Urban Forests of Riga, Latvia – Pressures, Naturalness, Attitudes and Management

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Abstract

The urban forest landscape in Europe differs depending on the past history of sociopolitical cultures. Latvia presents a special case, as perceptions of urban green spaces changed from a period of Germanic dominance, to a developed European Republic, later subdued in the Soviet era, and now to a European country in transition. The human footprint has been relatively moderate, and there is little alienation between people and natural values. In Riga there are 15 forest tracts, some connected with rural forests and others are isolated remnants of ancient or planted forests. These forest stands are mostly dominated by Scots pine *Pinus sylvestris* L. on poor dry soils, with a characteristic feather-moss layer. While recognition of the importance of urban forest ecosystems in resilience of the city is growing, recreational pressure and demands for aesthetical, novel, man-made landscapes are significant. Governance in Latvia almost completely overlooks the complexity of urban forest management and there have been no attempts at integration of ecological, social, aesthetic and recreational functions in all-encompassing landscape planning of Riga forests with all relevant stakeholders participating. As a result, the 'naturalness' of the forests has been largely shaped by recreation loads. Knowledge is needed on the ecological and recreational functions of these forests, in order to develop specific management plans. We firstly used species and plant functional groups to derive indicators to determine extent of ecological degradation of the forests. Secondly, we applied the psychophysical method to determine public preferences for forest landscape models on images that were created with the aim to portray different management practices (e.g. retention of deadwood, cutting of understorey, and recreational infrastructure). We examined four types of forest landscapes and found a significant difference both in public preferences between them and in choices of respondent groups for the most preferable landscape for recreation.

Key words: recreation, forest management, landscape preference

Introduction

Urban forests are part of a complex environment that contains complicated diverse and interconnected ecosystems. The wooded area is an indicator of sustainability in the city; forest provides natural areas to inhabitants, which needs to be considered in city development and policy (Weng 2007, Cekule 2010). While recognition of the importance of urban forest ecosystems in resilience of cities is growing, recreational pressure and demands for aesthetical, novel and man-made landscapes are high. Spatially non-planned recreation and excessive recreation loads have impact on forest ecological functions and create a mosaic of disturbed and undisturbed forest compartments (Bell 2008, Kuzmina and Treshkin 2010). Planning of the urban environment needs to combine landscape design with ecological management to develop stand stability, ensure that recreation does not cause degradation of forest ecological functioning, and to develop the respective infrastructure to increase forest accessibility while conserving its biological value (Emsis 1980, Heyman et al. 2011).

In Europe, the inclusion and maintenance of natural areas in cities has long traditions from the start of development of civilization (Cekule 2010). The roles of urban green spaces differ widely between European cities and towns due their different environmental and socio-cultural background. The forest culture of the northern Europe in the eastern Baltic countries and Fennoscandia is rather similar, in those forest is a significant element of everyday lives, it is important in national economies, and is a major element of the landscape (Tyrväinen et al. 2006, Bell 2008). In this respect, the recreational and aesthetic benefits of urban forest are traditionally important (Gunnarsson and Øhrstroom 2007, Chen and Jim 2008), which differ from the central Europe, where land conversion processes

have been profound. In Latvia, as in other countries of the Northern Europe, the human footprint on nature throughout the twentieth century and the alienation between people and nature had less impact.

About 0.8% of all Latvian forests are considered urban forests and 20% of urban areas are covered by forests (Donis 2001). Presently, natural areas contribute 54.2% of the total area of Riga (Cekule 2010), of which the inner city wooded area is 4244 ha. According to Latvia legislation the urban forests cannot be exploited for timber production as the main management goal and clear-cutting is not allowed. Thus, the main management activities are focused on forest structure and health. Governance in Latvia largely ignores the complexity of urban forest management and there have been no attempts at integration of ecological, social, aesthetic and recreational functions in all-encompassing landscape planning of Riga forests with all relevant stakeholders participating. Thus, while knowledge of the multiple functions and significance of urban green areas in Riga does exist (Jankovska et al. 2010), it is not integrated in planning documents. In Riga there is no unified forest or green area management model or plan, and information exchange with state institutions, NGO's and other organizations is poor (Gaiss 2009). Tyrväinen et al. (2008) considered that problems in regard to urban forest infrastructure exist in all of the new European Union countries. Generally, the intensity and ways of forest management are determined by forest policy and ownership but the financial resources allotted for management of European city forests is often insufficient, leading to degradation of functions ~~of~~ and decrease of use (Gundersen et al. 2006).

In Riga, there is a need to determine recreational loads to forests and thier impact on vegetation. Previous research showed that the recreational target of going for a walk in a forest was chosen by 60% of Riga city inhabitants and 34% of respondents travelled to the forest afoot. The mean distance for this recreational target in Riga city was 1.5 km on working days. This information was used to create a GIS model that predicted average distribution of visits/year to forest areas afoot for walking (Jankovska et al. 2013). The predicted highest recreational pressure occurred in isolated forests located in proximity to the city centre and in places with greater population density. Traditional phytosociological study showed insignificant changes of the forest environment and typical boreal forest vegetation. Significant proportion of boreal vascular plant and moss species) was observed in one group of communities, which were called unimpacted forest (Straupe et al. 2012). In another group (impacted forest), the proportion of boreal species was low (mainly in the tree and shrub layers), nemoral tree species were more common, ground vegetation was trampled, and there was a larger proportion of adventive and introduced species. However, the processes governing vegetation composition in relation to recreational load might best be studied using plant attributes (Ikauniece et al. 2013) rather than by the taxonomic units of species. Clearly this needs to be better understood, to enable choosing the correct management methods.

Natural character of the forest and the landscape are the main factors determining its perceived value and suitability for recreation. Each person's individual value of a forest for recreation is based on their conception of a landscape beauty and personal emotional longings (Gobster 1996, Jestaedt 2008). These different invidual needs and perceptions differ, creating conflicts in the choice of a forest lansdcape created by forest management (Tyrväinen et al. 2003). Therefore, there is a need to determine the perceptions and values of the human community regarding its recreation in forest, which would allow to choose management methods that retain or create these qualities. However, ecological functioning of a forest is just as important as are needs for recreation, and both need to be integrated in planning. The chosen managment methods should promote natural succession, be economically efficient, and promote use of forests for recreation (Jankovska 2013).

Assessment of visual quality and suitability for recreation, depending on forest management intensity, was carried out in Latvia in 2008 (Donis 2011). The preferred choice for recreation was a forest landscape formed by sparse stands, or a forest composed of a mixture of sparse to dense stands. The least preferred was landcape with clearcuts. Most respondents preferred some facilities (for example, paths) but while conserving naturalness. The least preferred were forest stands affected by cutting and those transformed into wooded parks.

This paper presents an empirical application of the psychophysical methods to study the landscape experience and perception. These methods employ techniques that allow to examine the relationships between experiential qualities of landscapes and their physical charasteristics. Photographs of landscapes are generally used, whereby the effect of specific physical charastersitics of landscape on perceived experiential qualities (safety, preference, scenic quality) can be investigated by manipulating the physical charastersitics of landscape (e.g. by adding or taking away different attributes) (Karmanov 2008). This approach allows high accuracy in assessment, as it involves humans as observers of landscape quality and estimates the

role of biophysical characters of the landscape. The psychophysical methods has been widely used in Fennoscandia in the past 30 years in assessment of landscape quality (Gundersen and Frivold 2008) and the most important recreation and landscape value paramaters have been utilized in forest policy, planning and management in several European countires (Kohsak and Dembczynski 2004).

The first goal of our study was to determine effect of recreational pressure and forest tract size on composition of vegetation in terms of plant attributes. The second goal was to evaluate the impact of different management activities to landscape attributes to identify the most preferred landscape models for recreational use by groups of local residents. Thirdly, the above goals were integrated to provide suggestions for optimal management directions for forests of Riga.

Materials and Methods

Site description

Riga city forests consist of 15 forest tracts, some of which are connected with rural forests outside the city and others are small isolated forests (Figure 1). The dominant tree species is Scots pine *Pinus sylvestris* L. (88% of total forest area). As most of the pine forests (80% of the area) occur on poor sandy soils, they have high landscape appeal due to openness but are highly susceptible to recreational pressure (Emsis 1980, Straupe and Kreile 2010). The city forests have been planted or are fragments of older forest. Stand age is mostly 80-100 years. The vegetation of Riga urban forests has diverse structure, from typical open dry pine forest to patches overgrown with shrubs or a grass-dominated cover. The management of green areas in Riga is regulated by the Riga Dome regulations No. 34 on use and building in the Riga territory. All green areas are defined as nature areas. They are not classified by functional, landscape and natural elements, and include recreation areas, forest parks, agricultural land and forest (Jankovska 2013). Most of the wooded area of Riga is classified as forest park with primary use by recreation, sports and tourism, however the accessibility and recreation infrastructure are not developed properly. Another category is forests, which are considered as areas with primary forest ecosystem function. Spatially, the inner city wooded areas are forest parks and those on the outskirts are forests. In this paper, we consider the forest category.

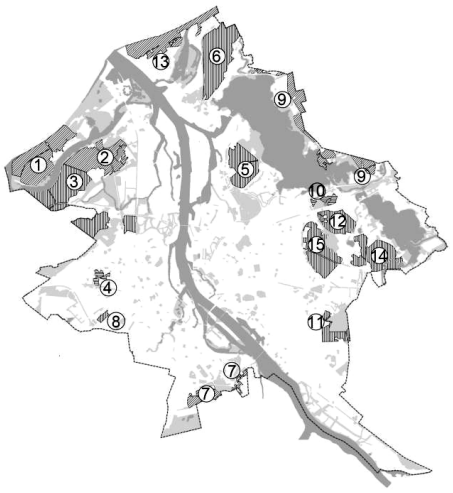


Figure 1. Riga city forest tracts: 1-Buļļi, 2-Bolderāja, 3-Kleisti, 4-Imanta, 5-Mežaparks, 6-Vecdaugava, 7-Katlakalns, 8-Šampēteris, 9-Jaunciems, 10-Bābelīte, 11-Ulbroka, 12-Šmerlis, 13-Mangaļsala, 14-Jugla, 15-Biķernieki

Vegetation analysis

Three plots (20×20 m) were placed in each of the fifteen forest tracts in dry *Myrtillosa* pine forests. Vegetation was decribed by layers using standard field methods (Straupe et al. 2012). To understand the main processes governing plant community formation rather than analyze vegetation by taxonomic species composition, the plots were described by plant attributes. A matrix was derived with total cover in plots of species by plant structure (tree, tall shrub, low shrub, forb, graminoid, fern and moss), common habitat (boreal forest, temperate forest, grassland), introduced plus adventive species, nitrophilous species, and plant strategies (stress tolerant, competitor and ruderal) sensu Grime (2002). Information on plant attributes was taken from the Biolflor database (Kuhn et al. 2004). A species was considered nitrophilous if it had a rank of at least 7 on the N according to the Ellenberg scale. Then, redundancy analysis (RDA) was conducted to identify gradients in vegetation composition based on these attributes, constrained on a matrix of environmental factors (recreation load and forest tract size). Recreational load was estimated as potential number of visits per year (Jankovska et al. 2013). Based on the estimated loads, the forest tracts were classified into 9 recreational load classes. Forest tract size was estimated in ha.

Landscape quality

We used the psychophysical method for evaluation of forest landscapes to determine forest management activities that affect the visual appeal of a landscape and willingness to use it for recreation. The psychophysical paradigm provides a way to predict which landscape factors are associated with public perception of scenic beauty, in a framework of landscape management application (Zube et al. 1982). We chose four typical landscapes of Riga city forests, which differed in vegetation, structure and landscape attributes (open-

ness, diversity, coherence, visual accessibility, etc.): two rather unimpacted forest tracts (Buļļi and Mangaļsala) and two impacted forest tracts (Anniņmuiža and Mežaparks). On these images, which we defined as the *status quo* state, we modified seven more images using PhotoShop 7.0. to portray changes in landscape (vegetation structure) and accessibility (amenities) that would result from various types of management. Thus, four choice sets were created ('Anniņmuiža'; 'Mežaparks';'Buļļi'; 'Mangaļsala'), each with eight images: *status quo* state and seven different hypothetical landscape models. On each image was also given the estimated cost of the management (per hectare) and defined changeable landscape attributes created by management (branches, understorey, logs and recreational facilities). A survey of residents was conducted in Riga city forests and neighbourhoods in 2011 to determine community preference. A total of 506 respondents were involved. Each respondent was provided with 4 sheets or choice sets corresponding to the four *status quo* situations and were asked to choose only the most preferred landscape model in each choice set for recreational activities.

Further, we tested significant differences in the preferences for all respondent groups among each hypothetical landscape model but in this paper we present only the differences between the *status quo* state and models. The respondents were divided in the following groups: women (A); men (B); visit on weekdays/weekends (C); visit on weekends (D); respondents with higher and secondary education, who visit a forest on weekdays/weekends (E); and respondents with higher and secondary education, who visit a forest on weekends (F). The level of significance between landscape models features was determined by calculation of confidence intervals. Assuming that in large sample groups the theoretical value of Student's criterion is t_{ik}= 1.96, then if $t_{0.05}$ <1.96, the relationship is not significant, and if $t_{0.05}$ >1.96, the relationship is significant (Liepa 1974).

Results

Vegetation analysis

RDA was used to determine effect of recreational pressure and forest tract size on composition of vegetation in terms of plant attributes (e.g. life form, strategies). A Monte Carlo test showed that the first RDA axis and the ordination of both axis were significant and could not be explained by chance (accordingly, p = 0.0080 and p = 0.0020) (Figure 2). Although the coefficient of determination R^2 was rather low (trace = 0.199), forest tract area was significantly related (GLM, p < 0.05) to RDA axis 1 and recreation load to RDA axis 2. More boreal and moss species were found in large forests. Greater recreational pressure was associated with more grassland, nitrophilous, tall-shrub, and temperate zone species.

Landscape quality

Of the landscape models that were significantly more often chosen than the *status quo* state, the models with the most significant differences in choice are presented in Table 1.

The *status quo* state of the choice set 'Buļļi' represents an open forest with uniform tree age structure but its location on dune topography and the presence

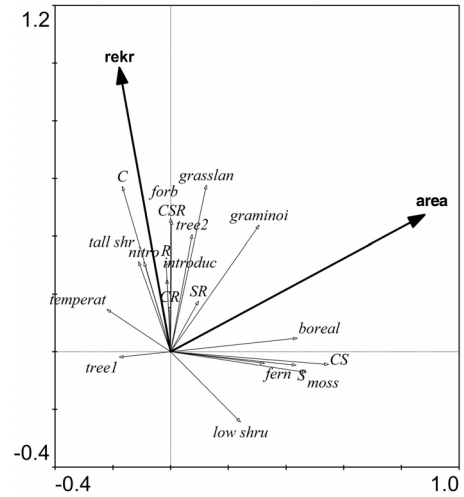


Figure 2. RDA ordination of plots described by plant attributes constrained on the environmental variables (recreation load and forest tract area)

of understorey saplings and shrubs make the landscape to be complex, attractive and diverse (Figure 3a). The most frequently chosen landscape models were VI and VII (Figure 3b-c), respectfully, confirmed by 31% and 16% respondents. In comparison, the *status quo* state was chosen only by 6% respondents. The most chosen landscape model was VI ($5.11d \leq t_{0.05} d \leq 9.26$) confirmed by all respondent groups (defined management activities: understorey removed; facilities implemented – path and bench; Figure 4b). The second most chosen landscape model ($3.72d \leq t_{0.05} d \leq 6.06$) for all the respondent groups was model VII (defined management activities: shrubs not cut, logs and dead branches present, and facilities implemented; Figure 3c). For A, B, D, E and F respondent groups, the third most chosen was model V ($3.00d \leq t_{0.05} d \leq 5.03$) (samplings and shrubs cut, logs removed, dead branches removed, facilities implemented; Figure 3d), but for respondent group C ($t_{0.05}$=2.19) – the third choice was model IV (understorey, dead branches and logs present, without facilities; Figure 3e).

Table 1. The most significant differences between the *status quo* state and landscape models

Respondents group/Three the most significant alternatives		Bulļi			Anniņmuiža			Mangaļsala			Mežaparks		
		1.	2.	3.	1.	2.	3.	1.	2.	3.	1.	2.	3.
A	Alternative No	VI	VII	V	VI	V	VII	III	-	-	VII	VI	V
	t	8.16	4.13	3.80	6.40	4.80	3.29	3.38			3.71	3.50	2.66
B	Alternative No	VI	VII	V	VI	V	VIII	III	-	-	V	VI	-
	t	6.50	5.50	3.00	6.53	5.32	3.59	3.98			4.71	2.03	
C	Alternative No	VI	VII	IV	VI	V	VII	III	-	-	VII	III	II
	t	5.11	3.53	2.19	4.81	4.29	2.09	2.81			4.55	2.66	2.33
D	Alternative No	VI	VII	V	VI	V	VII	III	-	-	V	VI	VIII
	t	9.26	6.06	5.03	8.04	5.77	4.50	4.45			6.10	3.69	2.84
E	Alternative No	VI	VII	V	VI	V	VII	-	-	-	V	VI	VI
	t	7.97	5.81	3.43	7.52	4.36	3.60				4.21	2.75	2.20
F	Alternative No	VI	VII	V	V	VI	VII	III	VII	-	V	VII	VI
	t	6.65	3.72	3.37	5.74	5.25	3.12	3.61	2.23		3.17	2.86	2.84

Respondents groups: A – women, B – men, C – visits on weekdays/weekends, D – visits the weekends, E – respondents with higher and secondary education who visit a forest on weekdays/weekends, F – respondents with higher and secondary education who visit a forest on weekends; t – Students criterion

The *status quo* state in the choice set 'Mangaļsala' depicted an open accessible pine stand with homogenous tree structure (Figure 4a). The most chosen alternatives models, which significantly differed from the *status quo* state, were III and VII, respectively, by 29% and 21% respondents. The *status quo* state was chosen only by 11.4 % respondents. Landscape model III was most often chosen ($2.81 d \leq t_{0.05} d \leq 4.45$) by all respondent groups except group E (defined management activities: understorey and dead branches present, logs removed and facilities not implemented; Figure 4b). Landscape model VII (understorey present, dead branches and logs removed, facilities implemented) was the second choice ($t_{0.05}$=2.23) after model III for respondents from group F (Figure 4c). For respondent group E, the landscape models did not differ in choice.

The *status quo* state of the choice set 'Anniņmuiža' was a forest stand with dense sapling and shrub understorey, which made the landscape to be closed, unable to see through and uniform (Figure 6a). The most often preferred landscape alternatives were VI, V and VII, selected by 27%, 21%, and 14% respondents, respectively. In comparison, the *status quo* state

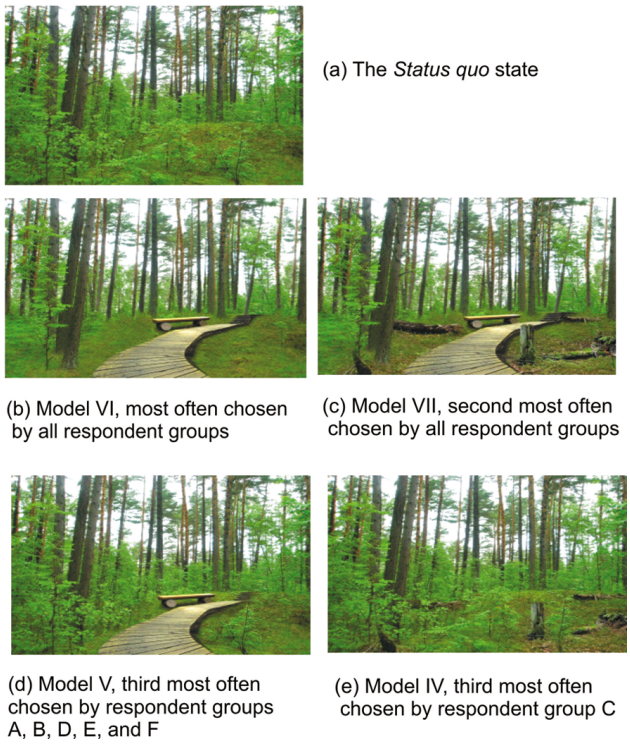


Figure 3. The most often chosen landscape models in the choce set 'Bulļi' (author: I. Bojare)

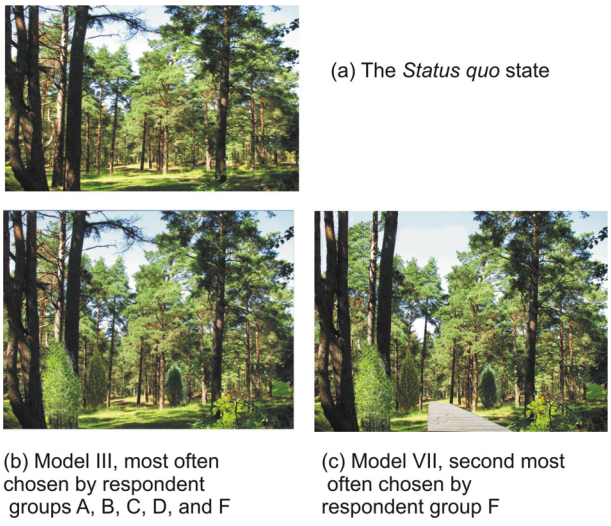


Figure 4. The most often chosen landscape models in the choice set 'Mangaļsala' (author: I. Bojare)

was chosen only by 5.3% respondents. Alternative VI was most often chosen by A, B, C, D, and E respondent groups ($4.81 d \leq t_{0.05} d \leq 7.52$), while this was the second choice for respondent group F ($t_{0.05}$=5.74). In this model, the defined management activities were: understorey, dead branches and deadwood removed, and facilities implemented (Figure 5b). Landscape model V (understorey and dead branches present, dead wood removed and facilities implemented) was the second choice for A, B, C, D, and E respondent groups ($4.36 d \leq t_{0.05} d \leq 5.77$), while this was the first choice for respondent group F ($t_{0.05}$=5.25) (Figure 5c). Landscape model VII was the third choice ($2.09 d \leq t_{0.05} d \leq 4.05$) for A, C, D, E and F respondent groups (understorey removed, deadwood present, dead branches removed, facilities implemented; Figure 5d), while model VIII was the third choice ($t_{0.05}$=3.59) for B respondent group (understorey, dead branches and deadwood present, and implemented facilities; Figure 5e).

The *status quo* state of the choice set 'Mežaparks' was a wooded meadow setting in an intensively managed even-aged stand. There was a path in the foreground, and the landscape was open, accessible and homogenous but the understorey made the landscape to be complex and attractive (Figure 6a). The most preferred alternative models were VI, V and VII, chosen by 27%, 21%, and 14% respondents, respectively. In comparison, the *status quo* state was chosen only by 5.3% respondents. This choice set had the most variability in respondent preferences, as also indicated by the lower values of significance. A and C respondent groups most preferred ($3.71 d \leq t_{0.05} d \leq 4.55$), and F group second-most preferred ($t_{0.05}$=2.84) landscape model VII (defined management activities: understorey and dead branches removed, deadwood present, and facilities implemented; Figure 6b). Landscape model VI (understorey removed, dead branches

(a) The *Status Quo* state

(b) Model VI, most chosen by respondent groups A, B, C, D, and E; the second most chosen by respondent group F

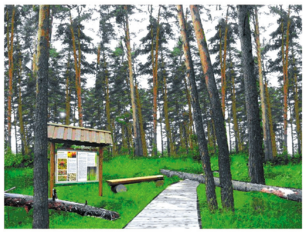
(c) Model V, second best choice for respondent groups A, B, C, D, and E; most chosen model by respondent group F

(d) Model VII, third most chosen by respondent groups A, C, D, E, and F

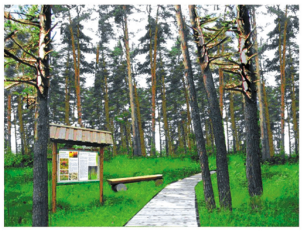
(e) Model VIII, third most chosen by respondent group B

Figure 5. The most chosen landscape models in the choice set 'Anniņmuiža' (author: I. Bojare)

(a) The *Status Quo* state



(b) Model VII, most preferred by respondent groups A and C; the second most chosen respondent group F



(c) Model VI, the second most preferred by respondent groups A, B, D, and E; the third most preferred by respondent groups E and F

(d) Model No V, the most preferred choice by respondent groups B, D, E, and F; the third most chosen by respondent group A

(e) Model III, second most chosen by respondent group C

e) Model II, third most chosen by respondent group C

f) Model VIII, third most chosen by respondent group D

Figure 6. The most preferred landscape models in the choice set 'Mežaparks' (author: I. Bojare)

present, deadwood removed, and facilities implemented) was the second preferred choice for A, B, D, and E respondent groups ($2.03 d \leq t_{0.05} d \leq 3.69$) and for E and F respondent groups – the third choice ($2.2 d \leq t_{0.05} d \leq 2.84$) (Figure 6c). Landscape model V (understorey present, deadwood removed, dead branches present, and facilities implemented) was the most chosen ($3.17 d \leq t_{0.05} d \leq 6.10$) for B, D, E, and F respondent groups and third in preference for A respondent group ($t_{0.05}$=2.66) (Figure 6d). For C respondent group, the second most chosen ($t_{0.05}$=2.66) alternative was model III (understorey removed, dead branches and deadwood present, no facilites implemented; Figure 6e), and the third most chosen ($t_{0.05}$=2.33) was model II (understorey removed, dead branches and deadwood removed, and no facilities implemented; Figure 6f). For D respondent group the third most preferred (significance $t_{0.05}$=2.84) was model VII (understorey, dead branches and deadwood present, and facilities implemented; Figure 6g). For B respondent group only two landscape models were significantly preferred (V and VI), in comparison with the *status quo* model.

Discussion and conclusions

In urban forests recreational load can cause changes in the landscape (Goris et al. 2007, Hamberg et al. 2008). The intensity of recreation is dependent on the number of inhabitants in neighbourhoods, the intensity and period of effect, and forest tract size (Emsis 1980, Malmivaara et al. 2002, Florgård and Forsberg 2006). The stress tolerant plant strategy, as defined by Grime (2002), is adaptation to growth in habitats, where resources are in low supply and the level of disturbance is low. Previous studies confirmed that recreation and trampling have the most significant impact on projective cover and number of boreal species in the herb (ferns, *Ericaceae* species) and moss layers (Malmivaara et al. 2002, Malmivaara-Lämsä et al. 2008, Hamberg et al. 2008). Thus, vegetation with stress tolerant species with low productivity on sandy soils is sensitive to man-made disturbances and regenerates very slowly (Malmivaara-Lämsä et al. 2008). The RDA analysis in the present study indicated that the plant communities in forests with high recreational loads are not necessarily predictable by species composition. The species composition can differ in stands but the cover of grassland, nitrophilous, tall-shrub, and temperate zone species is higher. Thus, analysis using plant attributes showed a more clear relationship between recreational load and forest tract size. We found that typical unaltered boreal forest vegetation with high cover of moss and stress tolerant species occurred in stands with low recreational load, when forest tract area was large (Mangaļsala, Buļļi and Jaunciems), or in less sensitive forest tracts (Biķernieki, Jugla and Šmerlis). In contrast, in smaller forest tracts located close to the city centre (Anniņmuiža, Mežaparks, Bābelīte, Ulbroka, Šampēteris, Kleisti, Vecdaugava, Lāčupe and Katlakalns), which are fragmented by city infrastructure and are under constant recreational load, there typically occurred a mixture of light-requiring grassland, tall shrub, nitrogen-requiring, ruderal and invasive species, independent of the effect of forest tract size.

In natural woodland the landscape is usually structurally and compositionally diverse at multiple scales due to disturbances and subsequent successions (Brumelis et al. 2011). However, in urban environments, natural processes are usually replaced by human-caused disturbances and simplified forest structure with even-aged stands has dominated (Nabuurs et al. 2001, Gundersen and Frivold 2008). Such management practice emphasizes a visual, stylized design of ideal nature that creates an illusion that a natural forest is in the mature stage and will always remain in this state (Gobster 1996). In the period since the 1960s, studies of landscape perception have shown that forest stands with multiple layers, which have arisen due to natural succession and are characteristic of old, overmature forests and edges, receive a low value in respondent preferences. Landscapes with an open view, accessibility, coherence, and homogenity in tree age and vertical structure, or, so called, savanna-type tree stands, are preferred (Jestaedt 2008). Deadwood and wood debris left after management lower the perceived landscape value (Tyrväinen et al. 2003, Ode et al. 2009). In present study we found that the most preferred landscape models for all of the choice sets (except 'Mangaļsala') was when the understorey, dead branches, and deadwood were removed and facilities (paths, benches, information boards) were implemented (for 27-31% of respondents). Although the landscape models with deadwood and understorey showing multiple successional stages were preferred by significant proportions of the respondent groups 'men' (B), 'visits forest on working days and weekends (C) and 'visits on weekends' (D), the presence of recreational facilities was significant. The recreational facilities provide assurance of the presence of humans and give direction of travel, improving feeling of security even if the understory or dead wood in general are not peferred attributes. We observed that a significant proportion of respondent group 'visits forest on working days and weekends' (C) preferred landscape models without facilities (choice set 'Buļļi', 'Mangaļsala', 'Mežaparks'). Tyrväinen et al. (2003) observed that women usually prefer an open landscape

without dense understorey. It was also confimed in the present study that the respondents group 'women' (A) mostly preferred park-forest landscape models.

An important issue of forest management analysis is related with the current state of management (*status quo*). Some studies have shown (Hanley et al. 1998, Horne et al. 2005) respondents prefer to retain the *status quo* alternative (when other facilities are identical). Surprisingly, in our datasets the proportion of *status quo* preferences varied from 5.3% to 11.4%, which was less those for other alternatives. This indicates that most would prefer a change in management (Pavlyuk and Jankovska 2012). For example, the Anniņmuiža forest tract is located within the Imanta residential area where the resident density is 5539 persons/km^2 (Jankovska 2013), and the visual attractiveness of it is relatively low (Emsis 1980). The high resident density creates a high social use and importance of the forest, which continuously increases degradation of the ecosystem. Thus, the residents use the area for recreation, but the high loads and insufficient management has led to low landscape quality. In contrast, the impacted Mežaparks forest tract with size 500 ha, which has implemented facilities and low resident density – 373 persons/km^2 (Jankovska 2013) has maintained relatively more typical vegetation of pine forests. In the less impacted forests in the city periphery ('Buļļi' and 'Mangaļsala' sets) the ecological role of the forest is more important than the social role, and the typical vegation and landscape has survived the low recreational loads. However, the residents also in those choice sets would prefer management, such as implementation of facilities.

The choice set 'Mangaļsala' differed from the others by having an open, easily accessible *status quo* landscape. In this case, all respondent groups preferred a model with understorey over the *status quo* state, and the presence of facitities was insignificant. Simonič (2003) found that the landscape of choice usually contains specific spatial information, has distinct structure and is complex, and less frequently, a simple or abstract landscape. Thus, a simple, homogenous open landscape with even-aged tree structure of 'Mangaļsala' choice set was not preferred, and mangement should therefore create a mosaic type uneven-aged stand structure with both open and closed spaces, increasing the landscapes complexity and mysteriousness.

We found that the landscape model choice was dependent on the *status quo* state. Management was preferred, if understorey was present in the *status quo* state ('Buļļi' and 'Mežaparks'), or the landscape was closed and uniform ('Anniņmuiža'). However, when the *status quo* state was an open-type pine forest ('Mangaļsala'), the public showed alternative preference for a diverse, complex and mysterious landscape.

The use of the psychophysical method and assessment of hypothetical forest landscapes in the present study confirmed that visual preception dominates over cognitive perception, as shown previously (Gobster 1999, Parsons and Daniel 2002). Persons firstly assess the landscape by psycho-emotional and biophysical parameters, while assessment of landscape elements that requires a cognitive approach and ecological knowledge has secondary importance. The respondent groups 'with higher and intermediate education, who visit forests on weekdays and weekends' (E) and 'with higher and intermediate education, who visit forests on weekends (F), who might be expected to landscapes with greater ecological and aesthetical values and higher biological diversity, did not however, differ from the other groups in preferred choice.

The present study allowed to determine the role of recreation load and forest size in determining impact on vegetation in the forest tracts of Riga. The views and social needs of the community were also identified, which can allow to identify the required management methods. Knowing the importance of both ecological factors and social preferences of landscape, both of these factors can be integrated in management, which should promote natural succession processes, be economically effective, and promote forest use by residents (Jankovska 2013). We consider that carefully organised surveys, such as those presented here, can help forest managers identify management alternatives preferred by the public and utilise this information for policy making. The most important management option that should be considered in the Riga forest tracts is to increase public awareness of natural structures, such as deadwood and understorey. Management activities should differ depending on the main function of the specific forest tract. In forests located in suburbs with undeveloped accessibility, ecological functions shoud be maintained by supporting the natural character of existing habitats and protection of biological diversity by provision of paths in the most accessible areas. In forests located close to residential areas and which have high recreational loads and social importance, the implementation of recreation facilities should be increased (i.e., paths, benches, picknicking areas), and openness of forest stands along paths to improve the landscape aesthetic value.

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References

Bell, S. 2008. Design for Outdoor Recreation. Taylor & Francis, London, 218 pp.

Brumelis, G., Jonsson, B.G., Kouki, J., Kuuluvainen, T. and Shorohova, E. 2011. Forest naturalness in northern Europe: perspectives on processes, structures and species diversity. *Silva Fennica* 45 (5): 807-821.

Cekule, M. 2010. Rīgas telpiskās struktūras analīze, izmantojot ģeogrāfiskās informācijas sistēmas [Riga's city spatial strukture analyse based on geographical information system]. Doctoral thesis, University of Latvia, Latvia, 115 pp. (in Latvian)

Chen, W.C. and Jim, C.Y. 2008. Assessment and Valuation of the Ecosystem Services Provided by Urban Forests. In: M.M.Carreiro, Y.C.Song., J.Wu (Editors), Ecology, Planning, and Management of Urban Forests. International Perspectives. New York, Springer Science+Business Media, LLC, p. 53- 83.

Donis, J. 2001. Urban forestry in Latvia: status, policy, management research. In: Randrup, T.B., Gustavsson, R., Christophersen, T. (Editors), Urban forestry in the Nordic and Baltic countries – urban forests under transition. Proceedings from an international seminar on urban forestry in Kaunas, Lithuania, Skov& Landskab, Report 9, Hoersholm, p. 19-23.

Donis, J. 2011. Saimnieciskas darbibas izvertejums izlases ciršu saimnieciba [The evaluation of economic activities in selective felling management]. - *http://www.lvm.lv/lat/lvm/zinatniskie_petijumi/2011gada_izpetes_projektu_ atskaites/?doc=14365 10.12.2012* (in Latvian)

Emsis, I. 1980. Rīgas pilsētas meži un to apsaimniekošana [The urban forests of Riga and their management]. LatZTIZPI, Rīga, 63 pp. (in Latvian)

Florgård, C. and Forsberg, O. 2006. Residents' use of remnant natural vegetation in the residential area of Järvafältet, Stockholm. *Urban Forestry and Urban Greening*, No. 5: 83–92.

Gaiss, U. 2009. Ilgtspējīga mežu pārvaldība Rīgas pilsētā [Sustainable Forest Management in Riga City]. MSc thesis, University of Latvia, Latvia, 108 pp. (in Latvian)

Gobster, P.H. 1999. An ecological aesthetic in forest landscape management. *Landscape Journal* 18: 54–64.

Gobster, P.H. 1996. Forest aesthetics, biodiversity, and the perceived appropriateness of ecosystem management practices. Proc. Workshop Defining Social Acceptability in Ecosystem Management: 77-97.

Goris, R., Kint, V., Haneca, K., Geudens, G., Beekman, H. and Verheyen K. 2007. Long-term dynamics in a planted conifer forests with spontaneous ingrowth of bradleaved trees. *Applied Vegetation Science* 10: 219-228.

Grime, J.P. 2002. Plant Strategies, Vegetation Processes, and Ecosystem Properties. Chichester, John Wiley & Sons Ltd., 417 pp.

Gundersen, V., Frivold, L.H., Myking, T. and Øyen, B.H. 2006. Management of urban recreational woodlands: The case of Norway. *Urban Forestry and Urban Greening* 5: 73-82.

Gundersen, V.S. and Frivold, L. H. 2008. Public preferences for forest structures: A review of quantitative surveys from Finland, Norway and Sweden. *Urban Forestry & Urban Greening* 7: 241-258.

Gunnarsson, G. and Øhrstroom, H.E. 2007. Noise and well-being in urban residential environments: the potential role of perceived availability to nearby green areas. *Landscape and Urban Planning* 83: 115–126.

Hamberg, L., Lehvävirta, S., Malmivaara-Lämsä, M., Rita, H. and Kotze, D.J. 2008. The effects of habitat edges and trampling on understorey vegetation in urban forests in Helsinki, Finland. *Applied Vegetation Science* 11: 83–98.

Hanley, N., Wright, R.E. and Adamowicz, V. 1998. Using choice experiments to value the environment. *Environmental and Resource Economics* 11 (3): 413–428.

Heyman, E., Gunnarsson, B., Stenseke, M., Henningsson, S. and Tim, G. 2011. Openness as a key-variable for analysis of management trade-offs in urban woodlands. *Urban Forestry & Urban Greening* 10: 281–293.

Horne, P., Boxall, P.C. and Adamowicz, W.L. 2005. Multiple-use management of forest recreation sites: a spatially explicit choice experiment. *Forest Ecology and Management* 207 (1): 189–199.

Ikauniece, S., Brumelis, G., Kasparinskis, R., Nikodemus, O., Straupe, I. and Zariņš, J. 2013. Effect of soil and canopy factors on vegetation of *Quercus robur* woodland in the boreo-nemoral zone: A plant-trait based approach. *Forest Ecology and Management* 295: 43-50.

Jankovska, I. 2013. Rīgas pilsētas mežu apsaimniekošanas problemātika un risinājumi [Problems and solutions in management of Riga urban forests]. PhD thesis, Latvia University of Agriculture, Jelgava, Latvia, 111 pp. (in Latvian)

Jankovska, I., Donis, J., Straupe, I., Panagopoulos, T. and Kupfere, L. 2013. Assesement of the forest recreational accessibility in Latvia. *Fresenius Environmental Bulletin* 22 (7b): 1-7.

Jankovska, I., Straupe, I. and Panagopoulos, T. 2010. Professionals' awareness in promotion of conservation and management of urban forests as green infrastructure of Riga, Latvia. *WSEAS Transactions on Environment and Development* 8(8):614–623.

Jestaedt, M. 2008. Experiences in the Management of Urban Recreational Forests in Germany. In: M.M.Carreiro, Y.C.Song, J.Wu (Editors), Ecology, Planning, and Management of Urban Forests. International Perspectives. Springer Science+Business Media, New York, p. 301-323.

Karmanov, D. 2008. Research methods in landscape perception and experience. In: de Haan H., van der Duim R. (Editors), Landscape, leisure and tourism. Eburon, p. 21-22.

Kohsak, R. and Dembczynski, K. 2004. Rough Sets Theory and Discourse Analysis. Interim Report IR-03-038. - *http://www.iiasa.ac.at/Admin/PUB/Documents/IR-03-038.pdf 02.11.2012*

Kuhn, I., Durka, W. and Klotz, S. 2004. BiolFlor – a new plant-trait database as a tool for plant invasion ecology. *Diversity and Distributions* 10: 363-365.

Kuzmina, S. and Treshkin, E. 2010. Climate changes and their effects on the vegetation recovery in the Pre-Aral region. Proc. 3rd WSEAS International Conference on Climate changes, Global warming, Biological Problems (CGB '10), University of Algarve, Portugal: 19-25.

Liepa, I. 1974. Biometrija [Biometry]. Riga, Zvaigzne, 336 pp. (in Latvian)

Malmivaara, M., Löfström, I. and Vanha-Majamaa, I. 2002. Anthropogenic effects on understorey vegetetion in Myrtillosa type urban forests in southren Finland. *Silva Fennica* 36 (1): 367-381.

Malmivaara-Lämsä, M., Hamberg, L., Löfström, I., Vanha-Majamaa I. and Niemelä, J. 2008. Trampling tolerance of understorey vegetation in different hemiboreal urban forest site types in Finland. *Urban Ecosystems* 11: 1–16.

Nabuurs, G.J., de Goede, D.M., Michie, B., Schelhaas, M.J. and Wesseling, J.G. 2001. Long- term international impacts of nature-oriented forest management on European forests – an assessment with the EFISCEN modelthrough trade flows of wood products. In: G.J.Nabuurs (Editor), European Forests in the 21st Century: Impacts of Nature-Oriented Forest Management Assessed with a Large-Scale Scenario Model. Alterra Scientific Contributions 2. Alterra Green World Research, Wageningen, p. 104–130.

Ode, Å., Fry, G., Tveit, M.S., Messager, P. and Miller, D. 2009. Indicators of perceived naturalness as drivers of landscape preference. *Journal of Environmental Management* 90: 375-383.

Parsons, R. and Daniel, T.C. 2002. Goodlooking: indefense of scenic landscape aesthetics. *Landscape and Urban Planning* 60: 43–56.

Pavlyuk, D. and Jankovska, I. 2012. Using of stated preference models for forest management: a case of Riga. In: Proc. 12th International Conference RelStat'12, Reliability and Statistics in Transportation and Communication: 45-54.

Simonic, T. 2003. *Preference and perceived Naturalness in Visual perception of Naturalistic Landscapes.* Zb. Bioteh. Fak. Univ. Ljublj. Kmet., *http://aas.bf.uni-lj.si/september2003/16simonic.pdf 03.04.2012*

Straupe, I., Jankovska, I., Rusina, I. and Donis, J. 2012. The impact of recreational pressure on urban pine forest vegetation in Riga city, Latvia. *International Journal of Energy and Environment* 6: 406-414.

Straupe, I. and Kreile, V. 2010. Vegetation changes in the Pine Forests of the Nature Park Tervete, Latvia. Proc. 3rd WSEAS International Conference on Climate changes, Global warming, Biological Problems (CGB '10), University of Algarve, Portugal: 42-48.

Tyrväinen, L., Gustavsson, R. and Konijnendijk, C. 2006. Visualization and landscape laboratories in planning, design and management of urban woodlands. *Forest Policy and Economics* 8 (8): 811- 823.

Tyrväinen, L., Silvennoinen, H. and Kolehmainen, O. 2003. Ecological and aesthetic values in urban forest management. *Urban Forestry and Urban Greening* 1: 135–149.

Tyrväinen, L., Buchecker, M., Vuletic, D. and Degenhart, B. 2008. Evaluating the economic and social benefits of forest recreation and nature tourism. In: Bell, S., Simpson, S., Tyrväinen, L., Sievänen, T. & Pröbstl, U. (Editors). European forest recreation and tourism: A handbook. Taylor and Francis Group Plc., London, p. 35-64.

Zube, E.H., Sell, J.L. and Taylor, J.G. 1982. Landscape perception: research, application and theory. *Landscape planning* 9: 1-33.

Weng, Y.C. 2007. Spatiotemporal changes of landscape pattern in response to urbanization. *Landscape and Urban Planning* 81: 341-353.

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ГОРОДСКИЕ ЛЕСА РИГИ, ЛАТВИЯ – АНТРОПОГЕННЫЙ ПРЕСС, ЕСТЕСТВЕННОСТЬ, ОТНОШЕНИЕ К НИМ И УПРАВЛЕНИЕ

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Резюме

Ландшафт городских лесов в Европе различается в зависимости от истории политической и социальной культуры. Латвия представляет собой особый случай, так как восприятие городских зеленых насаждений изменялось с периодом германского господства в развитую европейскую республику, покорённую в советские времена и теперь, ставшую снова европейской страной. Антропогенное воздействие здесь было относительно умеренным, а связь между людьми и природными ценностями довольно тесной. В Риге имеется 15 крупных лесных массивов, некоторые из которых связаны с сельскими лесами, а некоторые представляют собою изолированные остатки древних лесов или лесонасаждений. В этих лесах в основном преобладает сосна обыкновенная *Pinus sylvestris* L. на бедных сухих почвах, с характерным слоем мхов. В то же самое время понимание важности городских лесных экосистем в устойчивости города растёт, поэтому рекреационные нагрузки и требования к эстетическому, необычному и искусственному ландшафту являются значительными. Руководство Латвии не полностью контролирует сложность управления городскими лесами и было предпринято мало попыток интеграции экологических, социальных, эстетических и рекреационных функций во всеохватывающее ландшафтное планирование лесов Риги со всеми заинтересованными сторонами. В результате „естественность" лесов в значительной степени определяется рекреационными нагрузками. Необходимы знания касательно экологических и рекреационных функций этих лесов для разработки конкретных планов управления. Во-первых, нами использованы виды растений и функциональных групп для получения показателей, позволяющих определить степень экологической деградации лесов. Во-вторых, нами применялся психофизический метод для определения общественных предпочтений для моделей лесного ландшафта по фотографиям, сделанным с целью изображения различных методов управления (например, сохранение сухостоя, вырубка подлеска, рекреационная инфраструктура). Нами рассмотрены четыре типа лесных ландшафтов и обнаружены значительные различия в общественных предпочтениях между ними, а также в выборе групп респондентов для наиболее предпочтительных рекреационных ландшафтов.

Ключевые слова: рекреация, управление лесами, предпочтение ландшафта