Ukrainian Journal of Ecology

Ukrainian Journal of Ecology, 2019, 9(3), 399-401.

ORIGINAL ARTICLE

Influence of recreation on the forest ecosystems of Altai Region low lands

G. G. Sokolova

Altai State University, Lenin St. 61, 656049, Barnaul, Russia
E-mail: sokolova-gg@mail.ru

Received: 13.09.2019. Accepted: 21.10.2019

The paper describes the results of studying the dynamics of the species composition and changes in the structure of forest ecosystems in the lowlands of the Altai Territory under the influence of recreation. The study revealed five types of forest disturbance. Three groups of herbaceous plants were distinguished depending on the response to trampling. Recommendations on permissible loads in recreational forests are given.

Key words: Recreation; Forest ecosystems; Digression; Types of forest disturbance

Introduction

The processes of degradation of forest ecosystems under the influence of recreation are characterized by regular changes: disturbance of the stand begins with the appearance of paths and forest roads. The stand is divided into separate groups, the integrity of forest ecosystems is violated (Taran, Spiridonov, 1977; Rysina, Rysin, 1983; Taran, 1985). All components of forest ecosystems undergo changes under the influence of recreation. The laying of roads and paths, the massive collection of mushrooms and berries contribute to soil compaction, lead to mechanical damage and destruction of plants (Rysin, 1980, 1990; Tarasov, 1986; Rysin et al., 1987.). Recreation causes a change in the species composition and structure of the grass stand, and a decrease in the productivity of forest ecosystems (Melanholin, 2006, 2014; Lysikov, 2008; Martynenko et al., 2009; Melanholin, Lysikov, 2014).

Materials and Methods

When studying the degradation of forest ecosystems under the influence of recreation, geobotanical surveys and selective mapping of the territories that were subjected to the greatest recreational load were used. In the selected areas, a series of trial plots were laid for a more in-depth study of the processes of change in woody vegetation. Trial areas were laid in Shelabolikhinsky, Mikhailovsky, Kosikhinsky, Kamensky, Aleysky districts and in the vicinity of Barnaul, Kamen-on-Ob, Biysk.

Results and Discussion

Constant trampling and mechanical damage to plants disrupt the processes of growth and renewal of species of wood, shrub and grass layers. In forest ecosystems, under the influence of recreation, there is a decrease in the number and density of some species and activation of the growth and development of other species.

Along forest roads and paths, vegetation is formed mainly due to synanthropic species (apophytes and anthropophytes), which act as dominants and co-dominants. Plants growing on trails and forest roads are stunted; the number of generative shoots in them decreases or does not form at all. Such plants tolerate trampling and damage to stems well, multiply rapidly by vegetative or seed routes, are able to quickly capture the vacated territories. They are adapted to exist in conditions of insufficient and uneven moisture, sharp temperature fluctuations and strong compaction of the upper horizons of the soil.

Ruderal communities formed on trodden territories are characterized by monodominance or oligodomination, low diversity and instability of the species composition, lack of a distinct structural organization, and low productivity. The most characteristic types of such communities are: *Trifolium repens, Lupinaster pentaphyllus, Polygonum aviculare, Plantago media, Pl. major, Veronica chamaedris, Antennaria dioica, Achillea millefolium, Sanguisorba officinalis, Rubus saxatilis, Fragaria vesca, Poa annua, P. angustifolia, Potentilla supina, Geum urbanum, Deschampsia cespitosa, Carum carvi, Taraxacum officinale, Elytrigia repens, Cirsium arvense, Equisetum arvense, Urtica dioica, Geranium sylvaticum, Leonurus tataricus, Chenopodium album, Glechoma hederacea, Cannabis ruderalis,* and *Bromopsis inermis*.

Forest roads and paths in forest ecosystems are migration corridors under recreational impact. Synanthropic plants penetrate into natural communities and spread there, displacing native species.

The tree and shrub tiers are thinned out under the influence of recreation, but such changes occur much more slowly compared to changes in the grass tier and moss cover. When trampling, the natural renewal of tree species is disturbed. Thinning of tree and shrub tiers leads to a change in the appearance of natural ecosystems. They acquire a park look, in which there is an alternation of individual curtains of trees and shrubs with open meadow glades. Undergrowth and undergrowth are practically absent. The thinning and destruction of the tree layer changes the lighting conditions under the forest canopy, which affects the species composition of the grass layer and moss cover. The mechanical effect leads to the destruction of forest plants and the release of ecological niches for meadow and weed species that can exist under conditions of trampling.

Types of grass layer do not respond to the recreational load. During the study, we identified the following groups of plants:

1. Species that reduce abundance and occurrence with an increase in recreational load – *Equisetum hiemale, Pteridium aquilinum, Brachypodium pinnatum, Calamagrostis arundinacea, Melica nutans, Lathyrus vernus, L. pratensis, Vicia unijuga, Lupinaster*

pentaphyllus, Crepis sibirica, Solidago virgaurea, Inula salicina, I. britannica, Sanguisorba officinalis, Hieraceum umbellatum, Trollius asiaticus, Rubus saxatilis, Pulmonaria mollis, Majanthemum bifolium, Angelica sylvestris, Anthriscus sylvestris, Bupleurum aureum, Aegopodium podagraria, Viola montana, Pyrola chlorantha, Geranium sylvaticum, and *Vaccinium vitis-idaea*.

2. Species preserving the abundance and occurrence to a certain degree of recreational load – *Poa nemoralis, Dactylis glomerata, Deschampsia cespitosa, Carex macroura, Equisetum pratense, Trifolium pratense, Vicia sepium, Lathyrus gmelinii, Fragaria vesca, Alchemilla vulgaris, Prunella vulgaris, Iris ruthenica, Achillea millefolium,* and *Ranunculus polyanthemos*.

3. Species increasing abundance and occurrence with an increase in recreational load – *Taraxacum officinale, Trifolium repens, Berteroa incana, Plantago media, Pl. lanceolata, Convolvulus arvensis, Polygonum aviculare, Phleum pratense, Poa annua, P. pratense,* and *Agrostis gigantea*.

Recreational digression of forest communities is accompanied by a decrease in the diversity of species composition, projective cover, and the average height of the grass stand. The ratio of ecological groups changes in the direction of decreasing the proportion of mesophilic species, the ratio of botanical groups - in the direction of increasing the proportion of meadow and weed forbs (Table 1).

Table 1. Change in the structure of forest ecosystems under the influence of recreation

Indicators	The degree of recreational load				
	control	< 0.1	0.1–0.3	0.3–0.6	> 0.6
Number of species	35-57	30–42	24-40	16-25	10-15
Number of weed species	_	3	5	7	10
Projective cover of grass,%	75	70	65	40	30
The average height of the grass stand, cm	60	55	35	30	15
The ratio of botanical groups,%:					
cereals	42	39	29	23	15
sedge	3	2	1	–	–
bean	5	3	2	1	–
forbs	50	56	68	76	85
The ratio of ecological groups,%:					
mesophytes	95	90	89	86	80
mesoxerophytes	3	7	10	12	15
xerophytes	–	–	1	2	5
hygrophytes	2	1	–	–	–
The ratio of phytocenotic groups,%:					
meadow species	7	20	40	61	74
forest meadow species	35	42	40	24	10
forest species	85	38	19	10	5
meadow steppe species	–	–	1	3	5
steppe species	–	–	–	2	4
The closeness of the tree layer	0.7	0.7	0.6	0.4	0.3
Litter power, cm	3.0	2.5	1.2	0.5	0.1
Above-ground phytomass, g/m^2	129±13	105±9	64±5	30±2	25±2

Under the influence of recreation, their phytocenotic and floristic diversity of forest ecosystems decreases, the ecological differences of territories are leveled. Under the forest canopy, a uniform grass cover is formed.

To assess the degradation of forest ecosystems in the lowlands of the Altai Territory, we used an indicator of the degree of disturbance of forests — the ratio of the area of disturbed forest to the total allotment area. As a result of the survey of forests, we identified 5 types of forest disturbance:

Type 1. Very weak disturbance: It occurs during sanitary or selective logging, weak influence of recreation, after low-level fires of low intensity.

Type 2. Weak disturbance: It is characterized by the destruction of ground cover, undergrowth, undergrowth and partially forest stand on an area of up to 10–30%. In forest ecosystems of this type, the loss of individual trees, the appearance of open glades, the introduction of photophilous species are observed. This situation is considered satisfactory and requires the adoption of measures to limit the anthropogenic load.

Type 3. Medium disturbance: The forest stand and other components of forest ecosystems are destroyed due to fires, pests, windfalls and other factors in an area of up to 31–50%. Forest ecosystems of this type are characterized by a change in edificators, fragmentation of the forest stand and the replacement of conifers with hardwood. This state of forests is considered tense. In such ecosystems, various forestry and biotechnological measures should be taken to restore community integrity and prevent change of edificators.

Type 4. Severe disturbance: The death of the stand and other components occurs on an area of up to 51–70%. In forest ecosystems of this type, serious changes in the soil cover, undergrowth, undergrowth and shrub layer, and destruction of the forest stand are observed. This condition is considered critical and requires immediate action to restore damaged arrays.

Type 5. Very severe disturbance: The death of forest ecosystems is observed on an area of more than 71% under the influence of industrial emissions, severe forest fires, clear cutting and other factors. Forest ecosystems of this type are characterized by profound changes in the structure, the loss of indigenous edificators, and the complete destruction of the forest stand. This condition should be considered catastrophic and emergency measures should be taken.
The greatest degree of forest disturbance is currently characteristic of the environs of large cities (Barnaul, Rubtsovsk, Kamen-on-Ob, Aleysk and others) and areas of Altai Territory that have undergone massive fires (Upper Ob and Middle Ob Forests). Permissible recreational loads in the forests of the steppe and forest-steppe zones of the Altai territory, taking into account the edaphic and climatic coefficients, are given in Table 2.

Table 2. Permissible loads in recreational forests of Altai territory (according to Sokolova, 2014).

Zones	Climate compliance coefficient, C_{cc}	Soil compliance coefficient, C_{ec}	Recreational load, visitors per hour ha^{-1}		
			Minimal	Maximal	Medium
Forest-steppe	1.00	0.50	5	10	7
Steppe	0.70	0.45	3	7	5
Regionwide	0.85	0.47	4	8.5	6

C_{ec} - average forest productivity/maximum forest productivity; C_{cc} – average forest productivity in region within 100 years/maximum forest productivity in region within 100 years.

To preserve forests, it is necessary to carry out functional zoning of recreational areas with the allocation of active recreation zones, development zones and reserve zones. Forests, in which no more than 50% of the communities are at II-IV stages of degradation, should be assigned to the active recreation zone. The footpath network should make up about 10% of the area, the average load in the zone should be no more than 10–15 visitors per hour ha^{-1}. Forests should be assigned to the development zone, in which 50% of the communities are at I–II stages of degradation, the path network does not exceed 1–10% of the area, and the average recreational load is 5–10 visitors per hour ha^{-1}. The reserve zone should include forests in which 50% of communities are at the 0–I stages of degradation, the area of the path network does not exceed 1%, and the recreational load is 5 visitors per hour ha^{-1}.

Conclusion

Depending on the degree of disturbance of the stand and the intensity of the recreational load for the restoration and protection of forest ecosystems of the Altai Territory, three groups of measures can be recommended:

1. **Forestry activities.** They should include planning, landscape, sanitary, reconstructive and thinning, landscape and protective planting, the creation of forest crops and the promotion of natural regeneration, the maintenance of ground cover, undergrowth and forest stand, the formation of forest edges, and the maintenance of glades.
2. **Biotechnical activities.** They combine the forest protection from pests and diseases, comprehensive and partial landscaping, road maintenance, reclamation and fire prevention measures.
3. **Preventive measures.** Preventive measures include environmental education and upbringing and environmental advocacy.

References

Lysikov A.B. (2008). Izmenenie plotnosti lesnyh pochv pri rekreaci. Lesovedenie, 4, 44-49 (in Russian).
Melanholin P.N. (2006). Izmenenie vidovogo raznoobraziya travyano-kustarnichkovogo yarusa pri razlichnyh antropogennyh nagruzkah na lesnye ekosistemy. Lesovedenie, 6, 52-58. (in Russian).
Melanholin P.N. (2014). Izmenenie travyanogo pokrova pri snizhenii rekreacionnoj nagruzki v Podmoskovnom lesoparke. Lesovedenie, 4, 50-55 (in Russian).
Melanholin P.N., Lysikov A.B. (2014). Vliyanie dorozhno-tropinochnoj seti na travyanuyu rastitel'nost' i pochvy dubovyh lesov Moskvy i blizhnego Podmoskov'ya. Lesovedenie, 2, 38-45 (in Russian).
Martynenko V.B., Mirkin B.M., Shirokih P.S. (2009). Lesnye ekosistemy i urbanizaciya. Lesovedenie, 3, 77-78 (in Russian).
Rysin L.P. (1980). Metodologicheskie osnovy rekreacionnogo lesopol'zovaniya (na primere lesov Podmoskov'ya). Moscsow. Nauka (in Russian).
Rysin L.P. (1990). Problemy rekreacionnogo prirodopol'zovaniya. Problemy antropogennoj dinamiki biogeocenozov. Moscow. Nauka (in Russian).
Rysin L.P., Polyakova G.A. (1987). Vliyanie rekreacionnogo lesopol'zovaniya na rastitel'nost'. Prirodnye aspekty rekreacionnogo ispol'zovaniya lesa. Moscow. Nauka (in Russian).
Rysina G.P., Rysin L.P. (1983). Ocenka antropotolerantnosti lesnyh travyanistyh rastenij. Rekreacionnoe lesopol'zovanie v SSSR. Moscow. Nauka (in Russian).
Sokolova G.G. (2014). Vliyanie rekreacii na lesnye ekosistemy ravninnoj chasti Altajskogo kraya. Geografiya i prirodnye resursy, 17, 178–184 (in Russian).
Taran I.V., Spiridonov V.N. (1977). Ustojchivost' rekreacionnyh lesov. Novosibirsk. Nauka (in Russian).
Taran I.S. (1985). Rekreacionnye lesa Zapadnoj Sibiri. Novosibirsk. Nauka (in Russian).
Tarasov A.I. (1986). Rekreacionnoe lesopol'zovanie. Moscow (in Russian).

Citation:
Sokolova, G.G. (2019). Influence of recreation on the forest ecosystems of Altai Region low lands. *Ukrainian Journal of Ecology, 9*(3), 399-401.