. There is a considerable amount of forest resources in the Moscow Region.

Today, all the forests belong to different conservation categories, and clear cutting of mature and averaged forests are prohibited [13]. Forest exploitation in the Moscow area is highly unbalanced now.

2. Materials and Methods

The research database was formed on forestland statistical accounting, starting with General forestland surveying. Several materials of the Moscow Region Forestry Committee and Federal State Budgetary Institutions for forest inventory were also taken into account.

The study subject consists of 61 permanent sample plots at the Elk Island National Park made by the International Forest Institute and All-Russian National Research Institute of Forest Mechanization (VNIILM) in 1998-2000, which are regularly observed, as well as of 14 sample plots from Tschelkovo Experimental Forest Management Unit of BMSTU MB (former Moscow State Forest University), which were made in 2000-2003 and 2013-2015.

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All sample plots were installed in pleurocarpous moss forests (stand condition types B_2-B_3, C_2-C_3).

The methodology of the forest stand structure study is based on the methodological recommendations made by N. P. Anuchin (1931, 2004) and A. G. Moshkalev (1974, 1982).

The experimental materials were processed by variation statistics, resorting to standard software. In order to study the age structure, as well as for the rot diagnosis on sample plots, we chose cores at the height of 0.3 m using, the age drill.

3. Results

The zonal vegetation of most parts of this region consists of mixed coniferous-broad leafed and broad leafed-coniferous forests marked by blend composition of timber stand, common to natural forests, pronounced undergrowth, and herbaceous cover including floral elements typical to mixed and taiga forests.

Due to the heavy tillage of this territory, which has started in the first period of its reclamation, a considerable part of these forests has been substituted by the secondary growth of birch and aspen.

The percentage of forest land in the Moscow Region had been decreasing during the 18th and the 19th centuries (Figure 1), yet at the end of the 19th century and at the beginning of the 20th century deforestation became rampant [6, 7]. There are two main reasons for it: the need for agricultural land and the demand for wood of the developing industry. The intensification of anthropogenic activity has influenced the forests, especially the clean cutting that had an impact on the species composition of the forests, as the proportion of soft-wooded broadleaf stand increased: coniferous and oak high forests were replaced by burr aspen woods and stem birch woods.

Railway construction also had substantial influence on forest health. A considerable amount of industrial wood was required to construct ties, telegraph poles, station houses and outbuildings, then immense amounts of fuel wood were needed (during World War I and the civil wars, it was necessary to return to wood use). Railroad construction promoted stronger influence on the adjacent forests.

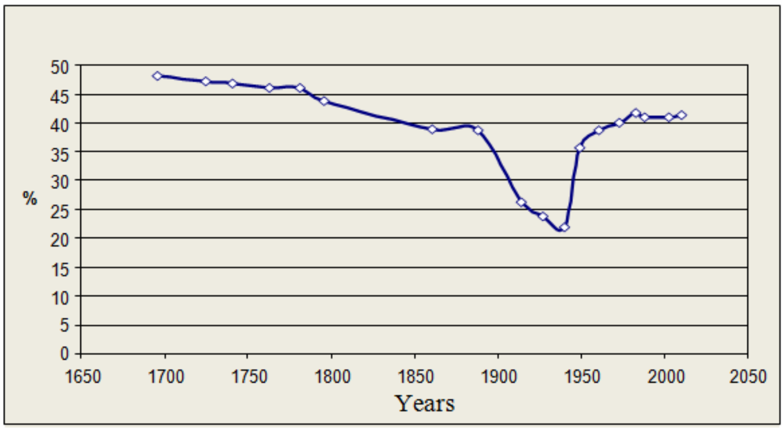

Fig. 1. *The dynamics of the forest cover in the Moscow Region*

In 1917-1923, the total area of 268 thousand hectares was deforested, and 50 thousand hectares of forestland were eliminated by fire in 1920 and 1921. By 1927, the proportion of coniferous and broadleaf stand decreased from 51% (1910) to 33%, while the percentage of soft-wooded broadleaf stand (birch and aspen) increased from 49% to 67% [6, 7]. Extensive cutting in the 1920s-1940s led to the decline in forestland percentage to 21% in 1938, and to the emergence of 173 thousand hectares of unstocked forestland, 2.4-fold decrease in the mature stand area and 22%-reduction in the mean stand volume by 1949 (compared to 1927).

From the 1950s to the 1990s, the quantitative indices of the Moscow Region forest status had been improving. This was the result of extensively developing cultured forests (planting and sowing major wood species), which have certain advantages over the natural stand. Mean forest capacity and mean forest density have increased; mean increment has grown from 3.3 to 3.9 m^3/ha, and the area covered by coniferous species has expanded. The changes in the species composition of the Moscow Region forests are summarized in Table 1.

The increase in the forestland percentage is, to some extent, connected to the territorial changes of this region. Since 1 July 2012, a substantial part of the Moscow Region territory has been included into Moscow city. The Moscow Region territory decreased by 144 thousand hectares, whereas the population reduced by 230 thousand people due to this transfer.

Despite the restrictions and prohibitions, Moscow is essentially a transit city. The road network development is provisioned in order to solve the traffic problems. The reconstruction of the Moscow Circle Road (MCR), which now is 10-lane, is another factor of strong influence on the forests of the Moscow Region. A substantial part of the planned road will affect the forest reserve land. According to the MCR route plan, more than 200 km of the total 525 km afferent to the road, will run across the forestland. The MCR construction will inevitably lead to building in the adjacent areas, resulting in further urbanization of the territory. The risks of the MCR negative influence are connected to:

- decrease in the forest-land percentage in the Moscow Region;
- substantial increase in air pollution by vehicular traffic;
- rise of forest-fire hazard;
- general decay in the sustainability of the forest area adjoining the highway;
- danger of forest-territory fragmentation;
- expansion of invasive plant species;
- manifestation of negative ecotone effects.

Forest forming species of the Moscow Region Table 1

Species	Area, %	
	End of the 19th century	2015
Pine	18	20.3
Spruce	30	24.4
Birch	25	39.7
Aspen	21	8.6
Other	6	7.0
Total	100	100

At the same time, the forest road network density in Moscow region doesn't increase. Nowadays, the length of motor roads within regional forest area is about 21.5 th km, including 14.7 th km of common roads, such as MCR [3, 4]. The forest road network density is 3.91 km/1000 ha. This is the lowest ratio in Russia's Central Federal District and obviously not enough for forest care and protection means.

The forest raw-material resources of the Moscow Region comprise a forested area of 1869.1 thousand hectares and total stock of 374.2 million m^3, including 101.6 million m^3 of mature and averaged wood. The age distribution of the forested area is given in Table 2. Middle-aged forest stand prevails within the pine and the birch forests. Most spruce forests are young forests of the 1st and the 2nd age categories, while mature and averaged forests are dominant among the aspen forests.

The acceptable annual wood extraction from exploitable and protection forests is determined by prescribed annual cut [1]. The annual cut is individually calculated in each forestry for exploitable and protection forests, by coupes (coniferous, hard-wooded and soft-wooded broadleaved) and by dominant species. The annual cut calculation is performed separately for clear cutting, selective cutting, cutting of dead and damaged forest stand, forest tending etc. According to our estimates, provided that all the Moscow Region forests are classified exploitable, the prescribed annual cut of only mature and averaged forests can reach 6 to 10 million m^3. The rate of the prescribed annual cut depends on many factors: the volume of actual performance stock, total wood increment at the object, specified cutting age and others.

Today the cutting age is prescriptive. However, the technical maturity age is the main criterion when determining the cutting age, and many researchers believe that it depends on the site class of the forest stand. According to K. B. Lositskiy [12], one cannot apply the same cutting age to the area defined by the wood consumption pattern. The cutting age should be separately set for each forestry of the area based on the local wood consumption patterns, and forest growth conditions. Currently, the technical maturity age is still one of the basic parameters for the maximum yield calculation. Most authors note that the technical maturity age of the forest decreases in case of improvement of the forest growth conditions (i.e. bonitet) [9, 12].

Table 2

Age distribution of major forest forming species of the Moscow Region

Major forest forming species	Forested area, thousands of hectares					
	total	by the forest stand age categories				
		young	middle -aged	approa-ching maturity	mature and over-aged	over aged
Pine	359.2	56.5	237.5	48.6	16.6	3.7
Spruce	432.8	173.3	91.1	98.5	69.9	0.1
Birch	703.6	44.2	376.2	132.4	150.8	5.3
Aspen	152.9	8.9	5.4	7.2	131.4	78.0

The felling rotation is determined based on the maturity age by the forest management specialists. According to M. D. Giryaev [1], the most beneficial felling interval is the one providing the forest stock, which can guarantee the highest mean increment in primary timber assortment – one of the top-priority tasks of forest management. In forest management and during the logging operation of the target species, for instance, to produce coniferous bolt, we suggest setting the age category span at 10 years, in case of the quantitative maturity age ranging from 61 to 65 years and relevant felling rotation. We believe that such a system of forest management would be the most suitable for the Moscow Region spruce forests. The research results [10] show that setting the felling rotation span at 60-70 years for the spruce forests of I-Ia site classes will provide higher-quality timber, compared to the felling rotation span of 81-101 years.

Many researchers have come to similar conclusions on the earlier maturation of the spruce forests of the highest site classes. M. M. Orlov [9] noted that the maturity age increases under worse habitat conditions. K. B. Lositskiy [12] demonstrates that the optimal technical maturity age for the spruce forests of the 1st site class is 71-80 years (IV age category).

In Sweden, the cutting age adjustment is recognized in legislative acts and special instructions; certain requirements for uniform forest stand cutting are also stated. Recommendations on the cutting age setting vary for different regions and site classes [11]. In Finland, alternative management strategies are often used in forest scheduling, including high variability of the felling periods [6].

As a matter of course, natural factors are imposed upon the forest management decisions, which are far from being optimal. Indeed, in the summer of 2010, an abnormally droughty weather dominated in the central part of the Russian Federation. According to the data of Federal Agency “Roslesozashchita” (Russian Center of Forest Protection), it was the main reason for mass reproduction of the European spruce bark beetle (*Ips typographus* L.). The second most important factor was, probably, the large amount of snags and windfall trees present in the forest stands. Secondary insect pests, including the European spruce bark beetle, tend to attack primarily compromised forest stands. The total forested area that suffered from the windstorms in 2008-2010 amounts to 16100.7 hectares. At the end of 2010, over 60 thousand hectares of secondary insect pests’ centers emerged in the spruce forests of the Moscow Region. By 2015, the total area of the forests, affected to a varying degree, was 275 thousand hectares.

Because of low-intensity human economic activities in the Moscow Region, forests and major climate changes, endemic spruce forests are being replaced by soft-wooded broadleaf forests, often of offshoot origin. Changes in the forest exploitation intensity in the Moscow Region are shown in Table 3.

All the timber produced in the Moscow Region in 2011-2014 was extracted only in course of salvage felling (Table 4). At the same time, recreational forest utilizations remains one of the most important ways of forest exploitation in the Moscow Region. Some 1.5 thousand lease agreements were made in the Moscow Region, in order to perform these activities, but the total area of involved territory is only 4.6 th hectares.

Table 3

Cutting volume in Central Federal District and the Moscow Region over 2006 – 2014, th m^3

Region	2006	2007	2008	2009	2011	2012	2013	2014
Central Federal District	18761.1	22194.2	16164.8	13500.0	20536.0	20412.2	21075.7	25223.7
Moscow Region	1708.6	1589.9	113.5	211.9	829.9	1114.0	2804.2	2887.7

Table 4

Prescribed and actual annual cut in the Moscow Region in 2011, th m^3

Year	2011	2013	2014
Prescribed annual cut	2044.4	2988.4	2988.5
Including clear cutting	1189.6	1688.5	1688.6
-selective cutting	854.8	1299.9	1299.9
Wood extracted	829.9	2941.0	Total – 3284.84 including merchantable – 2887.7
Including: -clear salvage cutting	796.2	2920.0	Total – 3201.9 including merchantable – 2844.5
-selective salvage cutting	33.6	21.0	Total – 82.94 including merchantable – 43.2

The patterns of species conversion fully reflect the problems of contemporary forest management, including primarily the absence of silvicultural cuts in the protection forests of the Moscow Region.

Today, the prevention of unsolicited species conversion should be one of the top-priority tasks at all stages of forest management [3, 4].

The issue of self-restoration is highly complex and includes certain features, inherently connected with soil and climate conditions and with the ability of broadleaf species to spread their seeds over new territories quickly. For instance, over the last decades, broadleaf communities replace composite spruce forests in Elk Island National Park. Generally, the area of linden-dominated stands, their age and stock have been increasing within Elk Island since 1891 [3, 4]. Linden used to be eliminated by human economic activities (livestock grazing, bast collecting, handicrafts etc.). Initial stages of spruce forests' replacement by linden are observed at the territory of Tschelkovo Experimental Forest Management Unit of BMSTU MB. Our studies show that linden-dominated communities are emerging in certain forested areas, where spruce forest stand has been almost completely eliminated [5].

4. Conclusions

Thus, the forest management in the Moscow Region, conducted in agreement with the currently applicable regulations, leads to a decline in the forest species composition, increase in debris amounts, deterioration of sanitary conditions, all of these resulting in the decrease of the recreation potential of the forests and in substantial economic waste. The silvicultural systems for protection forests should be developed, which would permit timber exploitation before the forest stand decomposition. The economic efficiency of intense forestry activity in protection forests can only be achieved if the conditions for recycling a considerable volume of low-quality wood and wood residue [2] and for implementing modern logging technologies [8] are created.

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