Recreational Capacity for Forest Tourism. The Case of the Republic of Tatarstan

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Abstract. The research deals with the assessment of the recreational potential of forests in green areas of cities and towns of the Republic of Tatarstan for forest tourism, as well as development of a system of forest cutting, ensuring the constancy of recreational forest use under conditions of increased recreational impact. The authors determining the recreational potential of plantations and assessed it, and summarized the results of selective logging in pine forests under conditions of increased recreational impact. The recreational potential of forests has been characterized, its assessment has been made, a cutting system has been developed to ensure consistency of recreational forest use in conditions of intensive recreation, a concept has been developed to optimize recreational forest use in green areas of cities of the Republic of Tatarstan. The results of the research may be used for working out the logging system, ensuring the constancy of recreational forest use in conditions of increased recreational loads.

1. Introduction
Considering the development trends of the forest sector of the republic in the context of global ones, we must note that a characteristic feature of the XXI century is the globalization of the world economy. The route of the developed countries towards the ecological way of life, supported by them, has been further developed in the “Forest and Man” International Forestry Forum. Indeed, the growth rate in demand for environmental and social utility of the forest in the second half of the twentieth century significantly outpaced the growth in demand for forest resources. The situation still remains the same today, the attitude to the forest is changing utterly: people are beginning to look at the forest not only as a source of timber, but also as the main component of natural ecosystems that determine the maintenance of stability and environmental balance on the planet. This is not just a statement of facts: in all forest-industrial countries of the world national forest programs exist or are in the development stage, in which strategic goals and priorities for the development of the forest sector for a long-term perspective are defined. The term “post-industrial forest” appeared, where the emphasis is not on timber production, but on environmental protection problems and on the development of rational forms of forest management.

The “post-industrial forest” is more than a simple change of priorities in the direction of multiple or non-exhaustive forest use. First of all, significant changes are planned both in the goals and means of forest science and forest management, as well as in new approaches to research and training of forest personnel. Preference is given to socio-economic research instead of traditional productive forestry. Non-material goods and services of the forest are appreciated more than its material values. As the population becomes more urbanized, the use of weightless forest utilities becomes one of the most important promising areas [1].
The forestry is a very interesting sphere for research not only for the foresters, but also for the linguists. We were interested in the works, who “interviewed and gave questionnaires collecting data” the foresters [2, 3]. Out of 6 billion of the world population about 1/3 make tourist trips. The ratio of the number of holidaymakers with an overnight stay to the number of tourists of one day averages from 10 to 30%. Based on these figures, we can estimate the total potential flow as 3–4 million people per year (1/3 of the total number of neighbour citizens), and the number of tourists with overnight stay is 1-2 million people per year.

Is it possible to ensure a sustainable, long existence of a natural complex that retains its attractiveness with the projected growth of recreational activity? The tourist and recreational complex of the region should be not only capacious, but diversified, i.e. the entire region should be attractive, while the main recreational attractions dominate. Maintaining a favourable ecological environment is the main condition for the arrival of the holidaymakers.

2. Methodology
There are many works, developing assessment of the recreational potential of the territory of entire regions. However, the assessment of the recreational potential by itself does not provide an answer to any of the main issues of recreational forest management, which has become the center of attraction for all: how to meet the demands of society in recreational services and at the same time to maintain the attractiveness of resources infinitely.

The research is based on the method of permanent test plots (SPT), established in accordance with OST (Sector Standard) 56-69-83. The main taxation indicators for 6 SPT measuring 0.5–1.0 hectares and 18 discount areas were obtained on the basis of an enumeration survey of trees and measurement of model trees.

Based on the results of the research, a system for assessing the recreational potential of plantings of green areas of cities and recommendations for management in the suburban forestry of the Republic of Tatarstan for forest tourism have been developed and are being implemented.

3. Discussion
The distribution of forests according to the value of recreational potential in the context of forestries shows a general picture of well-being and problems. The ratio of optimal and normal plantations to degraded and low in suburban forestry is 1.5, in Bavlinsky and Bugulminsky is 1.2-1.4. Other forest areas are significantly lower in this indicator. According to this indicator, the forestries line up in the following sequence: suburban forestry, Bugulma, Bavl, Nizhnekamsk, State National Natural Park “Nizhnyaya Kama” and Bilyarsk, schematically it is shown in Table 1.

| Forestry          | Area, hectares | Groups of recreational value |
|-------------------|----------------|------------------------------|
|                   |                | optimal | normal | degraded | low | crisis | zero |
| Bavly             | 22747          | 16.8    | 38.4   | 19.0     | 24.5 | 1.0    | 0.3  |
| Bugulma           | 43814          | 17.2    | 40.3   | 18.3     | 23.7 | 0.5    | -    |
| Bilyarsk          | 50187          | 2.9     | 12.2   | 58.4     | 23.8 | 2.1    | 0.6  |
| Nizhnekamsk       | 43028          | 11.0    | 32.4   | 32.4     | 18.6 | 3.6    | 2.0  |
| SNNP “Nizhnyaya Kama” | 18524 | 10.5    | 33.0   | 33.0     | 21.5 | 1.0    | 1.0  |
| suburban          | 30504          | 26.6    | 33.4   | 27.4     | 9.8  | 1.8    | 1.0  |
| Total             | 100            | 13.2    | 30.1   | 33.6     | 20.5 | 1.8    | 0.8  |

Table 1. Distribution of forest area by groups of recreational potential (%%)

Artificial plantings are only an imitation of the natural processes of nature. Therefore, forest cultures should be as close as possible to the natural by species composition, density, location of trees
and other indicators – the forest should be created according to the natural model. This is one of the main problems of artificial afforestation.

Among the numerous forestry measures to reduce the negative impact of recreational activities on the state of forests, the main role belongs to those that are irreversible and have a long-term after-effect. To that category we should attribute various options for cuttings carried out in recreational forests. In the forests involved in recreational forest use, the problem is aggravated by the fact that the replacement of the stand with a new generation must be made without interruption in the use of the forest.

The problem of renewal of pine forests is a key one. The reasons for the absence or weak reforestation of pine clearings is considered to be patternedness, the use of universal standards without taking into account the regional originality of forests and their ecological significance [4], leading to a change of pine to soft-leaved species. The problem is compounded by the involvement of pine forests in recreational use and the risk of losing the most valuable forests.

Analysis of the experimental group-selective felling and uniform-selective felling, conducted in 1992-1993 on an area of 11.2 hectares (single plot) in the population of Matyushinsky Bor, occupying about 15 thousand hectares [5, 6] in order to determine the possibility of reproduction of pine forests growing on brown forest sandy and light sandy loam soil on ancient alluvial sandy and sandy-loam sediments show their high efficiency.

Cuttings were carried out in two main variants. Pure pine forests with single specimens of birch without pine understory, aged 80-100 years, density 0.9, with a reserve of 445 m³ became the object of uniform-selective felling. Out of 609 trunks, 305 were cut down with a reserve of 230 m³. The density was reduced to 0.5. The soil mineralization was carried out with plow furrows PCL-70 and CLB-1,7 in 2 directions. The area of mineralization is 420 m² (PCL-70) and 44250 m² (CLB-1,7).

Group-selective felling was carried out in pine forests aged 100 years, density 0.6, with a reserve of 470 m³. 240 trunks were cut down with a reserve of 260 m³, schematically it is shown in Figure 1. Density reduced to 0.3. The soil mineralization was carried out with plow furrows PCL-70 and CLB-1,7 in 2 directions. The mineralization area is 4540 m².

![Figure 1. Plantings of pine before carrying out of the group-selective felling (q.48 of Matyushinsky district forest range)](image)

Group-selective and uniform-selective felling, as well as any felling, introduce significant changes in the forest environment in a number of catastrophic, but less noticeable. Summarizing the results of the experiment, let us turn directly to the state of the forest stand and other components of the forest after 18 years, since the key point for determining the effectiveness of any logging is a sufficiently long period of time.

Significant changes occurred in the logging sites after felling. An increase in the light intensity of the group-selective felling from 21,317 lx to 45,170 lx and uniform-selective from 11,143 to 41,170 lx changes the thermal regime – moreover, they are more noticeable in the group-selective felling, schematically it is shown in Table 2. On the soil surface of the logging area of the group-selective felling, the temperature was 22.50 °C versus 17.00 °C at the control, schematically it is shown in Table 3. Even more striking is the difference between the absolute minimum and maximum temperatures for the summer months in crowns and on the soil surface, where it reaches 20.40 °C. First of all, this refers to the removal of part of the maternal canopy, the subsequent parts of which are the increase in light intensity, the expansion of temperature scissors of air and soil, the fall in relative air humidity, the
drying of forest floor and the appearance of species, alien to forest formation, in the forest live cover. Within the same type of forest (cowberry pine forest) the overall decrease in thickness and reserves of forest floor is regular, depending on the distance from the forest border, schematically it is shown in Table 4.

**Table 2.** Light intensity on the felling and in the stand (lux, 07.15.10, 12:00)

| Height, m | Felling type | group-selective | uniform-selective |
|-----------|--------------|----------------|------------------|
|           | felling      | stand          | felling          | stand            |
| 0         | 45170        | 21317          | 41170            | 11143            |
| 1,3       | 49550        | 23986          | 48160            | 22943            |
| 0,5 hdp   | 56110        | 34303          | 56170            | 33671            |

**Table 3.** Temperature conditions on the felling and in the stand (12.00, 06.06.2015)

| Height, m | Felling type | group-selective | uniform-selective |
|-----------|--------------|----------------|------------------|
|           | felling      | stand          | felling          | stand            |
| 0         | 22,5         | 17,0           | 22,0             | 16,0             |
| 1,3       | 20,8         | 16,0           | 21,5             | 16,0             |
| 0,5 hdp   | 20,7         | 16,0           | 19,8             | 17,0             |

**Table 4.** The dynamics of soil humidity, %

| Part | Sampling depth, cm | Date of measurement |
|------|--------------------|---------------------|
|      |                    | 5.4 | 20.4 | 5.5 | 20.5 | 5.6 | 20.7 | 5.8 | 5.9 |
| a    |                    |     |      |     |      |     |      |     |     |
| b    | 1.5                | 100 | 105  | 69  | 31,0 | 48  | 31,9 | 9,3 | 46  |
| c    | 10                 | 27,4| 29,9 | 33,3| 17,6 | 17,1| 24,0 | 14,6| 9,5 |
| d    | 30                 | 17,6| 18,3 | 20,0| 15,3 | 14,9| 8,5  | 7,8 | 6,9 |
| e    | 50                 | 17,6| 21,2 | 15,7| 20,0 | 19,2| 10,8 | 17,2| 6,9 |
| f    | 75                 | 12,4| 17,0 | 19,8| 19,6 | 18,7| 16,2 | 19,6| 12,5|
| g    | 100                | 11,8| 15,8 | 20,2| 12,3 | 10,1| 15,3 | 8,8 | 9,8 |
| h    |                    | 98  | 33   | 50  | 43   | 27  | 31   | 42  | 31  |
| i    |                    | 10  | 31,8 | 35,0| 24,2 | 20,9| 18,0 | 9,5 | 13,9|
| j    |                    | 30  | 16,4 | 21,0| 20,1 | 16,0| 16,6 | 12,1| 10,5|
| k    |                    | 50  | 10,6 | 18,2| 22,3 | 15,8| 13,9 | 16,9| 19,2|

| Part | Sampling depth, cm | Date of measurement |
|------|--------------------|---------------------|
|      |                    | 5.4 | 20.4 | 5.5 | 20.5 | 5.6 | 20.7 | 5.8 | 5.9 |
| a    |                    |     |      |     |      |     |      |     |     |
| b    | 1.5                | 100 | 105  | 69  | 31,0 | 48  | 31,9 | 9,3 | 46  |
| c    | 10                 | 27,4| 29,9 | 33,3| 17,6 | 17,1| 24,0 | 14,6| 9,5 |
| d    | 30                 | 17,6| 18,3 | 20,0| 15,3 | 14,9| 8,5  | 7,8 | 6,9 |
| e    | 50                 | 17,6| 21,2 | 15,7| 20,0 | 19,2| 10,8 | 17,2| 6,9 |
Part of the forest stand, left for growing, showed radial growth of trees. This value is small (2.12 - 3.02 mm), but it is reliable. The reliability of the difference between the radial growth of trees in the felling area and the control is not significant, which is quite explainable by their rank, schematically it is shown in Table 5.

Table 5. Radial growth (mm) in diameter in the bands and in the forest (control)

| Felling type       | M, mm | ±m  | δ   | ν,%  | P,%  |
|-------------------|-------|-----|-----|------|------|
| Group-select.     | 2.45  | 0.12| 0.05| 26.0 | 16.1 |
| Uniform-select.   | 3.02  | 0.12| 0.01| 8.9  | 5.4  |
| Control           | 2.12  | 0.45| 0.10| 32.0 | 15.2 |

4. Results
Thus, noting the environment-forming role of group-selective and uniform-selective felling, the following main points should be noted: the trees left for growing during felling effectively perform environment-forming functions, manifested in many aspects.

They are not subject to windfall, regulate the wind flow and snow cover both inside and in the adjacent logging sites, water regime, serve as stations for wild animals and birds; radial growth increases significantly, although the rank position of trees does not change.

In terms of reforestation, it should be noted: the undergrowth acquires the features of the stand and its development follows the patterns inherent in every planting. The same conclusion is confirmed by the analysis of the height-age structure of the undergrowth. Moreover, the difference in reliability in the number of undergrowth according to the variants of experiment, observed at earlier stages of development, somewhat smoothens with age, but by the age of 20 it is still reliable. The main indicators of growth of undergrowth – the average height of undergrowth and the average annual increase in axial sprig over the past 3 years by categories of the condition also do not sharply differ, schematically it is shown in Table 6.

For normal plantations of the generalized row, the place of an average tree in the stand is from the beginning of the row by 57.2%, the maximum number of trunks take positions 0.8, 0.9 and 1.0, and constitute respectively 16.1, 18.4 and 18.1% from the whole. The place of the average tree in the undergrowth of the group-selective felling is 54.4%, and the uniform-selective 55.6%. The number of trunks in positions 0.8, 0.9 and 1.0 is, respectively, for undergrowth of group-selective felling 16.8, 20.7 and 20.2, and for the undergrowth of uniform-selective felling – 17.3, 21.7 and 21.2.

Table 6. Comparative assessment of silvicultural efficiency of the selective felling system

| Indicators  | Group-selective | Uniform-selective | Difference reliability |
|-------------|-----------------|-------------------|------------------------|
| Composition| 10C pieces B    | 10C pieces B      |                        |
| Number, thou. pieces       | 13,059±4,5 | 12,700±3,5 | 4,50 |
|----------------------------|------------|------------|------|
| Average age, years          | 16.8±0.1   | 17.1±1.0   | 33.73|
| a                          |            |            |      |
| b                          |            |            |      |
| c                          |            |            |      |
| d                          |            |            |      |
| Projective cover, %         | 98.1±1.8   | 98.0±1.2   | 41.90|
| Average height, cm          | 5.21±0.9   | 5.34±1.2   | 7.03 |
| Average diameter, cm        | 3.67±0.5   | 3.27±0.7   | 8.07 |
| Average lineal growth, cm   | 16.9±0.9   | 16.9±0.8   | 28.07|
| Needles amount on the axial sprig, year 2010, pieces | 21.0±3.0 | 19±2.0 | 11.11 |
| Needle length, cm           | 5.74±0.21  | 5.87±0.17  | 43.00|
| Needle weight 100 pieces, g | 4.69±0.15  | 4.76±0.20  | 37.80|
| Needle weight 100 pieces on conversion to 1cm needle length, g | 0.63±0.1 | 0.63±0.1 | 9.00 |
| Condition                   | Reliable   | Reliable   | 8.54 |
|                            | 96.3%±14.8 | 95.6%±16.9 |      |

### 5. Conclusions

The system of uniform and group-selective felling in uneven-aged pine forests (C. bilberry and cowberry, B_{2}A_{2}) with poor reforestation ensures the environment-forming role for the remaining part of the stand (there are no erosion processes; the remaining forest conditions are completely preserved; there is no damage of trees, underbrush or undergrowth; changes in the forest live cover are insignificant, there is forest fauna, there is a significant radial growth of trees).

Reforestation in the cutting areas in the system of uniform and group-selective felling in terms of undergrowth and condition is successful. The number of large undergrowth exceeds the necessary for satisfactory assessment of reforestation on the group-selective felling sites by 4.3 times, and on uniform-selective felling sites by 4.2 times.

The use of a selective felling system is aimed at preserving the gene pool of pine forests and their landscape characteristics.

The results of the conducted research allow us to recommend uniform-selective and group-selective felling in uneven-aged blueberry-cowberry pine forests with different intensity depending on the state of the stand and its silvicultural and taxation indicators.

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