# Mapping the Intensity of Recreation Impact in the NP Losiny Ostrov, Moscow

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Abstract: General recreational situation in the NP Losiny Ostrov (Moscow) is analysed. The technique of field observations and computer mapping of recreation intensity and status of forest landscapes is described. Corresponding maps are represented and correlated with the location of residential regions, entrances, and basic visitor flows. Five areas of intensive effect of stationary recreation were revealed at the studied territory of ca. 600 ha. In most cases, extreme recreation is thought to be the main reason of forest decline and decrease in recreational carrying capacity. Top-priority areas of landscape improvement were revealed. Maps reflecting the spatial distribution of recreation intensity and status of forest landscapes are regarded as an appropriate instrument of territorial planning.

## Introduction

National Park (NP) Losiny Ostrov is one of very few national parks of the world, which are situated in the national capital. Total park area is 128 km$^2$, which constitutes ca. 10% of Moscow area. One-quarter of its territory (31 km$^2$) is located within the city boundaries (Figure 1). The suburban part of NP territory is surrounded by cities – satellites of Moscow, with their developed industrial infrastructure.

The national park is visited mainly by the inhabitants of adjacent districts; only a minor part of visitors comes from remote districts of Moscow, predominantly as organised tourist groups.


Figure 1. National Park Losiny Ostrov and other green territories of Moscow and its suburbs.

The recreation in forested areas is very popular among urban population. The most common types of recreation are short-term visits to the peripheral areas of NP: walking, jogging, skiing in winter season, and picnics. The latter cause the most noticeable negative influence on NP landscapes, especially when they are accompanied by fire-making, which is prohibited in the national park and in Moscow in general.

The studies, carried out by the International Forest Research Institute (Moscow, Russian Academy of Natural Sciences) in 1990-s demonstrated that the recreational carrying capacity of peripheral forest massifs of the NP was exceeded by a factor of 5-6 (Proekt organizatsii... 1998).

Expert evaluations revealed that visitor flows were distributed extremely unevenly across the park territory (Gorokhov et al. 1990). Hence, there are several areas where the attendance is critical.

National parks have to combine nature conservation with the development of recreational and tourist activities. For this purpose, the evaluation of recreational impact, its spatial distribution, and recreational planning is extremely important.

Systematic studies of recreation impact were initiated in the NP Losiny Ostrov in 2000-2001. Twenty permanent observation plots were set in order to determine the effect of recreation on forest status. Trampling was found to cause soil compaction and decrease in radial increment of forest stands.

Monitoring at permanent plots helped to reveal the mechanisms of recreation effect and determine some critical values. However, permanent plots are point objects and prevent us from obtaining the picture of spatial distribution of anthropogenic effect. In 2001, a model territory with the area of ca. 150 ha was chosen in order to evaluate the character of spatial distribution of recreation intensity and its relation to

the spatial distribution of forest stand characteristics. The method of circular relascopic plots, which is commonly used in forest inventory, was applied (Shapochkin et al. 2003). Survey units were evenly distributed across the model territory and represented maximal variety of forest landscapes and recreation intensity. As a result, the most visited and most damaged sites were found to concentrate in the 1-km belt along park boundaries or around the most attractive places (Shapochkin & Kiseleva 2002).

The next stage of recreation studies is continuous mapping of recreational situation. This paper represents the results of recreation studies undertaken in 2003 and aimed at:

- finding an appropriate and simple technique for large-scale recreation survey;
- exploring and mapping the recreational situation in the most visited sites of NP;
- revealing the sites with extreme attendance and/or damaged forest landscapes;
- suggesting the system of practical measures directed to the improvement of forest status and recreational carrying capacity.

## Materials and Methods

Recreation intensity and impact were studied and mapped in the most visited sites of urban part of NP. Totally 3 sites with the area of 200, 140, and 330 ha were examined (Figure 2). They all border with high-populated residential areas. Maximal simultaneous attendance, calculated from the number of inhabitants, is evaluated as 7300, 4000, and 8300 persons, respectively. Since 1970-s, these sites were developed as local recreational areas, therefore, they are dissected by the net of pedestrian roads, often with asphalt and gravel coverage. In the westernmost site, in the valley of the Yauza River, complex landscape reconstruction was implemented in early 1990-s. As a result, the landscape became much more attractive and, accordingly, much more visited.

Forests of the sites selected differ by age and composition and thus, by attractiveness and carrying capacity. In fact, the sites represent three relatively independent recreational zones differing by natural conditions and social situation, in particular, interests of visitors coming from adjacent residential zones. Social structure and differentiated needs of visitors are to be studied in future.

Currently, the studies are focused on the issues of exceeding of carrying capacity and spatial distribution of visitor flows and recreation impact.

In order to evaluate the spatial distribution of recreation intensity and landscape status, a 100-m regular grid of observation points was used. In relatively intact sites, the grid was sparsed. The status of landscape at each point was characterised by a number of parameters. To make the work less labour- and time-consuming and avoid sophisticated measurements, semiquantitative indices were used.

The intensity of recreation was characterised by the percent of trampled surface, as trampling is the most pronounced and obvious aspect of recreation. According to the percent of trampled surface, the landscapes are assigned corresponding stage of recreational digression: I – below 1, II – 1-5, III – 5-10, IV – 10-25, and V - >25%.

Forest landscapes were characterised by the status of tree layer, undergrowth, and herbaceous vegetation.

The status of tree layer determines the stability of the whole forest landscape. The grades of sanitary status of forest stands are: 1 – healthy, 2 – depressed, 3 – strongly depressed, 4 – destroyed; subject guide was used to determine the grades.

The status of undergrowth determines the alternation of forest generations and thus, potential stability of forest landscapes. Undergrowth status was characterised by density and vitality, with corresponding

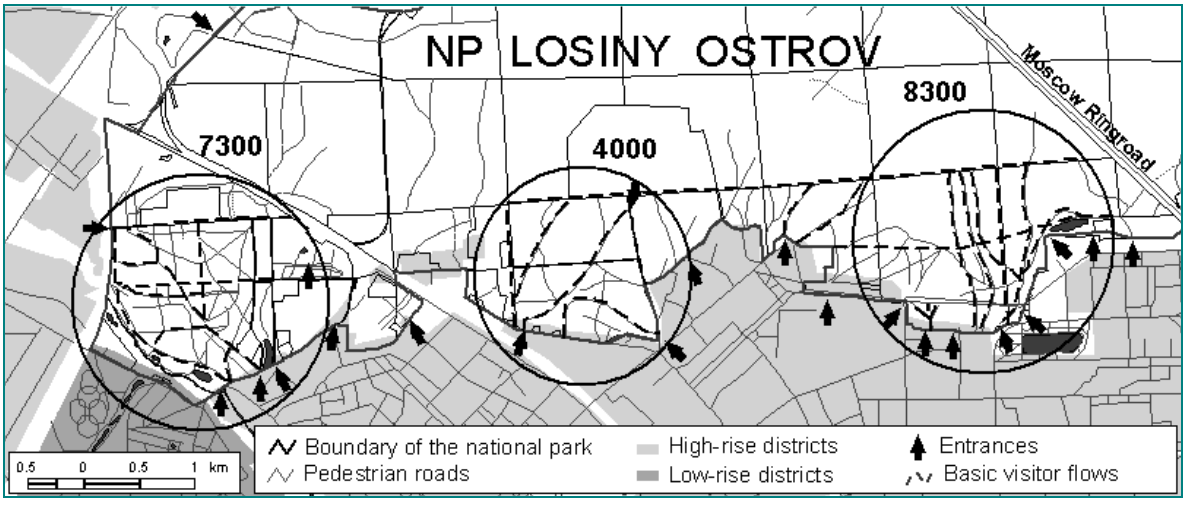


Figure 2. Location of studied sites (circled) in the south-western part of the NP Losiny Ostrov. Figures above the circles represent maximum simultaneous attendance.

grades: 1 – low, 2 – medium, 3 – high. Integral grade was obtained by multiplying the grades of density and vitality; product indices of undergrowth status were arranged as following: 0-1 – critical; 2-3 – unsatisfactory; 4 – satisfactory; 6-9 – undamaged.

The status of herbaceous vegetation is a clear indicator of intra-ecosystem changes. Predominant groups of species of herbaceous vegetations were described at each point: typical forest species, forest-meadow species, gramineous, or weeds.

Fireplaces and extremely trampled sites were mapped separately as point objects.

The data of field observations were put on the database, which was than used for the creation of new coverages in GIS projects with the help of ArcView, version 3.2.

At the first stage, the grid of point objects was created (Figure 3a). Then the groups of points with equal grades were encountered (Figure 3b), and the polygons reflecting the spatial distribution of studied characteristics were produced (Figure 3c).

The data were treated statistically in order to find interrelations among the characteristics of recreation intensity and forest status.

## Results

Compiled maps reflect quite a complex and contrast recreational situation in the most visited sites of NP.

The analysis of *recreational digression* demonstrates that the status more than 50% of the territory corresponds to the second and third stages, which are assumed to be permissible for normal forest growth. At this background, large areas with the status corresponding to the 4$^{th}$ and 5$^{th}$ stage of recreational digression (>10 and >25% of trampled surface, respectively) are revealed. They are not obligatorily attributed to the basic directions of visitor movement but form continuous areas in the peripheral part. These areas are characterised by multiple fireplaces and frequently found rubbish. Totally, 5 large areas of this kind were detected at the maps (Figure 4a). In addition, the observations allowed us to detect multiple "hot points" characterised by extreme trampling.

This points to a pronounced lack of places for stationary recreation near residential zones.

The most common *status of forest stands* is characterised as depressed, with the fragments of healthy and strongly depressed ones (Figure 4b). The latter form relatively large areals in the zones of extreme recreation intensity. However, besides recreation, other factors of forest decline were revealed: site overmoistening, diseases, and pests.

The status of undergrowth is mainly satisfactory within the studied territory. The areals with critical and unsatisfactory status form linear contours along the directions of major visitor flows or are attributed to the most visited peripheral part of the territory (Figure 4c). In some cases, unsatisfactory undergrowth was observed under dense forest canopy.

The *composition of herbaceous vegetation* proves to depend much on recreation intensity. Gramineous and weed species appear with increasing recreation intensity when trampled surface exceeds 10% of the area.

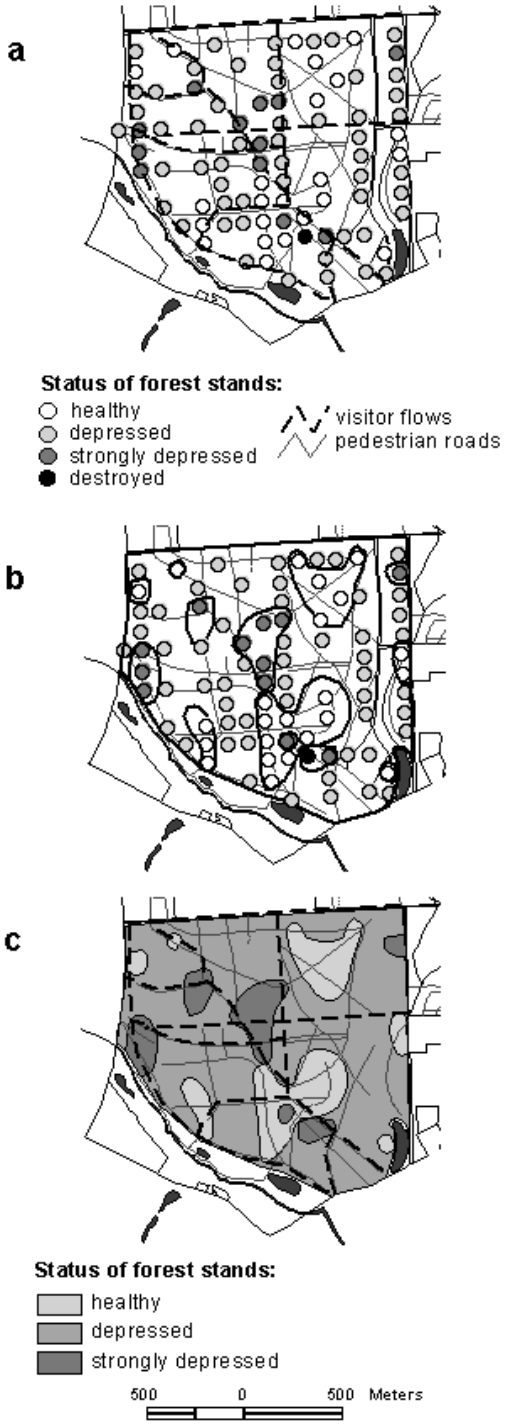


Figure 3. Stages of computer mapping: point objects (a), linear contours (b), and polygons (c).

This also points to the destabilisation of landscapes and decrease in their carrying capacity. Simultaneously, the islets of relatively undisturbed forest stands were found even in the most visited zones. This indicates that: (1) the net of pedestrian roads is temporarily stable, and visitors prefer to use them instead of searching new ways and (2) forest ecosystems possess a satisfactory potential of self-regeneration in case of reorganisation of visitor flows.

## Practical Issues

The analysis of compiled maps allowed us to work out some practical recommendations considering the improvement of recreational situation.

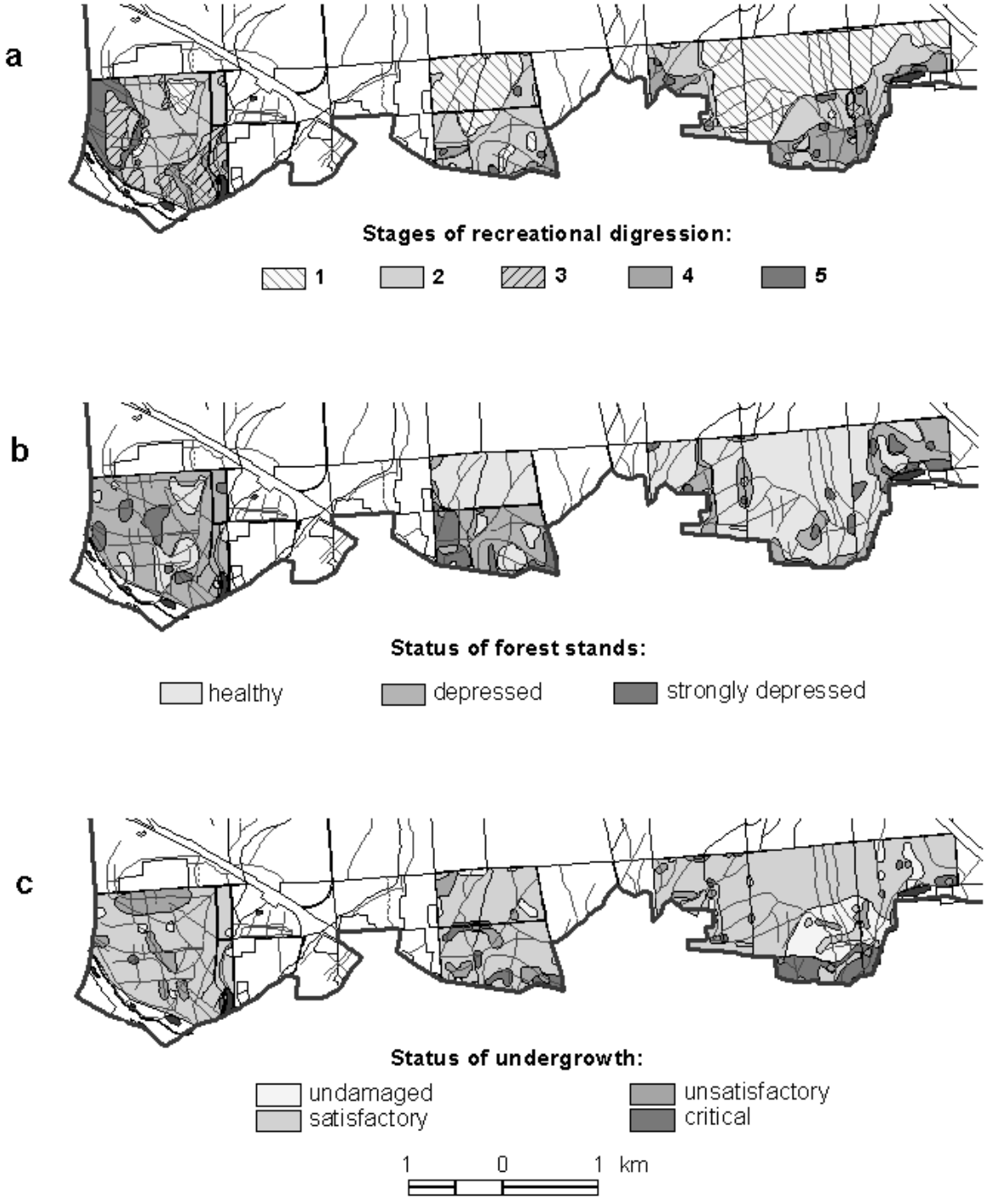


Figure 4. Maps illustrating the spatial distribution of recreation intensity (a), status of forest stands (b), and undergrowth (c).

(1) An obvious lack of facilities for stationary recreation leads to the emergence of stochastic picnic places spreading into the forest massif. In connection with this, there is a need in setting benches, tables, sheds, etc. along basic directions of existing visitor flows. They must be surrounded by hedges in order to avoid extra-trampling around.

In general, the development of recreational and tourist infrastructure should become the main instrument of management of visitor flows.

(2) Ground pedestrian roads should be covered with gravel or waste wood to protect tree roots.

(3) Stochastic fireplaces must be liquidated and replaced by groups of trees and bushes.

Simultaneously, the work with visitors should be conducted: more visitor-addressed information explaining the damage caused by fires is needed.

(4) In order to increase forest resistance to anthropogenic effect, it is necessary to restore full-component forest ecosystems by creating under-canopy cultures or planting groups of trees and bushes when necessary. These groups will serve as centres of regeneration of natural forest herbaceous vegetation and nesting areas for birds.

(5) Some fragments of significantly depressed and declining stands need reconstruction cuts: sparsing of upper weak tree layers in order to promote a proper development of undergrowth. At the studied territory, this will enhance natural restoration of oak and other broad-leaved trees, which are known to be more resistant to recreation effect and correspond to soil conditions of the territory.

(6) Sanitary cuts are recommended for elm stands destroyed by vascular stem disease, with the formation of half-open landscapes.

The recommendations also were mapped. The fragment of a map of this kind is represented at Figure 5. Visualisation of recreational situation and recommendations makes it possible to evaluate the volume and scale of indispensable work and determine top-priority objects.

## Conclusions

(1) Applied technique of mapping of recreation intensity and impact on forest landscapes proved to be appropriate for large-scale inventory.

(2) Mapping of recreational loads demonstrates that the spatial distribution of recreation effect is contrast: both relatively intact and severely degraded sites were revealed; they often form the mosaic complicating territorial planning.

(3) The status of the most part of forest stands is characterised as depressed but not endangered.

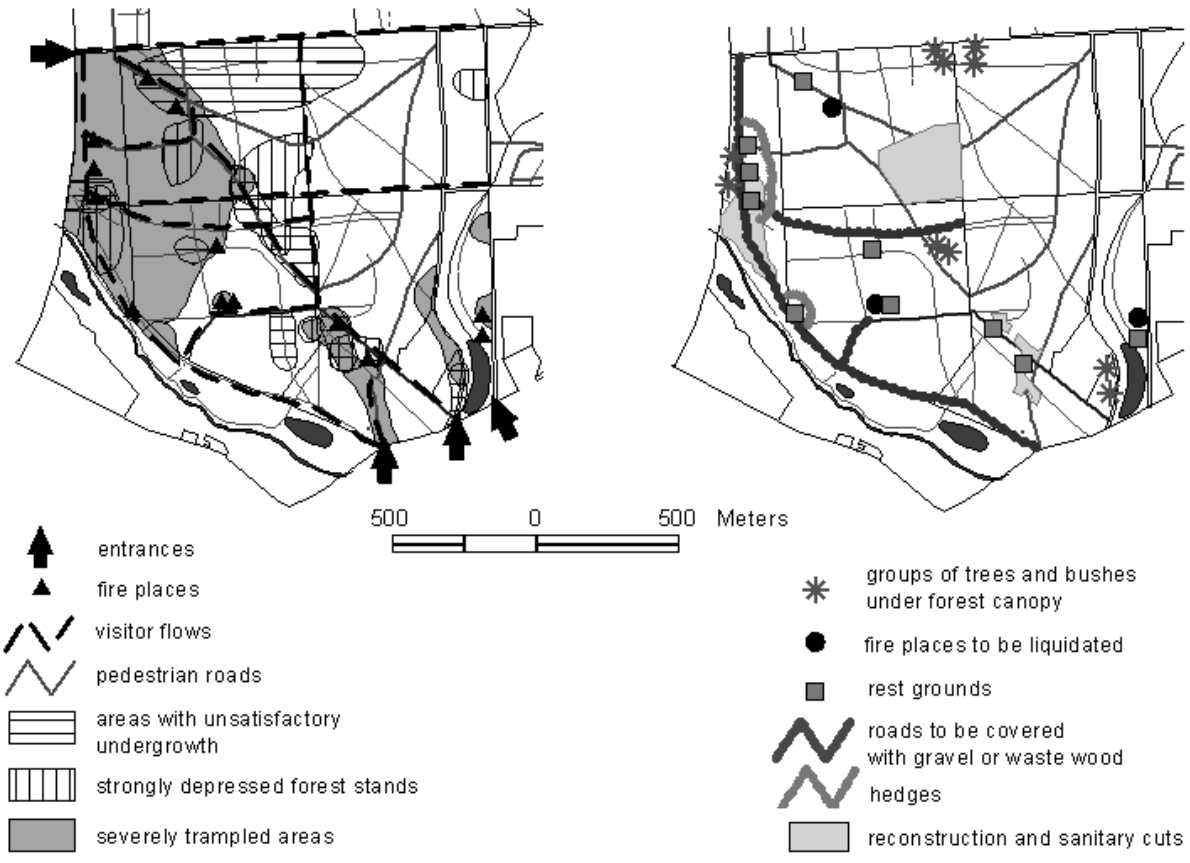


Figure 5. Example of integrated representation of endangered sites (left) and corresponding measures of landscape improvement (right).

Healthy stands usually are attributed to the least visited areas. The areals of severely depressed and declining forests are in most cases detected in the areas with the highest stages of recreational digression. The exceptions are the fragments with local overmoistening and the stands attacked by diseases or pests. This allows us to treat the intensity of recreation as a leading factor of forest decline.

(4) The undergrowth is mainly vital within the studied territory. The areals of undergrowth with critical and unsatisfactory status are related to the directions of major visitor flows or picnic places. In the same sites, crucial changes in the composition of herbaceous vegetation are registered. The absence of undergrowth and disappearance of typical forest species point to the destabilisation of ecosystems and decreased resistance to external effects, which may reduce the recreational carrying capacity.

(5) Within the studied territory of 600 ha, five areals demanding complex restoration measures were detected.

(6) Main principles of increasing the carrying capacity and stability of forest landscapes in the studied zone are:

- liquidation of fireplaces by planting groups of trees and bushes;
- organisation of facilities for rest along basic directions of visitor flows;
- strengthening of pedestrian roads with graved or waste wood;
- restoration and sanitary cuts in declining stands with following regeneration of more resistant broad-leaved species or formation of half-open landscapes.

The system of recommendations is visualised as a series of maps, which facilitate the work of decision-makers and practical workers. The results of recreational mapping represent an important stage in the development of recreational and tourist infrastructure in NP.

(7) The next stage of territorial planning is a substantiated development of tourist infrastructure, which will serve the instrument of management of visitor flows.

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