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# STAND COMPOSITION, KEEPS A HIGH RESISTANCE TO RECREATION AND IS ATTRACTIVE TO THE POPULATION

Found the average compositions of pine, spruce and birch stands and the direction of their changes under intensive recreational influence. High recreational load in the pine forests increases the proportion of birch, spruce reduce, simplify the composition of to a 2–3 most resistant species. Reduced pure area of forest stands. In spruce, there is some reduction in the number of tree species, their share slightly vary. More resistant spruce mixed with other species shares from 50 to 10–20%. In birch is an increase in the proportion of pine and birch, a significant reduction in the proportion of spruce. Identified average compositions stands in stands, characterized by high aesthetic properties, the direction of change of compositions by increasing the attractiveness of the population. Decorative pine stands are characterized by a decrease in the proportion of pure and mixed pine forests increase. Decline in the proportion of spruce and aspen, pine increase increases the attractiveness of spruce forests. Increase in the proportion of birch increases, and the presence of aspen and alder glutinosa reduces the aesthetic qualities of birch trees. Based on the identified trends recommended optimal composition of forest stands, as well as the optimal share of compositionally different stands.

**Key words:** recreation, composition, stand, sustainability, attractiveness.

**Introduction.** Different in composition, structure and productivity forest stands are characterized by different ability to withstand the effects of tourists (resistance). The forest type, topography and site location renders a large influence on the stability. Regulating the composition of the forest stand improves its architectural and landscape quality enhances horizontal and, in some cases, a vertical fragmentation of forest stands. Each breed has its own decorative effect and contributes to the propagation of the variety in shape of crowns, the colouring and texture of leaves, the play of light and shadow and other qualities, which the suburban areas should meet. The formation of the optimal composition of forest stands will significantly improve the sustainability of suburban forests to the recreational impact and their attractiveness to tourists. The work is performed under the grant BRFFR No. B13M-002.

**Main part.** To determine the optimal composition of forest stands, taxonomic descriptions of all areas of the forest-park parts of green zones around cities and other settlements were analyzed and summary tables of distribution of covered with forests lands of the studied formations (pine, spruce and birch) on the studied indicators (series of forest types, the average composition of trees, stage of recreational digression, class of aesthetic evaluation, the proportion of the predominant species in the composition) were made.

Pine stands are characterized by a significant average share of main tree species (mainly from 77 to 92%). On poor soils the trees ranges from 91 to 100%. As an impurity mainly birch (2–22%) and fir (15%) occurs, and the share of others does not exceed 1–2%.

Among the pine forests mixed forests with admixture of other tree species up to 20% – 77.2%, including pure – 52.0% are dominated.

In conditions of pine forests of lichen, heather, lingonberry, moss, ledum and sphagnum pure stands have more than 2/3 of the area. In mixed stands with pine shares of 50–70% mainly one type, at least two in oxalis, politric, blueberry and fern series grow.

Increased recreational activity in pine forests increase the share of birch (1–7%), reduce the share of spruce, simplify the composition up to 2–3 (pine, birch, more rarely oak or aspen) of the most stable wood species. The proportion of pine varies: on the poor, dry and fresh soils it increases, in the rich conditions of the habitat it often reduces. With the increase of recreational load the areas of pure pine stands reduce.

With intensive use for recreation it is necessary to form more mixed stands with pine shares from 50–90% and, more commonly, one type of impurity (Table 1). The proportion of pine can vary from 60 to 100%. As an impurity it is recommended to use birch (from 10 to 40%), spruce or oak (from 5 to 15%). The proportion of other woody species, as a rule, should not exceed 20%. Pure pine stands is recommended to form about 45%, mixed with the share of other breeds 10–20% – 30%.

Spruce stands differ from the pine in significantly higher diversity of woody species: the average percentage of main species in the composition ranges from 56 to 69%; impurities are usually dominated by birch and pine, alder and aspen; oak and ash up to 5–6%, other species are less than 1%.

Spruce forests unlike pine forests are characterized by large areas of mixed forest stands. Pure

stands occupy 12.0% of the area, mixed spruce with a share of 50–70% (49.9%) dominate, and among them two kinds of impurities (24.7%).

The influence of vacationers on the composition of spruce forests is less due to the predominance of mixed forest stands and less involvement in the field of recreation. There is some decrease in the number of tree species (depleted stock), the shares of breeds vary slightly.

In conditions of increased recreational pressure (3–5 stage of digression) mixed spruce forests with a share of other woody species from 50 to 10–20% dominate. Pure and with a significant (60–70%) admixture of other types the spruce forest stands are characterized as having a lower resistance.

In the conditions of the intensive recreational use, it is advisable to form the mixed spruce forests with a share of other woody species 50–20% (Table 2). As an impurity depending on the growing conditions pine, birch and oak (all 30%) are used. The proportion of other woody species, as a rule, should not exceed 5%. Mainly (65%) mixed forest stands with a spruce share of 50–70%, and pure and mixed with a significant (40–30%) admixture of other species – 5% should be formed.

In the birch forest the share of dominant tree species varies considerably (from 57 to 100%), due to the existence of derivative and root birch. Among wood species pine (21%), spruce (17%), alder (up 16%) and aspen (16%) may prevail in the impurities. Less common are oak, ash, maple, linden, alder and hornbeam.

The birch forests also are characterized by significant areas of mixed stands. Mixed forests of birch, with a share of 50–70% (53.1%) dominate, and among them two kinds of impurities (25.9%). Pure forest stands in them have 9.7%. There is a clear division on stands derived from pine and spruce (oak). The former are characterized by a higher proportion of pure forest stands, and a small admixture of other species, the later by the – mixed ones. Therefore, while forming the composition of the birch root breed should be taken into consideration.

In birch forests the increase in the intensity of visitation increases the proportion of pine (up to 16%), a significant decrease in the proportion of spruce, and, in most cases, the increase in the proportion of birch to the 5th stage of digression up to 80–100%.

The load increase leads to the increase in the share of pure and mixed birch with other small species (10–20%), and a decline in the diversity of woody species in the composition.

On the areas heavily used for recreation, the formation of both pure and mixed birch stands is possible depending on habitat conditions and native woody species (Table 3). The proportion of birch can vary from 60 to 100%, pine – to 30%, spruce and oak – up to 20%. The other tree species (a total of up to 20%) are also recommended. Mostly (55%) it is necessary to form mixed stands with the share of birch 50–70%, and mixed with the admixture of other breeds 10–20% – 25%.

In all three formations depending on conditions and recreational features of each area the share of critical species can be modified, mostly in the range of up to 10 percentage points.

Among other woody species depending on the habitat conditions aspen (forest edges), maple, Linden, hornbeam and, rarely, black alder can be recommended.

In the formation of the attractive for the visitors decorative tree stands of pine, spruce and birch the compositions given in Table 4–6 are recommended.

Table 1

**The recommended pine forest types composition to the most important for the organization of mass recreation, %**

| Forest type code | Pine | Birch | Spruce | Oak | Others |
|---|---|---|---|---|---|
| P. heat. | 80–100 | to 20 | – | – | – |
| P. cowb., P. pol. | 70–100 | to 30 | – | – | to 5 |
| P. fern., C. blueb. | | | to 5 | to 5 | |
| P. ox. | 60–100 | to 40 | to 15 | to 10 | to 10 |

Table 2

**The recommended spruce forest types composition to the most important for the organization of mass recreation, %**

| Forest type code | Spruce | Pine | Birch | Oak, Maple, Linden, Ash | Others |
|---|---|---|---|---|---|
| S. cowb., S. moss. | 50–80 | to 30 | to 30 | to 10 | to 5 |
| S. fern., S. blueb. | | to 20 | | to 20 | |
| S. ox. | | | to 20 | to 30 | |
| S. aeg., S. nett. | | – | | | |

Table 3

**Recommended composition in the most important for the organization of mass recreation birch forest types, %**

| Forest type code | Birch | Pine | Spruce | Oak | Others |
|---|---|---|---|---|---|
| B. heat., B. cowb., B. moss. | 70–100 | to 30 | – | – | to 5 |
| B. fern., B. blueb. | 60–100 | to 20 | to 10 | to 10 | to 10 |
| B. ox. | | | to 20 | to 20 | to 20 |
| B. aeg., B. nett. | 60–80 | to 10 | | | |

Table 4

**Recommended composition of the highly decorative pine stands, %**

| Forest type code | Pine | Birch | Spruce | Oak | Others |
|---|---|---|---|---|---|
| P. heat. | 80–100 | to 20 | – | – | – |
| P. cowb., P. moss. | 70–100 | to 30 | – | – | to 5 |
| P. fern., P. blub. | 60–100 | to 40 | to 20 | to 5 | to 5 |
| P. ox. | 50–100 | | to 20 | to 10 | to 10 |

Decorative pine plantations are characterized by a decrease in the participation of the main tree species with increasing soil fertility from 91–98 to 70–80%. The proportion of birch in them reaches 15%, spruce – 17%, other species – 2–3%. The increase of the classification of aesthetic avaluation leads to a decline in the share of pure pine stands and mixed with other woody species from 10 to 50%. At the same time from 49 to 55% of the decorative pine stands are pure. The most attraction pine forests with a share of other breeds 30–50% and net stands have. The admixture of birch (particularly 40–50%) increases, and the presence of spruce reduces the attractiveness of pine plantations. It is recommended to form the pine forests with a share of the main breed 50–100%, birch 40%, spruce to 20%, oak to 10%, and other breeds up to 10% (Table 4). Pure stands should be formed up to 50%.

The decline in the proportion of spruce (up to 60–70%) and aspen, the increase of pine (to 19%) in the majority of spruce forests increases the class of their aesthetic evaluation. The share of birch reaches 13%. Among decorative spruce forests (82.3–77.0%) forest stands with the share of other species from 10 to 50% predominate. Pure spruce forests among them are much lower than that of pine (6.2–9.5%).

Mixed spruce stands with the admixture of other species to 60–70% more often belong to the low-decorative ones. More attractive are spruce forests with the share of birch 40–50% and the proportion of pine 20–30%, and spruce with a share of 40%. Pure spruce stands and mixed with other woody species up to 20% if they are of different age and uneven allocation also belong to highly decorative ones.

It is recommended to form the spruce forests with a share of the main breeds 50–80%, birch to 40%, pine to 30%, oak to 20%, and other breeds up to 20% (Table 5).

Table 5

**Recommended composition of the highly decorative spruce stands, %**

| Forest type code | Spruce | Pine | Pine | Oak | Others |
|---|---|---|---|---|---|
| S. cowb., S. moss. | 50–80 | to 30 | to 30 | – | to 10 |
| S. fern., S. blueb. | | to 20 | to 40 | to 10 | |
| S. ox. | | to 10 | | to 20 | to 20 |
| S. aeg., S. nett. | | – | | | |

Table 6

**Recommended composition of the highly decorative birch stands, %**

| Forest type code | Birch | Pine | Spruce | Oak | Others |
|---|---|---|---|---|---|
| B. heath. | 60–100 | to 40 | – | – | – |
| B. cowb., B. moss. | | | to 10 | – | to 5 |
| B. fern., B. blueb. | | to 30 | to 20 | to 20 | to 5 |
| B. ox. | | to 20 | | to 30 | to 10 |
| B. aeg., B. nett. | | to 10 | | | |

Mixed stands with the share of spruce 70–50% should be formed 55%, 10–20% – 25%, 40–30% – 15%.

In highly decorative birch depending on the indigenous tree species (pine or spruce) the participation of the predominant species varies from 55 to 83%. The increase in the share of main tree species increases, and aspen and black alder reduces the aesthetic quality of birch trees. The high- and medium decorative birch unlike pine have the larger share of mixed stands with admixture of other species from 30 to 70%, and, accordingly, the share of pure and mixed stands with the admixture from 10 to 20% is lower. Unlike the spruce forests their share of the pure stands is a little higher. Among the birch forests mixed forests with admixture of oak or pine 30–50%, as well as pure stands have a greater attractiveness. It is recommended to form the birch forests with a share of the main breeds 60–100%, admixture of pine up to 40% spruce to 20%, oak to 30%, and other breeds up to 10% (Table 6). Mixed stands with the share of birch 70–50% should be formed 55%.

**Conclusion.** Increased recreational loads in pine forests increase the share of birch (1–7%), reduce spruce, simplify the composition up to 2–3 of the most stable breeds. The area of pure stands is reduced. More sustainable are mixed spruce forests with a share of other breeds from 50 to 10–20%. In birch, there is an increase in the proportion of pine and birch, a significant decrease in the proportion of spruce.

Decorative pine plantations are characterized by a decrease in the share of pure and increase of the mixed pine stands. The decline in the proportion of spruce (to 60–70%) and aspen, the increase of pine (to 19%) increases the attractiveness of spruce forests. The growth in the proportion of birch increases, and the admixture of aspen and black alder reduces the aesthetic quality of birch trees.

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