Aspects of recreational zoning of the forest park "Kuskovo"

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Abstract: Control over the state of protected areas in the city is an extremely important activity, as these areas are of great recreational, environmental and educational importance, and the pressure exerted on them by residents of the city and their activities can disrupt the balance in these ecosystems. There are four main types of anthropogenic impact on natural areas: trampling and littering, contamination of water bodies and animal disturbance factors. All these problems are related to the large number of visitors to natural areas. The natural environment has a response to any human impact, which means that it is possible to identify the force of this impact and to form methods to minimize it. The condition of natural-historical park "Kuskovo" is assessed with the help of environmental control methods and devices. The flora and fauna of the territory are considered and the Red Book species are identified. Classification of forest landscapes, analysis of road and path network, recreational digression and noise impact on the investigated area were also made.

1. Introduction

The planned natural-historical park "Kuskovo" is a popular place for recreation of residents and guests of the city and the habitat of animals and plants included in the Red Book of Moscow. Like any other protected area near or inside a settlement, Kuskovo Forest Park is subject to various human impacts [1]. Wood vegetation, as well as other natural ecosystems, is quite resistant to human impact. Recreation has an impact on these systems and leads to some changes in them, and under particularly intense pressure – to their death [2, 3]. There are four main impacts on natural territorial complex: trampling and littering, contamination of water bodies and animal disturbance. All these problems are related to the large number of visitors to the natural areas [4, 5].

It is important to monitor these types of impacts [6]. To do this, various methods and instruments are used to monitor the state of the environment, as well as to form an overall assessment of its condition.

In this article only the northeastern part of the Kuskovo forest park with the area of approximately 88.6 ha, which is more exposed to human impact, will be considered [7-9].

2. Flora and fauna

The flora and fauna of Kuskovo Forest Park is very diverse and includes a large number of rare species. Rare species of trees include blue spruce (Picea pungens), Manchurian walnut (Juglans mandshurica), Manchurian cherry (Prunus maackii), red ash (Fraxinus pennsylvanica).

The undergrowth includes typical species from the European part of Russia: mountain ash (Sorbus), bird cherries (Prunus padus), willow tree (Salix), less often alder buckthorn (Rhamnus frangula),
European spindle (Euonymus europaeus) and spread throughout all areas of plantations from private and group plantings - hawthorn (Crataegus) of different species, white dogwood (Cornus alba), common ninebark (Physocarpus opulifolius).

The grass cover is dominated by: wood avens (Geum urbanum), Aegopodium (Aegopodium podagraria), lady fern (Athryrium filix-femina), wood ferns (Dryopteris), wood-rush (Luzula), and stinging nettle (Urtica dioica). Rare for Moscow herbaceous plants grow in the forest park: ox-eye daisy (Leucanthemum vulgare), lily-of-the-valley (Convallaria majalis), lesser celandine (Ficaria verna), heath dog-violet (Viola canina), wide-leaved bellflower (Campanula latifolia), yellow anemone (Anemone ranunculoides) and some other plants listed in the Red Book of Moscow. According to the official site "Mospriroda", 9 species of plants listed in the Red Book of Moscow grow in the forest park: globeflower (Trollius europaeus), Corydalis marschalliana (Corydalis marschalliana), Corydalis cava (Corydalis cava), Corydalis intermedia (Corydalis intermedia), spring vetchling (Lathyrus vernus), black bitter vetch (Lathyrus niger), Scheuchzeria palustris (Scheuchzeria palustris), crested wood fern (Dryopteris cristata), kidney vetch (Anthyllis vulneraria).

The faunistic composition is diverse, with typical species such as squirrel (Sciurus), European hedgehog (Erinaceus europaeus), vole (Arvicolinae), small forest mouse (Apodemus uralensis), long-tailed shrews (Sorex) and others. There are about 60 bird species: sparrowhawk (Accipiter nisus), black-headed gull (Chroicocephalus ridibundus), mallard (Anas platyrhynchos), common goldeneye (Bucephala clangula), long-eared owl (Asio otus), thrush nightingale (Luscinia luscinia), common magpie (Pica pica), several woodpecker species (Dendrocopos) etc.

According to the data of the website "Mospriroda", 8 species of animals listed in the Red Book of Moscow inhabit the park's territory: Daubenton's bat (Myotis daubentonii), European water vole (Arvicola amphibius), ermine (Mustela erminea), brown hare (Lepus europaeus), white hare (Lepus timidus), forest mouse (Sicista betulina), water shrew (Neomys fodiens), brown long-eared bat (Plecotus auritus) [10].

3. Forest park landscape classification

The classification of landscapes in "Kuskovo" Forest Park can distinguish 3 classes of the most common landscapes:

1. Landscapes consisting of a mixture of trees such as linden, oak and birch. On the most part of the investigated territory trees are unevenly distributed, sometimes it is possible to see tree curtains, there is a large number of small glades, the closeness of the tree crown is about 0.5. A young undergrowth can be observed. Such a forest landscape can be classified as «2b»: Edged woodstands with group placement of trees.

![Figure 1](image1.png) **Figure 1.** Typical forest landscape in "Kuskovo" forest park. Mixed deciduous forests (mainly oak, linden, birch), with encountered tree curtains and a small number of glades.

![Figure 2](image2.png) **Figure 2.** Small cluster of pines in the forest park "Kuskovo". Pines with even distribution.
2. Landscapes consisting of small clusters of pines. The tree crown closeness makes from 0.3 to 0.5. Trees are distributed evenly. Such landscape can be classified as «2a»: Split tree stands with evenly distributed trees in the area.

3. Landscapes not covered by forests. In this forest park these are glades and places where trees are cut down. Such landscapes can be classified as «3b»: plots with single trees and young undergrowth up to 1 m high.

![Figure 3. Glade in forest park "Kuskovo". Sometimes there are lonely growing trees.](image)

4. Analysis of the road and path network (RPN) of the Kuskovo forest park

For assessment of the condition of the RPN the forest park zone in the northeastern part of the Kuskovo forest park was selected. The assessment of the RPN in the forest park was carried out according to the methodology of Y.A. Nasimovich [11, 12].

The RPN obtained with the help of GPS tracker was constructed and displayed on the map of the RPN of the forest park zone in the northern part of "Kuskovo" Forest Park. Each of the roads was measured in width. According to GPS tracker data, the total length of the road-tropical network of the forest area in the northeastern part of "Kuskovo" forest park was 8.93 km.

![Figure 4. RPN of the forest park zone in the northern part of the "Kuskovo" forest park.](image)
Also a map of ranking of the RPN by the width of the forest park zone in the northeastern part of the forest park "Kuskovo" was built to calculate the area occupied by the RPN from the total area of the investigated section of the forest park zone.

**Figure 5.** Map of the RPN ranking by the width of the forest park zone in the northern part of the forest park «Kuskovo». Blue indicates roads 5 to 7 m in width; green indicates 3 to 5 m in width; red indicates 1 to 3 m in width; yellow indicates paths up to 1 m in width.

**Figure 6.** Road 5-7 meters wide in the forest park "Kuskovo".

**Figure 7.** Road 3-5 m wide in the forest park "Kuskovo".
Having summed up the area of all roads, the area of the RRN of "Kuskovo" park was 17,900 m$^2$.

Using electronic maps, the area of the investigated territory was calculated - 0.60 km$^2$.

The share of the area occupied by the road and tile network from the area of the whole territory of the park is calculated by the formula:

$$ S = \frac{S_{RPN}}{S_{ter}}, \% $$

where $S_{RPN}$ – area covered by the RPN of the park, ha;
$S_{ter}$ – the area of the investigated park, ha.

$$ S = \frac{17900}{600000} = 2.98\% $$

The share of the area occupied by RPN from the investigated area in the forest park "Kuskovo" is 2.98%. These numbers do not exceed the standard.

On the basis of the information received, the zoning of the area was carried out to assess the recreational impact by the method of Y.A. Nasimovich. The results allow us to conclude that the majority of the territory is exposed to the second stage of recreational digression [13].

Working according to the given method, it is necessary to consider that stages of recreational digression do not always correspond to the selected zones on the density of the RPN. These stages depend not only on the attendance of the park, but also on the stability of the grass cover, which in turn depends on the granulometric composition of the soil, its moisture, slope of the surface, light (the more light, the more resistant the forest herbs to trampling), etc.

A large number of trees with mechanical damage were found on the territory of the forest park studied [14]. Some of them were marked with notches with a serial number.

The evaluation of noise pollution was carried out with the multifunctional device № DT-8820. During measurements in the northern part of the forest park values ranged from 50 to 70 dB, which is a rather high value. Such values can be caused by the fact that the park is surrounded by highways, and in the north of the park there are railways of the Moscow Central Circle (MCC). High noise levels can have a negative impact on visitors and the wildlife in the forest park [15, 16].
Figure 10. Northern entrance to "Kuskovo" forest park. Noise impacts are significant from the nearby section of the MCC.

5. Conclusion
The park mainly consists of mixed forest landscapes. Sanitary conditions and recreational digression are better than many other parks in Moscow, but not the standard for protected areas. Also in the territory of the forest park revealed a rather strong noise impact, due to its proximity to the highway network and tracks of the MCC. It is recommended to create acoustic screens along the perimeter of the park to reduce this impact.

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