Impact of brush fire and pinetum horizontal structure on the tree condition

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Abstract. The research focuses on pinetum in the South of Central Siberia. Studying was performed in the territory of low-mountain suburban forests. Sample plots were set up in the sites where wood fires of different strength happened; the pinetum plantations withstanding to burning were in the observational focus. It was found that post-fire condition of trees depends on the tree size and plant population. The fire damage to trees (scorch height) depends on a tree size and the distance from the nearest exemplar.

1. Introduction

Researchers highlight the environmental importance of the brush fire to form light-colored coniferous forest. However, the impact of the space structure (tree exposure, plant population) on the brush fire intensity needs to research.

2. Results and Discussion

Studying the flatland pinetum in National park “Shushenskiy bor”, O.P.Kalenskaya [1] determines pleurocarpous moss wood type plantation after the severe fire demonstrates the dependence of scorch height on stem diameter and average distance among trees. Scorch height increases if stem diameter and distance among trees increase. Plant health considerably depends on an average distance in independent fire of moderate and high intensity comparing to fires of low and moderate intensity.

The research focuses on pinetum in the South of Central Siberia. The observations were performed in low-mountain suburban forest. The sample plots were provided on the sites where the fires of different intensity happened; the plantations withstanding to fire were in the control group. The autumn post-bush fire forest stand demonstrated post-fire plant litter in the crowded plantation.

We should mention all trees on the sample plots were mapped (coordinate areas). Every tree breast height diameter was measured, plant health was determined, scorch height and damages (fire scars, resinosis, deseases) are described. The plantation in the sample plots were subjected to the autumn bush fire. The fire intensity increased and ranged from moderate to high when the cutslope ratio and its altitude elevation increased. The fire intensity in the specified point was determined by scorch height. During the spring fires, group location of young regeneration provided their survival due to later snow pack melting, and consequently, less fuel drying near the groups. During autumn fires a considerable plant litter percentage of grouping trees was mentioned. The phenomenon can be explained by complete plant litter dry and greater amount of dried plant litter under the tree groups and young regeneration clusters. In addition, as a rule, we registered the increase in the debris amount of big-sized trees having bigger canopy. Maximum quantity of fuel results in increasing the burning
power intensity and fire intensity, therefore, more damage. The observations highlight the impact of the factors on trees exposure to fire and tree size category [2, 3]. However, the observation needs mathematical proof.

Correlation analysis and variance analysis were performed to estimate complex and selective impact of space structure of forest stand and tree diameter on the fire intensity and tree condition. According to the plant health, the trees were grouped into three categories: vigorous trees, problematic trees, and dried up trees.

Index of competitiveness is a special coefficient to consider the ‘social’ factor (the plant population and exemplar size).

A tree location was determined by average distance within the social group (the central tree and its neighborhood).

The correlation analysis was performed to evaluate the closeness relationship among the factors above. Table 1 contains the results.

Table 1. Interrelation matrix among different indexes of pine tree exemplars.

| Characters                      | Average distance, m | Competitiveness Index | Scorch height | Stem diameter | Plant health category |
|---------------------------------|---------------------|-----------------------|---------------|---------------|-----------------------|
| Average distance                | 1.0                 | -                     | -             | -             | -                     |
| Competitiveness Index           | -0.028              | 1.0                   | -             | -             | -                     |
| Scorch height                   | 0.018               | -0.274                | 1.0           | -             | -                     |
| Stem diameter                   | 0.332               | -0.627                | 0.288         | 1.0           | -                     |
| Plant health category           | 0.202               | 0.503                 | -0.026        | -0.027        | 1.0                   |

Remarkable interrelation was between plant health category and stem diameter (-0.827); plant health and index of competitiveness (0.503). These data confirms the impact of trees size and plant population on their post-fire condition. Index of competitiveness (-0.274) and stem diameter (0.288) demonstrate a low impact on selective fire intensity.

The regression analysis results in multivariate linear equation:

\[
K = 2.773 - 0.068 \times d_{1.3} - 0.033 \times L_{cp},
\]

K – plant health category (1-2-3); \( d_{1.3} \) – stem diameter, sm; \( L_{cp} \) – average distance in the social group, m.

The equation obtains several features: adaptation factor – 0.628; capital error – 0.7 (within a category); Fisher's variance ratio – 119; they indicate an equation dependability.

We use the two-way analysis of variance to estimate a regressor effect degree on tree condition and selective fire intensity.

Fisher ratio test determines two constraints as indubitable: \( K = f (CI,d_{1.3}) \) и \( H_{in} = f (L, d_{1.3}) \), they correspond to \( F_P = 4.1 > F_{ct} = 1.6 \) и \( F_P = 2.4 > F_{ct} = 1.5 \) respectively.

66.4% means the impact percentage of competitiveness index and stem diameter to plant health category. 38.6% is scorch height under the impact of average distance and stem diameter.

Post fire trees condition dramatically depends on exemplar size and plant population. The tree fire damage (scorch height) depends on its size and the distance to the ‘neighboring’ exemplar. It could be explained by the considerable amount of plant litter of large-sized trees and groups of trees. Low plant population occurs due to unaccounted factors; the main is tree dependence on nano- and micro-relief elements [4, 5, 6].

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