The Evaluation of Pine Forest Vegetation in Riga City, Latvia

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Abstract: - The article focuses on analysis of *Myrtillosa* type pine forest vegetation in 15 urban forest tracts in Riga city, Latvia. In order to determine the impact of recreation on vegetation the composition of the plant communities and projective coverage of tree, shrub, herb and moss layer as well as the coverage of each separate species has been evaluated. All *Myrtillosa* type pine forests in Riga have been anthropogenically impacted. Insignificant changes of forest environment and typical forest vegetation are preserved in Bulli, Bolderaja, Jaunciems and Mangalsala. Medium antropogenic impacted are Smerlis, Bikernieki, Kleisti, Mezaparks, Jugla, Vecdaugava, Katlakalns, Ulbroka and Sampeteris forests: the composition of vegetation and projective coverage of layers indicate the increase of significant changes and their degradation. The most impacted are Babelite and Imanta forests: nemoral tree species are more represented, ground vegetation is trampled down.

Key-Words: - urban forest vegetation, *Pinus sylvestris*, recreation, Riga city

1 Introduction

Urban areas include greenspaces which range from tiny city parks to extensive woodland landscapes, and from rounded spots to linear greenways and river corridors. Greenspaces include substantial forest resources that have the potential for significantly improving the quality of the urban environment and the well-being of its residents.

Urban forests can strongly influence the physical/biological environment and mitigate many impacts of urban development by moderating climate, conserving energy, carbon dioxide, and water, improving air quality, controlling rainfall runoff and flooding, lowering noise levels, harboring wildlife, and enhancing the attractiveness of cities. The level of biodiversity of urban green areas is often surprisingly high, representing nature close to where people live. Urban forests can be viewed as a 'living technology', a key component of the urban infrastructure that helps to maintain a healthy environment for urban dwellers and stability of urban ecosystems [1,10,13,14].

Forests are prominent components of the landscape in most urban areas, at the same time urban forests provide a wide range of recreational and outdoor leisure opportunities. Urban forests also have high educational values by representing nature and natural processes in cities and towns, and they have often been used as testing and education areas for forestry and other disciplines [10,13,14,28,30]. The recreational and aesthetic benefit of urban forests is traditionally important especially in the Nordic and Baltic countries, because the forest is a major element of the landscape and national economy [32]. At the same time urban forests are a part of a complex environment, complicated diverse and interconnected ecosystems, which consist of groups of plants, animals, as well as microorganisms and soil, which are interrelated and influence each other and the environment. Unorganized recreation and excessive recreation loads cause significant disturbances to forest ecological functions. As result, mosaic type forest structure is formed – disturbed and undisturbed forest compartments [4,11,15,17,30,35,36,38]. Over the last decades in urban forests, especially sensitive pine forests, the ecosystem is changing and even degrading considerably. The urban environment provides a unique opportunity to meld landscape design with ecological management, therefore the objective is to develop the stability of the stand, its recreational properties and the respective infrastructure, which would increase the forest accessability and at the same time preserve its biological values [12,35,38]. The aim of the paper was to analyse and evaluate the current situation of pine forests' vegetation in Riga city.

2 Problem Formulation

2.1. Description of the territory

Riga has been the owner of forests since the thirteenth century and they have always been

accessible for inhabitants. According to Donis 0.8% of all Latvian forests are considered urban forests and 20% of urban areas covered by forests [9].

Today Riga is one of the biggest owners of forests in Europe: municipality owns more than 55.600 ha of forests and in inner city there are 4243.7 ha of forests [24]. The dynamics of land use and management of green space in Riga city are based on the main laws in Latvia and the numerous documents and regulations of municipality [18,23,25,37]. The legislation does not specify differences between maintenance and management of rural and urban forest, and there are disagreements between management, functional significance and demands for real use of urban forests. Riga city forests consist of 15 forest tracts which are connected with rural forests and some small, isolated forests – the remnants of ancient forest or planted forests (Fig. 1).

The main tree species is Scots pine *Pinus sylvestris* L. (46.9 km^2 or 88% of total forest area) on the poor sandy soil and is characterized by landscape attractiveness to recreational pressure.

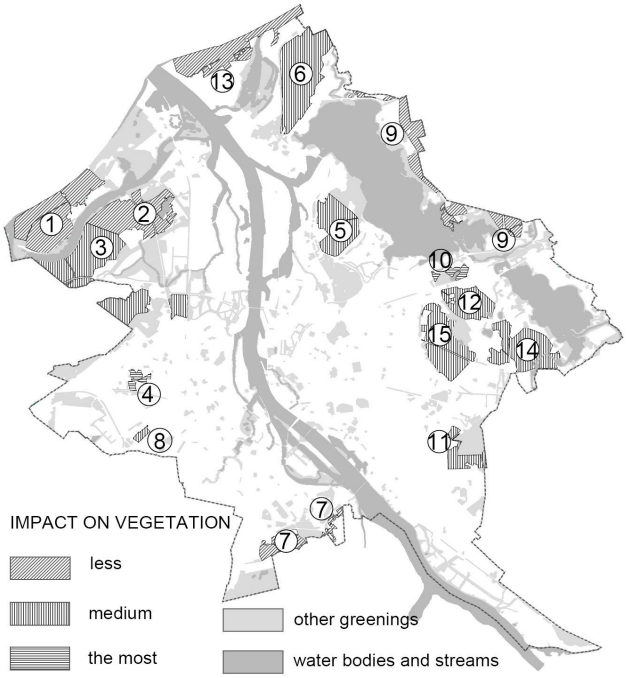

Fig.1 Riga city forest tracts: 1-Bulli, 2-Bolderaja, 3-Kleisti, 4-Imanta, 5-Mezaparks, 6-Vecdaugava, 7-Katlakalns, 8-Sampeteris, 9-Jaunciems, 10-Babelite,11-Ulbroka, 12-Smerlis, 13-Mangalsala, 14-Jugla, 15-Bikernieki.

2.2. Methods of vegetation research

The research was carried out in *Myrtillosa* type pine forests, which constitutes the highest proportion (33%) of the prevailing forests on dry sites in Riga city [25,26]. In each forest tract during the vegetation season of 2011, 45 vegetation sample plots were arranged and surveyed (the area of each sample plot - 400 m^2). The age of pine is 80-94 years. The Braun-Blanquet method was used to describe the plant communities: the total projective coverage of tree (E3), shrub (E2), herb (E1) and moss (E0) layer as well as the coverage of each separate species was evaluated in the sample plots in percentage [6,21].

2.3. Data processing methods

The descriptions of vegetation were summarised in the data base of the Excel software programme. The occurrence of plant species is characterised by the constancy class which is calculated by referring the number of those sample plots where the species has been identified to the number of the whole group of sample plots: I - < 21, II - 21-40, III - 41-60, IV - 61-80, V - 81-100 % [19]. Data processing was carried out with the software programme *Community analysis package* (Pisces Conservation Ltd.) TWINSPAN and PCA (*Principal component analysis*) [7]. For the credibility evaluation statistical methods were used [2].

3 Problem Solution

In Riga urban pine forests in total 154 vascular plant species, including 44 tree and shrub species were found (in the tree layer -10 species, in shrub layer - 37 and in herb layer - 32 species) and 110 herbaceous as well as 18 moss species. The number of species in sample plots does not differ significantly, although the highest number was found in Mangalsala (64 species), but the lowest – in Imanta forest (22 species). The coefficient of occurrence and constancy class show how stable a species is in a particular habitat: the higher constancy class, the more stable position the species occupies in the plant community. The researched plots are located in anthropogenically impacted forests, therefore the tendency of species inconstancy has been observed.

The most often (constancy class V) found tree species is *Pinus sylvestris* and shrub species are *Sorbus aucuparia and Amelanchier spicata*. There are neither herbaceous plant nor moss species in this class. In the constancy class IV *Quercus robur*, *Acer platanoides* and *Frangula alnus* in the shrub layer and herbaceous species *Luzula pilosa*, *Lerchenfeldia flexuosa*, *Fragaria vesca*, *Rubus idaeus* are observed. The constancy class III is represented by *Acer platanoides* in the tree and herb layer, *Padus avium* in the shrub layer and *Sorbus aucuparia* in the herb layer, as well as herbaceous species *Trientalis europaea*, *Vaccinium vitis-idaea*, *Vaccinium myrtillus*, *Chamaenerion angustifolium*,

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Maianthemum bifolium, *Solidago virgaurea*, *Impatiens parviflora*) and moss species - *Pleurozium screberi* and *Hylocomium splendens*, which are typical of coniferous forests.

The results obtained show that in forest ecosystem the layers of herbs and mosses respond most sensitively to different unfavourable disturbances [5,33]. Low level of constancy may be indicative of two reasons: either the species has just been established and will be developed in the future or it will be suppressed by other species and cast out of the plant community. Apparently, in the pine forests the species with low constancy are typical meadow species [8]. It should be taken into account that after the disturbance succession starts in the forest. As a result of that the plant communities which are similar to the previous vegetation are restored. Therefore long-term monitoring is required to precisely characterise the conditions of forest vegetation [29].

The pine and spruce forest species are the most commonly found (*Pinus sylvestris, Vaccinium vitis-idaea*, *Vaccinium myrtillus*, *Trientalis europaea*, *Maianthemum bifolium,* mosses *Pleurozium screberi* and *Hylocomium splendens*), however, *Quercus robur*, *Acer platanoides* and *Padus avium* are determining species of nemoral forest. The species introduced in Latvia such as *Amelanchier spicata*, as well as adventive species *Impatiens parviflora* have been naturalized in urban forests. They both are considered to be very expansive synanthropic species, which are rapidly overtaking more fertile soils in trampled down places [3,16,20]. The species *Chamaenerion angustifolium, Fragaria vesca* and *Rubus idaeus* are rapidly developing after anthropogenic disturbances, which are connected with the improvement of light conditions (open spaces, cutting-areas, forest edges, roadsides) and more rapid decomposition of nutrients in such places.

In order to determine the impact of recreation on Riga forest tracts, the composition of vegetation and projective coverage has been evaluated [37]. In Riga pine forests 10 tree species are found. Pure pine stands are found only in Mangalsala and Vecdaugava, pine in admixture with one species (*Betula pendula, Populus tremula*) in Bulli, Smerlis, with *Acer platanoides* - in Jugla and Bikernieki. The presence of pioneer species *Betula pendula* and *Populus tremula* indicates minor natural disturbances in the coniferous forest. In other forest tracts there are several species in admixture. The occurrence of broad-leaved trees indicates forest euthrofication and changes in the plant communities [15,16,17]. The projective coverage of layers in Riga *Myrtillosa* type pine forests is shown in Fig.2.

The average projective coverage of tree layer in forest tracts is similar, it differs significantly in Mezaparks (35%) and Smerlis (72%). The comparision of projective coverage (%) of tree layer and *Pinus sylvestris* shows that the lowest pine coverage is in Imanta (19%), where deciduous trees were found in admixture. The highest pine projective coverage is in Smerlis and Jaunciems (72% and 63% respectively). In the tree layer of Kleisti, Mezaparks, Ulbroka, Mangalsala and Jugla the admixture of other tree species is insignificant. Successful regeneration of Scots pine has been observed only in Mangalsala, Bolderaja and Jaunciems, which indicates the possibility of the preservation of pine as a species also in the future. In Mezaparks, Jugla, Bulli and Vecdaugava Scots pine occurs either in shrub layer or in herb layer. The frequent occurrence of Norway maple and penduculate oak in all layers of vegetation indicates rapid spread of these species, the increase in the soil fertility and the changes in the lighting in the forest stand.

In Riga forests 37 tree and shrub species occur in the shrub layer. The highest number of species has been found in Babelite and Ulbroka (14 and 13 species respectively), but the lowest number in Keisti (8 species). In the remaining forest tracts 9-12 species occur. The average projective coverage of the shrub layer differs significantly in several forest tracts (Fig.2): in Jaunciems the projective coverage of shrubs is 6 % and in Bolderāja - 10%, where seldom some tree species and shrub species are represented with insignificant projective coverage. In Sampeteris and Ulbroka the shrub layer is very dense (the projective coverage respectively 62 % and 66 %). It can been seen that fruitification has taken place. It shows gradual expansion of shrub communities and deciduous forests in the territory of Latvia, which is connected with climate changes and enrichment of the environment with nutrients, especially with nitrogen [15,31]. A dense undergrowth hinders not only forest regeneration, but it also makes the forest stands uniform, out of full vision, impenetrable and unsuitable for recreation [22]. In these places it is advisable to carry out such activities as thinnings and partial cutting of undergrowth to improve the landscape.

In the herb layer 142 species of vascular plants (16 tree, 16 shrub and 110 herbaceous plants) occur. In order to analyse the composition of species of herb layer, the data on the belonging of a species to a certain functional group have been used [34]. The distribution of herb layer species in funcional groups is shown in Fig.3.

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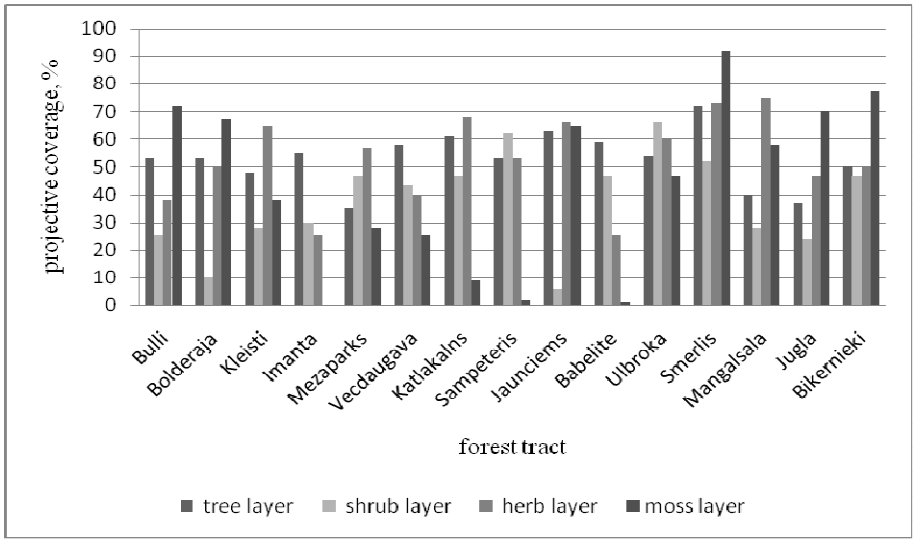

Fig.2 The projective coverage of layers (%) in Riga *Myrtillosa* type pine forests

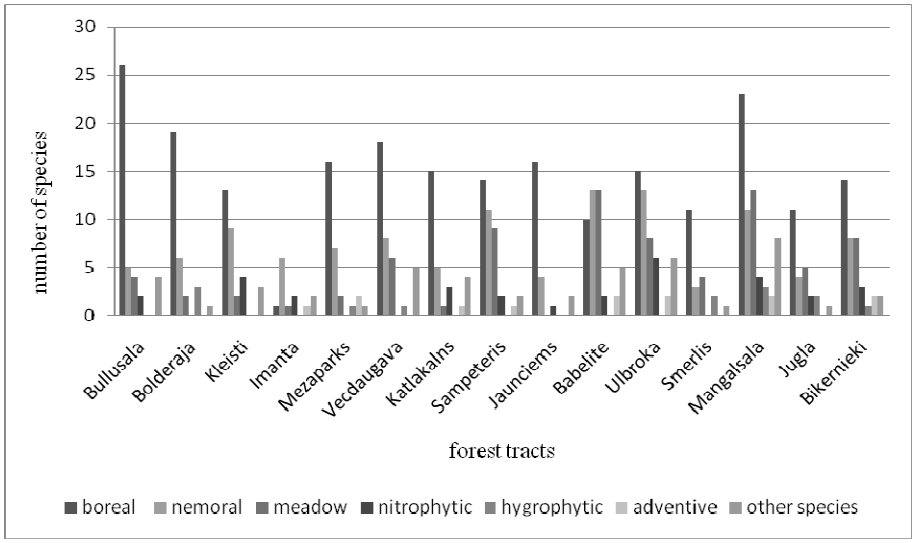

Fig.3 The distribution of herb layer species in funcional groups

In Riga pine forests the most widespread species are boreal - 40; 31 species belong to meadow plant group which expand in impacted forest soils; 37 species are nemoral, 17 - nitrophytic species (indicate a nitrogen-rich environment); 8 species are hygrophytic (characteristic of wet soils, which are formed in the lowlands of forest microrelief). The adventive species are *Acer negundo*, *Cerasus sp*., *Impatiens parviflora* and *Solidago canadensis* L., while 16 are other species: the majority of which are introduced species - garden escapers, such as *Aesculus hippocastanum*, *Amelanchier spicata*, *Cotoneaster lucidus*, *Symphoricarpos albus, Rosa rugosa, Ligustrum vulgare* and *Berberis vulgaris.* In most of forest tracts boreal species prevail, except Imanta and Babelite, where nemoral species prevail. A significant number of nemoral species has been found in Babelite, Ulbroka, Sampeteris and Mangalsala. The highest number of meadow species is found in Babelite and Mangalsala. The number of nitrophytic and hygrophytic species is insignificant. Adventive and other introduced species are more represented in Mangalsala, Ulbroka and Babelite. The graminification (an intensive grass spread) which is promoted by the growth of total amount of nitrogen was not observed in the researched pine forests. The average projective coverage of the herb layer in Riga forest tracts does not differ significantly (Fig. 2): the lowest coverage is in Imanta and Babelite (25 %), the highest in Smerlis and Mangalsala (73 % and 75 % respectively).

In the moss layer 18 species are found, from which most species (*Dicranum polysetum, Dicranum scoparium, Hylocomium splendens, Plagiomnium*

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affine, Plagiomnium undulatum, Pleurozium schreberi, Polytrichum juniperinum, Ptilium crista-castrensis, Rhytidiadelphus squarrosus Rhytidiadelphus triquetrus) are characterized by poor sand soils in coniferous and coniferous-deciduous forests, five species (*Brachythecium rutabulum, Cirriphyllum piliferum, Eurhynchium angustirete, Eurhynchium striatum, Homalothecium sericeum)* indicate the soils rich in humus, but three species (*Climacium dendroides, Polytrichum commune, Rhodobryum roseum)* - wet soils.

The composition of moss layer shows the differences between the forest tracts, e.g. the mosses characteristic of coniferous forests are found in Bulli, Bolderaja, Jaunciems and Smerlis, while in the remaining forests very different growth conditions have formed, e.g. open spaces have formed in Mangalsala, Jugla and Bikernieki. The projective coverage of moss layer differs significantly (Fig.2): it is poorly developed in Sampeteris, Babelite and also Katlakalns (2 %, 1 % and 9 % respectively), but not is not found in Imanta. In other forest the coverage of tracts moss layer ranges from 25 % to 77 %, but the highest it is in Smerlis (92%).

4 Conclusion

In Riga city all the *Myrtillosa* type pine forests have been anthropogenically impacted (Fig. 1). Insignificant changes of forest environment and typical forest vegetation (significant proportion of boreal forest species and high projective coverage of boreal mosses) are preserved in Bulli, Bolderaja, Jaunciems and Mangalsala, in those forest tracts the natural regeneration of pine has been observed. Medium antropogenic impacted are Smerlis, Bikernieki, Kleisti, Mezaparks, Jugla, Vecdaugava, Katlakalns, Ulbroka and Sampeteris forests: the composition of vegetation and projective coverage of layers indicate the increase significant changes and their degradation. The most impacted are Babelite and Imanta forests: the proportion of boreal species is low (they are found mainly in the tree and shrub layers), nemoral tree species are more represented, ground vegetation is trampled down, adventive species *Impatiens parviflora* prevails and there are no mosses.

The further research of forest vegetation needs to be done, modelling the distribution of visitors in forest tracks for different distances by using of GIS technique. It would be potential to interpret results of forests' ecological and social functions as well as to develop more advanced management of urban forests.

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