THE IMPACT OF SPATIAL CHARACTERISTICS ON THE SANITARY STATE OF NORWAY SPRUCE (*PICEA ABIES* (L.) KARST.) PURE STANDS IN LATVIA

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Introduction

Coppice management has always been an important matter for forest owners because forest management is related to tree productivity as well as the possibility of various risks. Biotic, abiotic and anthropogenic risk factors endanger coppices. Every owner is trying to manage his property in a way which limits or fully averts the spread of risk factors which can reduce the productivity of coppices. Timely recognition of these risk factors will prevent the deterioration of the sanitary state of the coppices.

It is certain that pest and tree diseases, cloven-hoofed animals, snow breakage and windfalls can all be reasons behind tree cutting, loss of growth ability or death in the coppice. However, the anthropogenic factor is also of great importance in forest management. Human activity can have both a negative and a positive effect on the productivity of a coppice. The productivity can be affected in many ways; however, most often it is done by leaving too many trees per hectare or not performing timely thinning.

The creation of such infrastructure objects as forest roads and forest drainage systems can bring positive or negative changes to the structure of the adjacent stands. Correctly located forest roads and drainage ditches are of crucial importance in forest management (Demir, 2007).

In spring and autumn when groundwater and above-water levels increase, forest machinery carrying heavy loads leave deep ruts in the forest roads which lead to soil compaction. If these ruts are deeper than 40 cm tree ingrowth and growth becomes stunted. It is known that the Norway spruce (*Picea abies*), which is the third most important tree species in Latvia (Zviedre, 1999), has a shallow root system and the roots can be easily damaged. When the roots are damaged there is a possibility that they might become infected with one of the root rot inducing fungi .

However, the impact of the infrastructure can be positive as well. The spruce's productivity near drainage ditches (up to 30 m) in *myrtillosa mel.* and *myrtillosa turf. mel.* type forests is increasing because water is one of the essential elements for tree growth ensuring the preservation and productivity of the ecosystem. As the spruce is a moisture-loving tree species, this element is very important for it (Zālītis, Indriksons, 2003).

Regardless of the main objectives, it is important to preserve the productivity of future forest stands, therefore a significant process in forest management is the identification of silvicultural risk factors and the possibilities for their reduction and prevention (Kaktiņš, Arhipova, 2002). Therefore an aim has been set to analyse the impact of spatial characteristics on the sanitary state of Norway spruce pure stands. To achieve this aim the following tasks have been set out:

- to analyse the sanitary state of Norway spruce stands;
- to analyse the impact of the anthropogenic risk factor on the sanitary state of Norway spruce.

Methods

Empirical material from 2011 and 2012 obtained while surveying up to 40 year-old Norway spruce coppices. The data have been collected from 12 pure stands which were surveyed in 2011 in all four regions of Latvia. 50 temporary sample plots were created in these stands. In 2012, 13 pure stands were surveyed from which the empirical material was obtained and 43 temporary sample plots were created. The following biotic damage was discovered in the Norway spruce pure stands: damage caused by greenflies, weevil, needle-cutting beetles, mealybug, eastern spruce gall adelgid, bark beetle, bud moth, needle drop, root rot, needle rust and cloven-hoofed animals; as well as the following abiotic damage: windthrow, windfall, snow crush, snow breakage and snow falls.

The area of forest compartment is the most important factor in choosing the number of sample plots. Rectangular sample plots on diagonals or transects in equal distances have been created only in dense stands and comprise the entire area of the forest compartment. All sample plots have been chosen according to the systematic principle and most of them are round. The area of sample plots was chosen according to the average tree height in the stand. All the discovered damage has been divided into six damage levels. The stability of spruce pure stands against snow breakage was determined by calculating the slenderness coefficient – the tree's height versus diameter H:D. The location within the forest massif has been determined to be able to ascertain what effect the adjacent stands have on the status of the Norway spruce coppices. The form of forest compartments (regular or irregular) has been determined using the State Forest Service's (SFS) geographical information system (GIS) maps ArcGIS.

Results

From pure Norway spruce stands surveyed in this research, most topical damages are those of the biotic risk factors – damages by cloven-hoofed animals and sicknesses - *Lophophacidium hyperboreum* as well as root rot. Damages by cloven-hoofed animals are quite frequent in pure stands and may cause big losses to forest owners. They have been noticed in 16 coppices in different forest site types: *Hylocomiosa*, *Oxalidosa*, *Myrtillosa mel.* (coefficient of occurrence may occure from 0.8 – 49.0 %, coefficient of intensity – 0.2 – 20.2%), still only the damages in *Oxalidosa* will be taken into account in this survey, because their number in this type of forest growth circumstances is the biggest.

Most significant damages made by cloven-hoofed animals have been stated in 24 to 40 years old pure stands of Norway spruce with average height of trees and variation 15.0±0.37 un 20.5±0.62 m (Fig.1.).

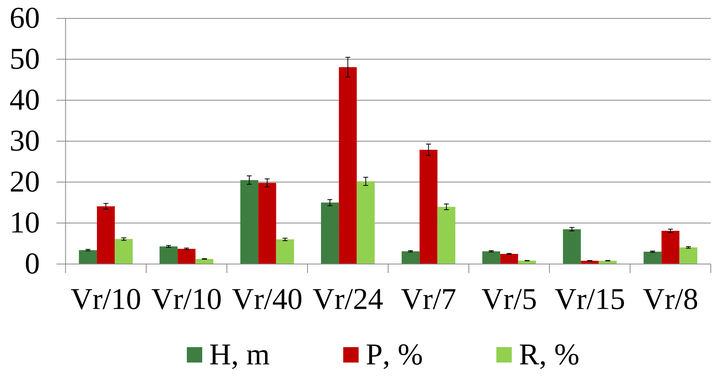

Fig. 1. Occurance and intensity of damages by cloven-hoofed animals according to type of forest, average height and age of trees (Vr* - *Oxalidosa;* H – height of trees; P – occurance of damages; R – intensity of damages).

The biggest damages of *Laphophacidium hyperboreum a*re those in *Myrtillosa mel*., 36 to 38 years old spruce stands with average height of trees 13.7±0.61 un 15.1±0.65 m, as well as in *Oxalidosa*, with average height of trees 9.1±0.95 un 11.5±0.34 m.

Root rot damages were stated in 8 pure stands of spruce. Calculating intensity of influence coefficients fluctuate from 0.3 to 17.2 %. The most significant damages of root rot – 36 to 38 years old coppices of Norway spruce with average tree height 15.0±0.61 and 15.1±0.65 m, as well as in *Oxalidosa* – 34 years old coppices with average tree height 9.1±0.95 un 11.2±0.68 (Fig.2).

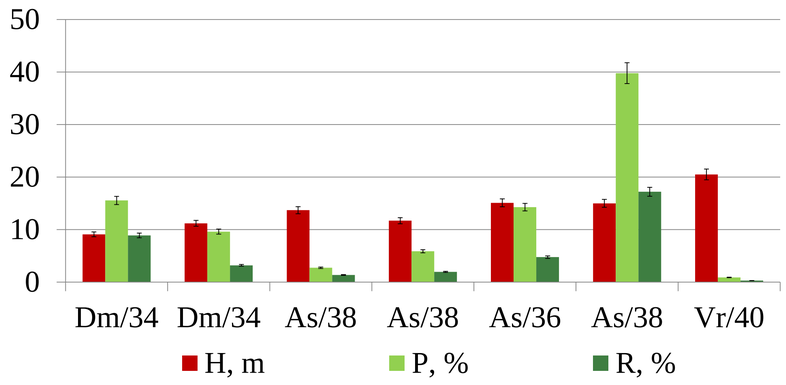

Fig. 2. Occurance and intensity of damages by root rot according to type of forest, average height and age of trees (Vr* - *Oxalidosa;* H – height of trees; P – occurance of damages; R – intensity of damages).

Conclusions

1. The most significant biotic risk factors, which threaten sanitary state in Latvian forests are cloven-hoofed animals, needle cast damage and root rot.
2. Sanitary state mostly worsens in pure stands, which are located between two coppices in forest array, and suffer from influence of damages caused by cloven-hoofed animals, also stands, which suffer from influence of needle cast damage, located in *Myrtillosa mel*. which are located between two ripening forest stands in forest array. Also in those, which suffer from influence of root rot, located by infrastructural objects.
3. In estimating influence of anthropogenic factor to damaged pure stands, worsening of sanitary state was stated as a result of improper thinning, making risks for multiplication of insects and sicknesses in stand.

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