Assessing the condition and monitoring results of the high conservation value forests in the Totemsky District of Vologda Oblast on the leased parcel of forest land

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Abstract. For the rational and sustainable forest use, some representative (reference) areas of ecosystems being high conservation value forests within the leasing estate of Tolshmenskoe, LLC, were selected. After that, the monitoring study for the assessment of the forest breeding, environmental and medium stabilizing functions and the reproduction capacity of the preserved forest ecosystems was carried out. Within the ecosystems, six sample sites were drawn and the survey based on the standard forest ecology methods was performed. The objects of the study (sample sites) were shaped to cover the maximum of all types of forest communities available at the leasing estate. Generally, the monitoring observation showed that the arboreal plants growing in the studied sample sites featured high resistance. The forest formation process is continuous but requires some silvicultural practices, such as appropriate care to stimulate the domination of the economically valuable wood species.

1. Introduction

Being a self-restoring and self-regulating ecosystem, in the absence of the forest-destructing anthropogenic factors, a natural forest can last forever. The main component that determines the dynamics, formation intensiveness and consistency of the forest as a system is tree vegetation. Having germinated in the forest, the young seedlings go through several growth, quality, and age stages, transforming into trees, and as they grow old, they die or fall for any other reason. Then, they are replaced with a new generation of wood species [1]. The intensifying economic activity of man increases the impact it makes on the forest ecosystems. It is known that massive deforestation causes degradation of soil and soil cover, disturbs the forest growth conditions required for phytocenosis and dendrocnosis, destructs the forest zoocenosis or forces the animals to migrate. For this reason, the environmental aspect of sustainable forest use manifests itself in the establishment of principles for maintaining the vitality and the self-reproduction capacity of the forest ecosystems, preserving the main forest functions and the biological diversity it features [2].

At the present time, FSC certification is practiced in 74 countries of the world, including Russia. In recent years, Canada and Russia have been the world leaders in the total area of the FSC-certified forests [3]. Criterion 6.4 of FSC certification requires: "Representative samples of existing ecosystems within the landscape shall be protected in their natural state and recorded on maps, appropriate to the scale and intensity of operations and the uniqueness of the affected resources" [4]. The purpose of this criterion is to create a system of protected areas (with full or partial restriction for forest use),...
functionally connected with each other, to ensure the conservation of the biodiversity of flora and fauna, terrain, ecosystems and habitats within the given territory.

This representative area function is also performed by the high conservation value forests (HCVF). It is worth noticing that the identified HCVF do not include or represent all types of habitats within the given territory to the full extent. For this reason, this representative area network needs to be complemented with additional forest areas [4]. HCVF are mapped out with the purpose of conservation of the biodiversity and diversity of species, forest biogeocenoses, increasing the environmental potential of the territories with respect to the anthropogenic factors (clear felling). We have carried out a survey intended to detect, study and assess the HCVF and representative areas found within the leasing estate of Tolshmenskoe, LLC. Mapping out the HCVF creates the necessary conditions for enhancing security, protection, reproduction, as well as rational multipurpose sustainable use of forests, preserving their ecological functions and biological diversity.

2. Research methods

Before the field study, a desktop preparation was carried out, including studying the literature on mapping of the HCVF and representative areas. Based on the forest development project, mensurational descriptions and cartography materials, the forest stock of the leasing estate was evaluated.

After mapping out the HCVF and representative areas, the forest allotments for continuous monitoring observation for the assessment of the forest reproduction and condition of the protected seedlings were selected. As these indexes are the basic criteria for the forest biogeocenoses recovery, the following tasks were fulfilled:

- in the monitoring territory, six sample areas were mapped out, and a series of mensuration measurements was carried out;
- in each sample area, the trees were counted, their diameters were measured to classify them into technical feasibility categories;
- for 109 trees (32 spruces, 25 birches, 43 pines and 9 aspens), the heights were measured;
- for the assessment of natural reproduction under the forest canopy, including the auxiliary species, by their species composition, number, and height, 132 quadrats of 10 m² each were allotted.

3. Results and discussions

Based on the survey, a high conservation value forest monitoring program was developed. The main objective of the monitoring observation is to check whether the required protection is ensured, to see the condition of the mapped high conservation value forests (HCVF) and the representative areas, and to introduce the appropriate changes into the forest management plan in case of any negative changes in the assessed indexes. A sample area is defined as a specially allotted phytocenosis area for the identification and description of its typical features. The allotment territory was selected to ensure the uniformity of all the vegetation mensuration indexes and the habitat conditions [5]. The monitoring observation was carried out at the leasing estate of Tolshmenskoe, LLC, on the six stationary sites represented by coniferous vegetation. The coniferous wood share in the forest stand composition constitutes from 7 to 9 units. The studied areas are analysed based on the average mensuration indexes (table 1).

3.1. Life condition of the forest stands

The phytosanitary survey of the pine tree forests was carried out in compliance with the Decree of the Government of the Russian Federation dated 20.05.2017 No/ 607 "On the regulations of the sanitary security in the forests". As a result of the forest registry work, the life condition categories of the trees have been defined.

According to the survey results, there is a category of trees of high sanitary quality classes (table 2). The life condition analysis shows that the majority of the wood species have no signs of degeneration.
However, these forest stands are remarkable for their high resistance to adverse climatic factors. There are no blown-down trees or windfall in the studied areas.

**Table 1.** Forest management and mensuration indexes of the studied areas.

| Composition | Forest type index | Element of the forest | Average | Quantity, trees per hectare | Completeness s | Stock, m³ per ha | Capacity |
|--------------|-------------------|-----------------------|---------|----------------------------|----------------|----------------|----------|
|              |                   |                       | D, cm   | H, m                       |                |                |          |
| 7P2S1B       | Bilberry spruce   | Pine                  | 28.4    | 24.3                       | 162            | 30.05          | 74       |
|              | spruce forest     | Spruce                | 16.4    | 17.4                       | 148            | 9.11           | 03       |
|              |                   | Birch                 | 18.1    | 21.3                       | 48             | 3.42           | 11       |
| 9P1S         | Bilberry spruce   | Pine                  | 26.1    | 22.3                       | 147            | 7.89           | 05       |
|              | spruce forest     | Spruce                | 11.3    | 16.2                       | 169            | 1.69           | 06       |
|              |                   | Birch                 | 12.5    | 19.5                       | 45             | 0.18           | 03       |
| 9P1S         | Sorrel pinery     | Pine                  | 26.7    | 24.6                       | 218            | 3.56           | 06       |
|              | Spruce            | 9.6                   | 12.0    | 246                        | 24.4           | 0.15           | 23       |
|              | Sorrel pinery     | Pine                  | 11.1    | 11.0                       | 287            | 2.8            | 01       |
|              | Spruce            | 12.5                  | 19.5    | 45                         | 0.18           | 03            | 3        |
| 9P1S         | Sorrel pinery     | Pine                  | 28.8    | 30.0                       | 100            | 32.55          | 075      |
|              | Spruce            | 10.4                  | 16.0    | 106                        | 4.0            | 0.2            | 35       |
|              | Spruce            | 32.2                  | 30.2    | 324                        | 26.4           | 0.6            | 359      |
| 8P1S1B       | Sorrel pinery     | Pine                  | 14.3    | 24.9                       | 468            | 7.49           | 01       |
|              | Spruce            | 20.2                  | 25.5    | 152                        | 4.87           | 0.1            | 52       |
|              | Birch             | 20.2                  | 25.5    | 152                        | 4.87           | 0.1            | 52       |

**Table 2.** Sanitary condition of the wood vegetation.

| No. sample area | Species | Distribution of trees by sanitary assessment classes, % | Average phytosanitary condition class |
|-----------------|---------|-------------------------------------------------------|---------------------------------------|
|                 | I       | II          | III         | IV          | V           | VI          | VII         | windfall, blowndown trees |                      |
| 1               | S       | 53          | 28          | 5           | 8           | 6           | -           | -                        | I, 9                  |
|                 | P       | 84          | 8           | -           | 1           | 7           | -           | -                        | I, 4                  |
|                 | B       | 88          | 6           | -           | 6           | -           | -           | -                        | I, 3                  |
| 2               | P       | 27          | 63          | 3           | 4           | 3           | -           | -                        | I, 9                  |
|                 | S       | 9           | 38          | 49          | 4           | -           | -           | -                        | III, 5                |
| 3               | P       | 40          | 46          | 10          | 2           | 2           | -           | -                        | I, 8                  |
|                 | S       | 2           | 26          | 47          | 21          | 4           | -           | -                        | III, 0                |
|                 | P       | -           | 28          | 36          | 17          | 19          | -           | -                        | III, 2                |
| 4               | S       | 13          | 34          | 28          | 31          | 9           | -           | -                        | II, 8                 |
|                 | B       | -           | 13          | 74          | 13          | -           | -           | -                        | III, 3                |
| 5               | P       | 2           | 42          | 40          | 16          | -           | -           | -                        | II, 7                 |
|                 | S       | 26          | 58          | 10          | 6           | 1           | -           | -                        | I, 7                  |
|                 | P       | 4           | 30          | 39          | 15          | 12          | -           | -                        | III, 0                |
| 6               | S       | 13          | 34          | 28          | 16          | 9           | -           | -                        | II, 7                 |
|                 | B       | 4           | 17          | 68          | 11          | -           | -           | -                        | II, 8                 |

Note: I — no degeneration signs; II — degenerating trees; III — severely degenerating trees; IV — drying out trees; V — fresh drywood; VI — previous years' drywood
The major share of the trees belongs to the I-III sanitary condition categories. The general sanitary condition of the forest stands is evaluated as good. The maximum number of drywood trees was registered in the sample area No. 4, and the minimum number was found in the area No. 1.

3.2. Forest stand component damage
Along with the phytosanitary assessment, the signs (types) and reasons of tree damage were studied. The most common damage type was mechanical damage caused by the intraspecific competition. In total, 10 types of damage were found (table 3).

Table 3. Tree damage in the sample areas.

| No. sample area | Species | Share of undamaged plants, % | Distribution of trees by damage type, % |
|-----------------|---------|------------------------------|----------------------------------------|
|                 |         | contamination with parasitic plants | lop trees | dry branches | misshaped tree | barkless spots | staghedness | broken meetops | contamination with pests | mechanical damage | Share of damaged trees, % |
| 1               | S       | 97 - 1 - 2 - - - - - - - - - - - - | 3 |
|                 | P       | 93 - 3 - 3 - - - - - - - - - - - - | 7 |
|                 | B       | 100 - - - - - - - - - - - - - - | - |
| 2               | S       | 95 - 3 - 2 - - - - - - - - - - - - | 5 |
|                 | P       | 67 - 2 - 2 - 9 - 9 - 9 - 2 - - - - | 33 |
| 3               | S       | 84 - - 4 - - 6 - 2 - 4 - - - - - | 16 |
|                 | P       | 97 - - 3 - 3 - 1 - 2 - 3 - - - - | 3 |
| 4               | S       | 88 - - 3 - 3 - 1 - 2 - 3 - - - - | 12 |
|                 | P       | 73 1 - 7 - 3 - 6 - 10 - - - - - | 27 |
|                 | B       | 92 - - - - - - - - - - - - - - | 8 |
| 5               | S       | 92 - - 1 - 1 - 2 - 3 - 3 - 1 - - - | - 11 |
|                 | P       | 95 - - 3 - 2 - - - - - - - - - | 5 |
| 6               | S       | 87 - 3 - 10 - - - - - - - - | 13 |
|                 | B       | 96 - - - - - 1 - 3 - - - - | 4 |

Among the wood species monitored around the sample areas, the minimum damage was found in silver birch. Its condition was greatly influenced by its occupation of both the superordinate and subordinate canopy. Among all the species, Scots pine is the most vulnerable to damage. It was especially obvious in the sample areas 3 and 4, where the share of the damaged trees reached 33%. The forest stand contains some lop trees, misshapen trees etc. However, they are not numerous in quantity. In all the forest areas, single dry trees were found.

Generally, the monitoring observation showed that the arboreal plants growing in the studied territory feature high resistance.

3.3. Natural forest formation process assessment
In accordance with the developed HCVF monitoring program, it can be concluded that the sanitary condition of the given forest vegetation can be characterized as healthy, without any prominent signs of degradation. For this reason, the first stage does not require any forest management actions to improve the resistance and condition of the forest vegetation.

The forest biogeocenosis is quite a long process associated, first of all, with the natural regeneration of the forest. The artificial forests that do not occupy a large area (maximum 6%) do not make a critical influence in replacement of the coniferous forest with the foliferous forest in the operation process [6]. The effectiveness of forest regeneration depends on the reproduction process of the forest stand.
(fructification, seed production) and abiotic factors (nutrient content of the soil, temperature, humidity, light). The flourish of the trees, production and dispersal of seeds, germination and growth of the seedlings, natural seeding development, undergrowth formation are the components of the 5 seed regeneration stages [6]. In the management evaluation of the natural regeneration effectiveness, we considered the height, age, and life condition of the undergrowth, the quantity of the young trees and the evenness of their distribution around the area (table 4). The undergrowth rate varied from one area to another to a great extent. The undergrowth composition in uneven.

In all the stationary objects (sample areas), the dominating species are the basic forest-formation tree species of Vologda Oblast. In the formed forest canopy, the dominant position is occupied by aspen (over 5.0 thousand trees/ha) and birch (over 0.5 thousand trees/ha). The coniferous and foliferous undergrowth is evenly distributed around the forest allotment area. No pines were found in the undergrowth count process. Quantity composition of the spruce undergrowth under the key canopy exceeds 1.0 thousand trees/ha. In all stationary areas, the viable trees prevail. According to the height classification, the undergrowth is represented by tall trees (fr 1.5 m to 4.0 m).

**Table 4.** Forest management assessment of the natural forest formation process in the studied areas.

| No. sample area | Specie | Undergrowth distribution by categories of size and life condition, % | Total, trees per hectare |
|-----------------|--------|-------------------------------------------------|--------------------------|
|                 |        | small | medium | large |                  |
|                 | U | D | U | D | P | U | D |                  |
| 1               | S | 14 | 9 | 4 | 27 | 10 | 16 | 4 | 16 | 1621 |
| 2               | A | 4 | 24 | 5 | 24 | - | - | 18 | - | 2843 |
| Total, %        | 6 | 22 | 7 | 3 | 19 | 18 | 13 | 7 | 5 | 5047 |
| 3               | S | 4 | 12 | 5 | 33 | 14 | 12 | 2 | 17 | 1209 |
| 4               | A | 57 | 11 | - | 7 | 5 | 10 | - | 10 | 5225 |
| Total, %        | 4 | 18 | 14 | 5 | 28 | 7 | 6 | 10 | 8 | 4052 |
| 5               | S | 29 | 0 | 10 | 13 | 3 | 5 | 33 | 0 | 6560 |
| A               | - | 30 | - | 6 | 45 | 18 | - | - | 550 |
| 6               | B | 4 | 24 | 27 | 5 | 24 | - | - | 18 | 2843 |
| Total, %        | 3 | 21 | 9 | 3 | 21 | 20 | 10 | 7 | 6 | 4602 |
| 7               | A | 45 | 14 | - | 16 | 5 | 10 | 10 | - | 5127 |
| Total, %        | 5 | 10 | 7 | 10 | 15 | 3 | 5 | 27 | 0 | 6544 |
| 8               | A | 4 | 18 | 17 | - | 36 | 4 | 21 | - | 1825 |
| Total, %        | 6 | 25 | 30 | 10 | 24 | - | - | 11 | - | 1587 |
| 9               | B | 8 | 7 | - | 8 | 28 | 14 | 15 | 12 | 8 | 789 |
| Total, %        | 4 | 17 | 16 | 6 | 29 | 5 | 12 | 8 | 3 | 4201 |

Note: P — promising undergrowth, U — unpromising undergrowth, D — doubtful undergrowth

Generally, at the moment of research, the natural forest regeneration process continues. However, it should be noted that without the proper forest management actions, formation of a young generation with a dominating share of economically valuable species would take extremely long. Among the forest management actions stimulating the forest formation process, timely care is worth being recognized.

**4. Conclusion**

The study has shown that during the study period, the natural forest regeneration process was more active in the so-called regeneration windows. However, it should be noted that without the proper forest management actions, it is impossible to form a young generation of trees with the dominating share of economically valuable species. An important forest management component is the potential impact
consideration principle. According to its definition, HCVF incorporates the forest territories bearing the greatest value from the nature conservation or social perspective. For this reason, it is extremely important not to lose the identified value. Therefore, HCVF monitoring should be carried out once every 2-3 years, at the end of the calendar year. The classification of the forest stand condition is very important for the vegetation condition assessment. In case of domination of the first two categories (undamaged, slightly damaged), the vegetation condition is assessed as satisfactory. If any forest stand of the next category or transition from the second to the third category (medium-damaged forest stand) is found, the decision on increasing the monitoring frequency to twice a year (at the beginning of the vegetation period and in autumn before the snow covering) shall be made. As the wood vegetation is noticed to transit into the fourth category (severely damaged trees), response measures shall be taken, i.e. forest management operations are assigned in the area. If the trees are classified as belonging to the fifth category (dead trees), the forest regeneration work in the territory shall be done.

On the tenth year, the forest registry work is organized and carried out for the development of the forest management and mensuration certificate of the vegetation area. An extraordinary HCVF sustainability monitoring is carried out in case of any adverse ecological factors (forest fires, massive windfall or blow-downs, massive pest attack or diseases) and the negative changes caused by these factors in the territories.

References
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