Estimation of Recreational Potential of Urban Forests

Photo: S.Rysin

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Abstract

The aim of this study was to evaluate two typical recreational forests in Russia and Sweden in terms of their potential for recreation. The study of Russian and Scandinavian literature was carried out as a background for the analyses of the obtained results. With these analyses the possible trends, weaknesses and strengths of the both recreational forests as well as the advantages and disadvantages of the selected method were planned to be studied.

292 forest stands covering 256.3 ha of the national park "Losiny Ostrov" (Russia) and 101 forest stands covering 198.5 ha of the Torup forest (Sweden) were investigated by the study.

The selected method examines recreational forest from its attraction and comfort for visitors and tolerance (stability) to anthropogenic influence. The outcome of the estimation is based on integral assessment of these three categories, which express the recreational potential as Class of Recreational Value (CRV).

The lowest results are registered among indices of stability category. It confirmed the study hypothesis about determinative function of these indices and stability category as a whole in estimation of recreational potential of forests. In about 90% of the stands in the both surveyed areas, restrictions and limits for precise recreation utilization and sustainable development in the future were recommended due to the low stability/high sensitivity of the forests. The main differences between the results from the two areas were found with regards to the attraction and comfort categories owing to social specific and traditions in forest management of the countries. The analysis showed that the method mainly corresponds with many statements of other studies in the subject.

Generally the method considered as quite objective and reliable one. Nevertheless the study found it recommendable to rewrite or modify some weak points of the method but only with respect to tradition and specific of country or forest type. For the both case areas accurate forest management has to be well balanced between recreation and other forest uses. One of the main decisions should be increase the amount of, and qualities related to mature stands. This definitely could increase first of all aesthetic values of the areas.

Keywords: recreation, recreational potential, visitor, attraction, comfort, stability, the Torup forest, the Mytishchinsky lesopark.

CONTENTS

1. INTRODUCTION

1.1. Why recreation subject is important?

Present societies have a big demand of green areas and nature (Gadow 2002, Grahn & Stigsdotter 2003). The ongoing urbanization process in many countries and upspeeded modern lifestyle with stress and stress-related illnesses make the interest to urban forests higher from year to year (Ode & Fly 2002). In that case outdoor recreation concerned to become as a most crucial aspect of forests especially on dense populated areas (Rydberg 1998 in Ode & Fly 2002) due to it "free nature" (Sandell 1993), opportunities to ameliorate injurious factors, restorative environments free from stress are provided (Kellomäki 1975, Bolshakov 2000, Grahn & Stigsdotter 2003).

The survey done among Swedes (Uddenberg 1995 in Lindhagen & Hörnsten 2000) showed that "94 per cent agreed with the statement that "spending time in woods and fields, by the lake or by the sea makes me feel relaxed and harmonious". This "spending time" could also be called outdoor recreation. Each activity during leisure time was defined by Lindhaden (1996b) as more specific outdoor recreation, namely "forest recreation".

The high importance of forest recreation in Southern Sweden and the Moscow region is predetermined by their conditions. For instance, forest cover of South-Western Skåne is only 18% (National Board of Forestry 1997 in Hörnsten & Fredman 2000), but urbanization and immigration processes are still active (Kajala 2006). At the same time Moscow region is overpopulated, and its biological environment could not always meet the demands of visitors (Rysin & Rysin 1998, Rysin 2003, Ryzhkow et al. 2003).

This is the background why it is important to estimate both the biological possibility to resist recreational pressure as well as the recreational values of forest landscapes from the positions of people preferences of forest ecosystem, especially in urban environment.

1.2. Recreation subject in Russia and Sweden

To be able to make consequences about differences in approaches towards recreation issue between two countries, the analysis of the basic directions in recreational sciences in Sweden and Russia has to be done.

The fundamental directions of researches with relation to forest recreation subjects in Russia are mainly based on studies of biological stability (tolerance) of forest ecosystems and their elements. The history and development of mainly soviet scientific period about forest recreation are discussed in detail by Rysin & Rysin (2003).

According to this paper, the first scientific researches in Russia (Soviet Union at that time) were carried out by Karpisonova (1962, 1967), who have started with oak affection by recreation in Moscow region and development of a scheme of forest ecosystem degradation. This theme was carried out and later continued on in researches of Kazanskaya (1972, Kazanskaya et. al. 1977). Subsequently, the geography, as well as subjects of researches was gradually extending.

Reaction of coniferous forests (Malysheva & Polyakova 1977, Polyakova 1979, 1980, Rozhkov & Romanov 1979; Polyakova et al. 1981 etc.) and broadleaved forest (Polyakova et al. 1983 proceeded; Shudrya & Peshko 1986, 1988, Goltcev 1982a, 1982b, Polezhay et. al. 1985, Rysin et. al. 1999) as well as their elements towards recreation have been widely investigated. The big attention was paid to the study of reaction of ground vegetation on trampling (Rysina 1973, Rysina & Rysin 1987, Karmanova & Rysina 1992, 1995). Besides these investigations, reaction of soil, microflora, and many other aspects of recreationists' influences on forest environments were studied.

Spheres of interests of the Swedish recreational science are rather connected with social aspects than with biological ones. Since Sweden has long socio-democratic tradition with public decisionmaking the strong tradition of surveys of people preferences could be reasonable (Ode & Fly 2002).

Due to low population density of Sweden and huge areas covered by forests a question about biological ability of forest ecosystems to "recreate" visitors is less important compared to scenic and amenity values of forests.

Different methods like questionnaires, onsite and telephone interviews, direct observation watched the qualitative and quantitative aspects or people preferences towards recreational forests. Some methods were used in different parts of Sweden for the studies so-called "visitor monitoring" (Kajala 2006).

Qualitative aspects of forest recreation were studied in connection with features and tendencies of people preferences concerning properties of forest landscape and its elements. In such a way Hultman (1983) is one who first started these researches in Sweden continuing the work of his Finnish colleagues (Kellomäki 1975, Savolainen & Kellomäki 1981). On the basis of questionnaires people preferences to various parameters of forest like tree species, type of mixture, age, height and density of stand, deadwood on the site and others were studied. The themes about forest aesthetic and people preferences were continued later on by other scientists (Kardell 1990, Axelsson-Lindgren & Sorte 1987; Axelsson-Lindgren 1990).

Quantitative aspects of forest recreation constitutes the features of recreational utilization like frequency of visits, length of visits, motivations and type of recreation activity, sexual distribution and other data. Those types of research as well as obtaining of results of qualitative attributes of forest recreation were performed by questionnaires or interviews (Lindhagen 1996b, Hörnsten & Fredman 2000). In addition, the dynamic of these properties over the decades had been under the surveys as well (Lindhagen & Hörnsten 2000, Hörnsten 2000).

In several other studies of Swedish scientists (Rydberg & Falck 2000, Mattson & Li 1993, Lindhagen 1996a, Bostedt & Mattsson 2005) questions about optimum silvicultural treatments to obtain the balance between people preferences, economical and silvicultural reasons have been arisen.

The recreation issue in Russia could be distinguished from the Swedish one by the difference in theoretical approaches. "What the nature according the biological features can give for the society and what can not" is a question the Russian scientific philosophy constructed on. At the same time the Scandinavian approaches and especially Swedish one based mainly on the social question like "what society prefers to have from the nature".

Corresponding to the idea about such division more than 30 years ago German scientist Wolf (1976) due to comparison of 20 methods of forest landscape suitability for recreational purposes showed two main groups of studies:

a) evaluation of recreational suitability trough behaviour and preferences of people, based on economical assessments and sociological inquiries;

b) evaluation of recreational area, its nature features and elements of infrastructure.

Nevertheless, the results from both kinds of studies together could be shifted to the practical sphere and create the essential outputs for responsible and well-considered manager decisions.

1.3. Meaning of "recreational potential" term

The investigation of "recreational value" of forest area by itself could be adequate in description of several components of forest landscape, which can be appreciated by visitors, but at the same time it will not show if the environment could be "pleasant to invite visitors" to. Different types of forest have a different sensitiveness to recreational utilization and could be negatively affected, changed and finally damaged by anthropogenic pressure (Repshas 1994, Drobyshev 2000, Rysin & Rysin 2003, Lehvävirta et al. 2004, Rysin 2006).

According to aforementioned, we could say that sustainable recreation utilization will take place when conditions of recreational forest area will be estimated from people preferences aspects and from biological aspect.

The "recreational potential" is a term used in this study, which is resulting from aggregate of social and biological evaluated aspects.

Recreational potential of landscape is a "degree of possibility to perform its recreational functions conditioned by its nature features as well as results of human activities" (Rysin 2003).

1.4. Selection of method

There are different methodological complications, which occur in front of studies of recreational potential or recreational suitability in some interpretations. The absence of ideal (etalon) landscape to compare with, human subjectivism in perception of different environment features are the main complications.

Except these difficulties some other barriers on a way to investigate forest landscapes by proper methodological implementations occur:
-the optimum amount of indices to characterize each forest landscape comprehensively;
-objectivity and simplicity of investigation.

Some of the methods include the tolerance or stability of ecosystems as an aspect for evaluation (Emsis 1989, Repshas 1994, Drobyshev 2000, Rozhkov 2001, Rysin 2003). However, not all of them were simple in implementation.

As far as Rysin's method (2003) of recreational potential evaluation seems to be quite easy in implementation and at the same time accumulates the main aspects concerning recreation within integral estimation, this method has been selected for current study.

According to the study only two case areas (one from each country) have been taken for evaluation. Nevertheless, the way to make this study more precise and representative was found out. The more typical forest sites for recreation were selected in Russia and Sweden. The exclusive importance of the case areas for the main recreant (population of neighbour city) in both countries is crucial point of the study.

1.5. The aims and hypothesis of the study

The study follows the aim to estimate recreational potential in two selected case areas by one approach or method. As mentioned above the main aspects of recreation are well-highlighted by the selected method. By the way we use the method in Russia and Sweden on two areas with different nature, social, traditional and cultural conditions. In this sense, how the method works, how well or enough it describes and evaluates the areas' recreational features are relevant issues for determination.

The analysis and comparison of obtained results from the estimation of recreational potential with earlier literature background complete the aim of the study. These could show how the method works, describe the reached differences and tendencies in both cases and clarify possible changes to reach higher level of recreational potential too.

The first hypothesis of this study is that the "stability" category has a crucial importance since that part of the method will very often determine the recreational potential. The obtained results will show low "stability" category for both areas (also resulting in low integral evaluation of Class of Recreational Value (CRV)). The second hypothesis is that the literature analysis will show similarities within most basic criteria of people preferences, and only some criteria could be found out as different ones. The main reasons for these differences could be management practice and traditions.

2. MATERIALS AND METHODS

2.1. Study areas

2.1.1. The Mytishchinsky lesopark as a part of the national park "Losiny Ostrov"

According to the study idea to compare features of recreational areas around Russia and Sweden, two typical recreational forests (one in each country) were selected. The Russian case area was the part of the national park "Losiny Ostrov".

This national park was established on the properties of Moscow city and Moscow region in the year of 1983. The aims were to maintain national culture and to create the organized recreational

utilization as well as protect the typical regional ecosystems around pure urbanized area (Rodichkin 1977, The national parks….1996, Nosov 2006).

For the first time, the name "Losiny Ostrov" was mentioned in the chronicle of the year 1339. From the ancient times, the importance of these forests for game hunting was very high for the great dukes (knyazi in the Russian language) and, later on, for the tsars. These forests were filled with game including moose. This fact is reflected by the name of the national park, which means "Moose Island" in English.

Two hundred years ago in 1805 "Losiny Ostrov" got an official status of forest with some protective functions, but in fact these lands became preserved early during the time of noble hunts.

In 1934 "Losiny Ostrov" was included in The Green Belt of Moscow (50 km of forests around the city). The "sad" time for the area came with The Second World War, when a huge part of the forests was cut down.

Nowadays the territory of "Losiny Ostrov" includes not only environmental "treasures" for the megapolis, but also more then 100 historic-archaeological heritages like barrows of the tribe Vyatichi from the 11^{th}-12^{th} centuries, ruins of the palace from the end of 17^{th} century, etc. (The chronology of…..2006).

"Losiny Ostrov" is covered by: 9604 ha of forests (which is 83% of the total area), 169 ha of water and 574 ha of peatlands. The whole territory is 11621.5 ha. One third of the national park is situated inside the megapolis, but only 8 kilometers from the Kremlin. The geographical coordinates of "Losiny Ostrov" stretch from 55^{o} 49' N to 55^{o} 54' N in latitude and from 37^{o} 40' E to 38^{o} 00' E in longitude.

The climate is continental with snow in winter (-10° C in January, average temperature) and relatively warm summer (+19,5° C in July, average temperature). The mean frost period is 149 days, but the mean period of kept snow cover (41 cm depth on average) is 140 days. The annual precipitation is around 650 mm. The humidity level is 80% with low variety during the year. The vegetation period is about 129 days. The prevailing wind directions are from north and north-west. There are very typical quick decrease and rise in temperature in winter period.

Almost all frontiers of the national park are surrounded by urban infrastructure of cities like Moscow (from the south, south-west), Mytishchi (from the west), Korolev (from the north), Shelkovo (from the north-east) and Balashikha (from the south-east).
The area is situated in a flat landscape. The altitude varies between 146 and 175 meters above sea level (GIS-data of National park, 2006). The soils are loam moraines mainly. The huge area of the former glacial lakes is under peatlands.

The case area for the project was selected near Korolev city in a part of the national park so-called "Mytishchinsky lesopark". The term "lesopark" means managed urban forest for mainly recreation purposes (Rodichkin 1977). The case area includes artificial forests created in 1950-ies by a project of landscape architect Korzhev and forester Marinin (Rysin 2006). According to the modern functional division, the northern part of the Mytishchinsky lesopark has recreational functions mainly. The area is widely represented by 50-60 years stands with different species

composition. It also includes quite old (120-140 years old) artificial and natural coniferous (*Pinus sylvestris* L. and *Picea abies* L.) stands representing natural forest ecosystems of the Moscow region. According to the inventory materials, the proportion of tree species in the national park is: 44% of birch, 22% of pine, 15% of spruce, 12% of lime, 3% of oak, 4% of aspen, and minor proportion of species like alder, willow, ash, maple, elm as well as introduced species like larch and amur cork tree (*Phellodendron amurense*- Rupr.).

The Mytishchinsky lesopark as well as the whole national park "Losiny Ostrov" is extremely popular recreational area (Park and man 2006). Some forest compartments of recreational zone which are bordering to the urban infrastructure of Korolev city (the northern part of the Mytishchinsky lesopark) were selected for study area (totally 256.3 ha of forest stands without roads and other lands). Korolev is a modern city with developed infrastructure and population of over 170 thousands. Just some steps away for the local people almost wild nature of different forest types occurs. Owing to such neighborhood the area of the city green structures ("nature") is 79 m^2 per citizen according to the official data (Ecological situation 2006). This forest seems to be very typical recreational area in terms of how forests surround settlements in European Russia (Rodichkin 1977). Besides that fact, the Mytishchinsky lesopark is a primary source of recreational facilities for the local people. These all make the lesopark appropriate for this study.

2.1.2. Torup estate (Bokskogen)

The Torup estate or Bokskogen (beech forest in translation from Swedish) is situated between 55° 32' N to 55° 34' N in latitude and 13° 11' E to 13° 13' E in longitude on the approximate distance 12 km west of Malmö city. This remote location of recreational forest sites from cities is typical for the Skåne (Southern Sweden). The altitude varies between 20 and 70 m above sea level. The total land area of the property is 957 ha, where 360 ha is productive forest land, 477 ha - agricultural land, 27 ha - peatland and 94 ha - other land use. The estate is owned by the municipality of Malmö since 1972.

The area is situated on hilly landscape with a mosaic of forest, lakes and agricultural areas. The soils are mainly clay moraines formed during the end of the last glacial period. The bedrock in the area was created during the tertiary period and is composed of limestone.

The dominating forest type is noble broadleaved stands, mainly herb rich beech forests. However, the occurrence of other noble broadleaved stands, mainly oak, are occasionally great. The conditions for the noble broadleaved tree species are very good, with fertile, well drained soils. The vegetation is mainly very rich thanks to the rich mineralogy, good water supply and favourable climate. The area has also a long continuity of having forest, which together with the past cultural influence contributes to very high biodiversity values. The area hosts many very rare and threatened species, especially insects and flora. Owing to the fact that the Torup area used to belonged to noble owners, its area has kept these values through a continuity of old trees, broadleaved trees, etc.

The huge open farmer lands around Skåne say about centuries of deforestation. Finally, only some woodland under noble properties has been saved. The Torup estate is one of such areas.

The history of the Torup estate begins from 12th century. From this time until the year of 1972, the estate has been owned by different noble families.

The first public recreational utilization of the area could be referenced to the time of Henriette Coyet authority. The railway transportation between Malmö and the estate has been opened due to popularization of outdoor activities like festivals, picnics, and concerts on the nature. During Coyet's handling new schools were created also (Jonsson 2006). Since 1972 municipality of Malmö has become the last owner of the Torup estate.

The climate of the Torup estate is maritime one with snowfree winter (0° C in January, average temperature) and relatively cool summer (+17° C in July, average temperature). The annual average temperature is +7° C and annual precipitation is around 650 mm. The vegetation period is about 250 degrees (average temperature above 3° C). The prevailing wind direction is from south-west.

The forest management in the area is oriented towards a strong adaptation to recreation. The utilization of the area for forest recreation is wide, but mainly prevails in the north-central part near visit centre. Visitors come mainly from the city of Malmö, for whom it remains the first and main recreational facility on forest landscapes. This area is not also out of the attention of any kind of tourists and guests of Sweden. The recreation adaptation is done by many ways, as creating paths and rest places, keeping older stands and planting different species. Besides that, large considerations to maintain high biodiversity values found in Torup are taken. This is done by e.g. large and dead trees leaving, and creating set-aside areas.

Finally, the aim of the estate management rests on economical revenues which it produces. According to the management plan of the Torup forest the proportion of productive stands with commercial functions is very high and over 80%. This is an important contribution to the economy of the municipality of Malmö and the backbone to be able to manage visit centre, paths which make it easier for visitors to get access to the forest.

2.2. Study design

The investigation started in Russia in June 2006 by preparatory operations made both indoor and outdoor. The first part of it included study of graphical and statistical materials about the area and descriptive data as well as consultation with specialists from the national park and through data collection. The outdoor part was pre-revision of the national park in order to make judgments about the most popular recreational places there, clarify the current situation with recreation activities and determine stands features and structure. To choose smaller area for precise investigation, preliminary survey of the northern part of the Mytishchinsky lesopark was made.

The assessment of the recreational potential through the evaluation of Class of Recreational Value (completely described below) was done in 292 forest stands on 13 compartments (№ 4, 5, 9-13, 16-21) of area equal to 256.3 ha totally (*Figure 1*). Since some of the compartments (4, 5, 9, and 16) had been revised with the same method before, partly this study is based on the old data from these compartments but with corrections and additions. Three forester students, who were well skilled in the methodology, took participation in the inventory process of the 13th, the 20th and the 21st compartments. The inventory period started in the beginning of July and finished in the middle of August and took 20 days.

The second case area for the method implementation the Torup forest (Bokskogen) was revised firstly by topographical and stands' data materials, and later an outdoor pre-revision was performed in terms to get knowledge about infrastructure and stands structure. The selected area includes southern and northern parts separated by a big field (*Figure 2*). Natural edges (agricultural fields for example) as well as roads and trails were the basic elements in delimitation the study area. There were 101 selected stands covering 198.5 ha. The field work started in early autumn (beginning of September) and finished in late October 2006 by performance of one expert. The inventory took 15 days.

2.3. Structure of the method

The evaluation of recreational potential comprises of three main categories (three groups of evaluation indices):

- Decorative effect ("attraction");
- Comfort for visitors ("comfort");
- Stability (tolerance) of the forest to recreational influence ("stability").

These categories include different amount of specific indices (*Figure 3*). According to the Rysin's method (2003) evaluation process should be done for every forest stand.

Each index should be evaluated by expert from "0" up to "4" score. The maximal sum of scores for the "attraction" category is 40, since 10 different indices are evaluated by this category. Then the calculated sum of scores has to be compared to the maximal possible sum for every category.

One aim of the study was to test the method. That is why during the pre-revision of the first case area lack of indices useful and essential for recreational potential evaluation was found out. So, from the beginning the method were modified by an additional index namely "visibility through stand" in the "attraction" category. Therefore, the sum of whole attraction group became 44 instead of 40 scores.

Also the possibility to correct the reached results by sum of scores decreasing for the "attraction" and "comfort" categories was used. The reason for the corrections in attractiveness was the presence of some negative factors like neighborhood of urban infrastructure, fences, buildings which are untypical and even ugly for any recreational purposes etc. Finally, the sum of score could be reduced with up to "4" scores. The uprooted trees, leaved cut brunches and logs, which could prevent walk through the area, were taken into consideration as negative factors for the "comfort" category (see Appendix 1).

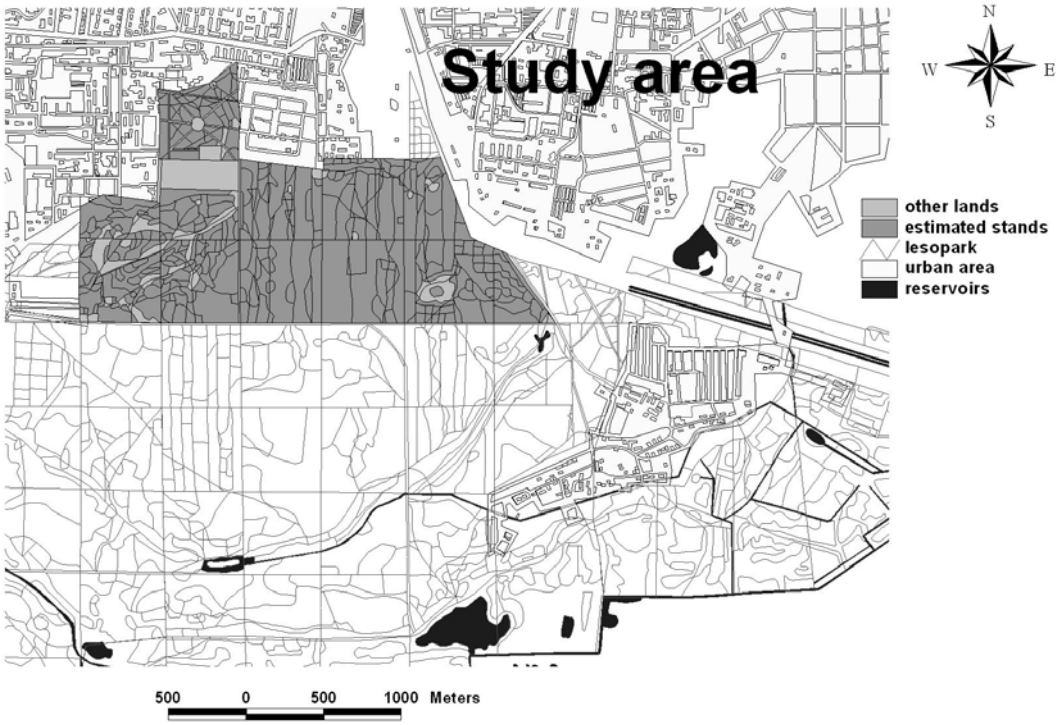

Figure 1. Location of the study area in Mytishchinsky lesopark (national park "Losiny Ostrov"). There is urban infrastructure of Korolev city in the north of the area. Map made by ArcView GIS 3.3.

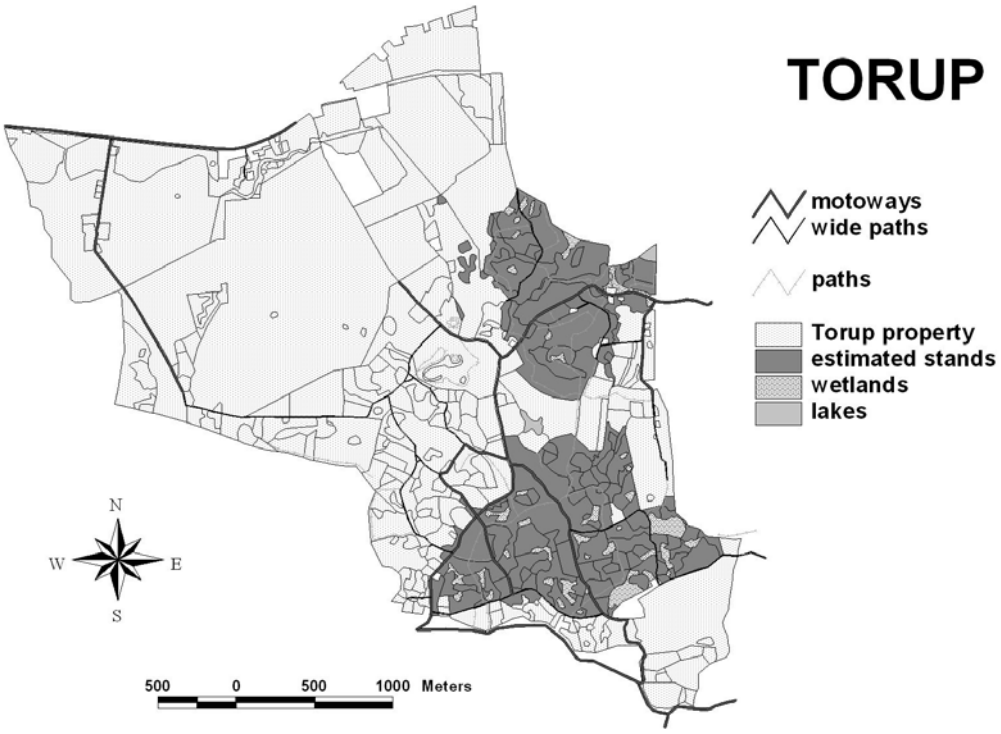

Figure 2. Location of the study area in the Torup estate. There are northern and southern agglomerations of stands (green color). Map made by ArcView GIS 3.3.

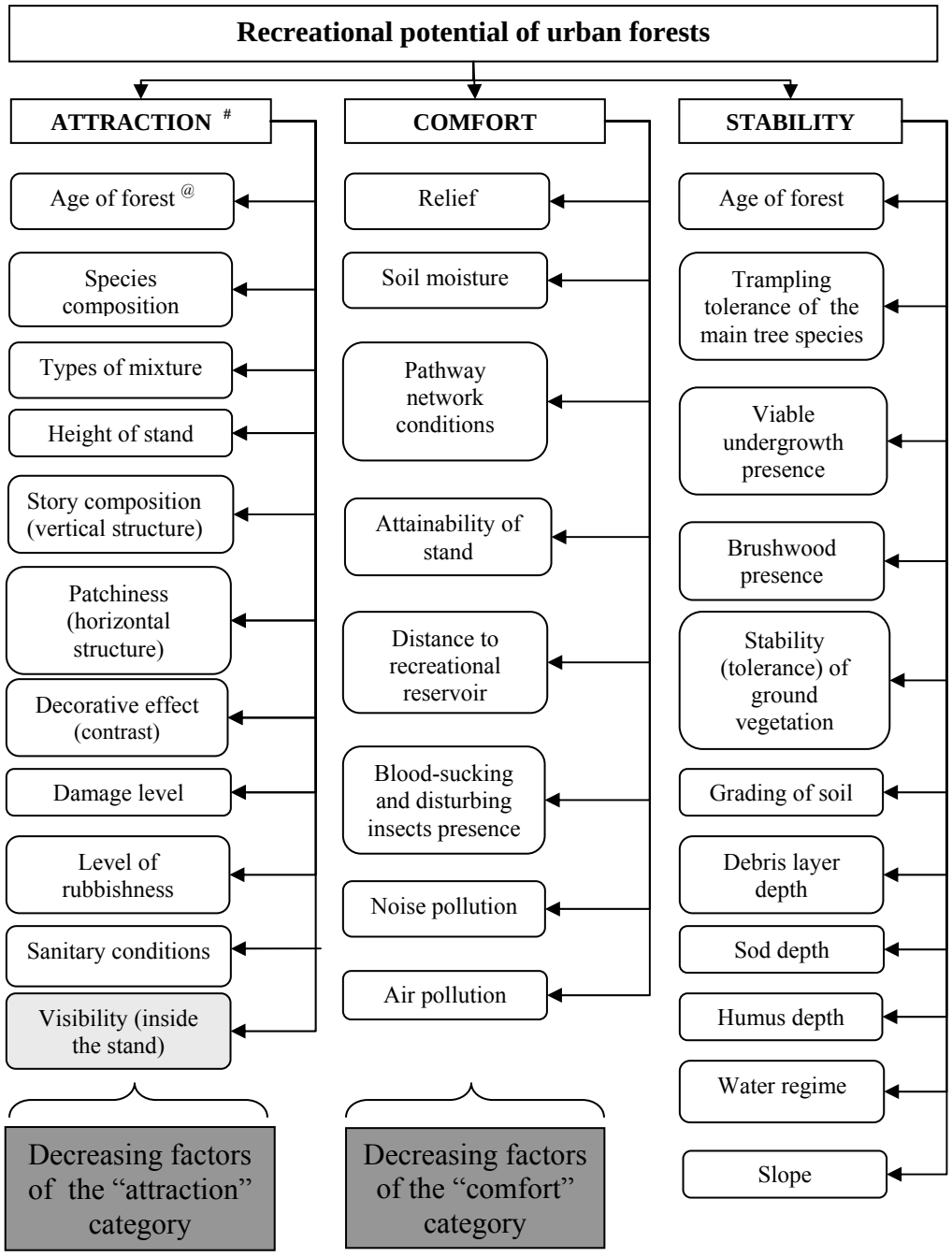

Figure 3. Structure of the method of recreational potential evaluation
Undergrowth* - trees which could reach the height of first stand layer
Brushwood ** - trees and bushes which could NOT reach the height of first stand layer and will grow under canopy
- as a group of different component;
@ - as a component from the attraction group

2.4. Calculations

For the next step, to make the data clear and understandable for further analyzing certain coefficients have to be used according to the method. Due to an aggregative processing of scores noted in checking form (Appendix 2) and method's formula we get coefficients CA, CC and CS correspondingly for every observed stand in “attraction”, “comfort” and “stability” categories:

$$C_N = (SS_n + f)/SM_n$$

where C_N – corresponding coefficient (CA (attraction), CC (comfort) или CS (stability));
SS_n – sum of scores according to N category;
SM_n – maximal possible sum of scores (44 for the “attraction”, 32 for the “comfort” and 44 for the “stability” categories);
f – decreasing factors, which change the quality of stand by certain presented disadvantages.

According to reached coefficients we make a pre-conclusion about quality of observed stands for every category of evaluation (*Table 1*).

Table 1: Estimation of stand quality by values of attraction, comfort and stability coefficients

Coefficients CA, CC or CS equal to	**Observed stand quality**
0 – 0.20	very low
0.21 – 0.40	low
0.41 – 0.60	medium
0.61 – 0.80	high
0.81 – 1.00	very high

Final result expressed via Class of Recreational Value (CRV) includes integral evaluation of recreation potential of stand. The different classes (from “I” up to “IV”) are divided according to the following rules:

a) If at least one of the coefficients is lower then 0.40, the observed area (stand) corresponds to CRV IV. Then the recreational utilization can’t be managed without any significant management for recreational potential enhancement.
b) If at least one of the coefficients are between 0.41 up to 0.60 and the others are higher than 0.61, then the observed area (stand) corresponds to CRV III. Then the recreational utilization could be managed only with some limitations.
c) If at least one of the coefficients is between 0.61 up to 0.80 and the others are higher than 0.80 then the observed area (stand) corresponds to CRV II. Then the recreational utilization could be managed without any significance changes.
d) If all coefficients in three categories are higher than 0.81, the observed area (stand) corresponds to CRV I and potential is the highest.

So, the result reached via Classes of Recreational Value (CRV) will be a consequence about recreational potential in particular cases.

After getting the result in easy descriptive forms (very low, low, medium…) for each category or in classes division (CRV I, II, III, IV) for integral evaluation we could present this data in more clear way. In that case coloring of every stand regarding to each CRV was used for mapping.

All noted and reached field data was processed by mathematical and statistical software MS Excel and GIS software ArcView GIS 3.3.

3. RESULTS

There are not only final integral results of recreation condition, but also specific indeces and conditions quite significant and could be compared, analyzed and emphasized

3.1. A comparative estimation of the "attraction" category

One of the features that differ mainly among the areas is a type of tree species mixture. Owing to forest continuity in Torup, the mixture nature of numerous stands in Torup is more natural. Therefore the mean score in the "types of tree species mixture" index is essentially higher than for the artificial stands of the Mytishchinsky lesopark (3.80 compared to 2.59 respectively), where a mixture by rows essentially reduces their aesthetic properties. On the other hand, artificial mixtures with three and more tree species (the "species composition" index) in the Mytishchinsky lesopark cause more attractiveness and adequate difference with the Torup forest (*Table 2*, *Figures 4, 5*).

The good sanitary condition of the stands is also a distinctive attribute of the Torup forest where the highest scores ("3" and "4") had been received by more than 90% of the investigated area, whereas in the Mytishchinsky lesopark with significant lower mean score (*Table 2*) only about 60% of the surveyed area had been estimated highly.

The indices so-called the "species composition" and the "decorative effect" are the main "suppliers" of minimal ("0") and low ("1") scores for both areas. At the same time the "height" and the "age of forest" indices are the "positive suppliers" for attraction category because of many values with maximal ("4") and high ("3") scores.

The Mytishchinsky lesopark is composed mainly of middle-aged and mature stands (from "2" up to "4" scores, Appendix 1) with a mean score of 3.48 (*Table 2*), whereas all classes of age with high proportion of young stands can be found in Torup. These facts as well as other are more clearly traced from the comparative diagrams (*Figures 4, 5*). Because of the presence of unattractive young stands and clear cuts with the new regeneration in the southern part of the Torup forest the average estimation of the "age" index decreases to 3.05. The presence of young stands is also the reason for lower mean score of the "height" index in the Torup forest compared to less various in height and age stands of the Mytishchinsky lesopark (*Table 2*).

The low scores ("0" and "1") on the "story composition" index in the Torup forest as well as some indices described above are related with the presence of young stands. At the same time the highest score ("4") had been recorded also more often in Swedish case (*Figure 5*).

The average scores of the "patchiness" index as well as distribution of the scores reflect the fact that the Torup forest seems to be more varied in its horizontal structure distribution.

A large variation of the "decorative effect" index was found in the Mytishchinsky lesopark. Here, an aesthetically beautiful and scenic diverse stands, the composition of picturesque glades, unattractive artificial stands distinguished from others by the "monotony" of straight tree rows could be noticed at the same time. The main advantage in the Swedish case area is that "nature" of both mature and young stands was detected. On the other hand, in the Torup forest there are

huge areas of almost open landscapes formed by clear cuts and young stands of beech (*Fagus silvatica* L.), which were described with the term "monotony" as well.

Middle level of damage caused by recreation activity is equally shown in both case study areas (*Figures 4, 5*). The most damaged sites belong to the more popular visitors' places. Unorganized fireplaces, shelters and unattractive camps of homeless people, sometimes hidden in very dense and almost impassable stands are more specific for the Mytishchinsky lesopark (the mean score is equal to 2.55), but basically do not really damage the nature around. In this respect, the Torup forest (the mean score is equal to 2.58) has more attractive fireplaces and scout shelters, but not less damaged environment.

The mean score of the "level of rubbishness" index in the Mytishchinsky lesopark is lower compared to the Torup forest (*Table 2*) where up to 90% of the investigated area had been recorded with the high scores ("3" and "4"). High level of rubbish presence in many stands of the Mytishchinsky lesopark can be explained by greater number of visitors and dwellers from neighboring housing estates.

Both case study areas are described by stand features of different visibility from mostly full absence (visibility is less than 5 m) up to high visibility conditions (exceed 50 m). More than 45% of the investigated area of the Torup forest, structured mainly by extremely dense young beech stands, had been evaluated as low and very low (scores "0" and "1"). There is a reverse situation concerning the Mytishchinsky lesopark which contains about 45% of old-growth spruce and pine stands' area with high and very high visibility ("3" and "4" scores). This fact explains the difference in mean score of the "visibility" index (*Table 2*).

One of the indices added in this study was called the "decreasing factors of the "attraction category". This index highlights disadvantages as not related to recreational purposes features of stands and their neighbourhoods. In this respect, the northern part of the Mytishchinsky lesopark "blessed" with neighboring industrial or other infrastructure areas (plants, farm territories, buildings, fences). Therefore, the whole sum of the score of the "attraction" category was reduced. This was also the case for the Torup forest because of the private farm yard or buildings near by these properties. Mean decreasing values of CA reduction (*Table 2*) do not exceed 5% of the result.

Table 2: Mean scores of indices in three categories of recreational potential evaluation in the Mytishchinsky lesopark and the Torup forests

Index of "Attraction" category	Mean score in Mytishchi / Torup	Index of "Comfort" category	Mean score in Mytishchi / Torup	Index of "Stability" category	Mean score in Mytishchi / Torup
Age of forest	3.48 / 3.05	Relief	4.00 / 3.41	Age of forest	3.48 / 3.05
Species composition	1.84 / 0.90	Soil moisture	2.95 / 2.80	Trampling tolerance of the main tree species	2.61 / 3.52
Types of mixture	2.59 / 3.80	Pathway network conditions	0.83 / 1.69	Viable undergrowth presence	1.60 / 2.11
Height of stand	3.73 / 3.35	Attainability of stand	3.96 / 3.41	Brushwood presence	2.31 / 1.52
Story composition (vertical structure)	2.48 / 2.29	Distance to recreational reservoir	2.92 / 3.00	Stability (tolerance) of ground vegetation	1.13 / 0.74
Patchiness (horizontal structure)	2.20 / 2.40	Blood-sucking and disturbing insects presence	1.47 / 2.07	Grading of soil	3.19 / 3.33
Decorative effect (contrast)	1.79 / 1.56	Noise pollution	2.09 / 2.04	Debris layer depth	1.46 / 1.10
Damage level	2.55 / 2.58	Air pollution	3.96 / 3.96	Sod depth	0.07 / 0.39
Level of rubbishness	2.88 / 3.23			Humus depth	0.13 / 0.41
Sanitary conditions	2.61 / 3.60			Water regime	2.95 / 2.80
Visibility (inside the stand)	2.39 / 1.62			Slope	4.00 / 3.41
Mean decreasing value of CA	-0.031 / -0.011	Mean decreasing value of CC	-0.004 / -0.019		
CA (coefficient of attraction)	0.64 / 0.63	CC (coefficient of comfort)	0.69 / 0.68	CS (coefficient of stability)	0.52 / 0.51
Mean of minimal coefficients' values (or mean/typical CRV)		in	Mytishchi / Torup	0.50 (CRV III) / 0.51 (CRV III)	

3.2. A comparative estimation of the "comfort" category

One of the most strongly pronounced distinctions between the areas in this category had been obtained in the "pathway network conditions" index. Owing to well-developed paths and tracks system of several functional purposes (walking paths, running-tracks, tourist routes, riding roads) the Torup forest impresses more favourably, than the Mytishchinsky lesopark. The surveyed part of the Mytishchinsky lesopark has more "wild" appearance inherent for the natural forest environment. There is a considerably lower amount of well-developed territories compared to the Torup forest (*Figures 6, 7*). This is evidenced by spontaneously formed paths around the area and by great lack of paths with covering generally. From spring to autumn these paths are affected by a visitor's foot, a wheel of a bicycle or a motorcycle, a horse's hoof at once with rain erosion. At the same time more than 30% of the Torup forest have maximal score due to their well-developed partially illuminated path system, what indicates to the high level of recreation infrastructure development. Nevertheless, the huge areas of dense young-growth beech stands and bog surroundings (together about 50% of the area) without any paths again are acting in the Torup forest against receiving of the high scores. These facts are the reasons for the lowest scores of the "pathway network conditions" index among other ones in the "comfort" category.

The "suppliers" of high and very high (maximal) scores mainly are distributed among four indices: "relief", "attainability", "distance to recreational reservoir" and "air pollution".

The features of the results from the first index namely "relief" is also quite dissimilar between two study areas. The distinction could be clear recognized on the diagrams (*Figures 6, 7*) describing distribution of the areas by stands distinguished from each other by recorded score (from "0" up to "4"). According to Rysin' method (Appendix 1) the maximal score should be received by sites with flat relief. Practically the whole investigated area of Russian case study is flat; hence, the mean score of "relief" index is 4.00 here. On the contrary, the territory of Torup estate has various relief (the mean score is equal to 3.41) with ranging from "0" up to "4" scores. Slopes of streams' banks, hills and lowlands reduce proportion of areas with maximal score to 67% (*Figure 7*).

The presence of the wet site conditions, surroundings with bogs and streams in Torup estate determines about 7% of the area, which had been received the low scores due to the "soil moisture" index evaluation. At the same time normal moisture sites prevail in both study areas and make up to 95% of Russian case area and about 87% of the Swedish one (*Figure 7*).

The indices "attainability" and "distance to recreational reservoir" reached mainly the high scores ("3" and "4") in both case areas. The difference, first or all, consists of varied locations of urban infrastructure. For instance, most of the stands of the Mytishchinsky lesopark are neighbouring the southern part of city of Korolev. This location itself predetermines the maximal scores for more than 95% of the case area and the high mean score (*Table 2*). However, the Torup forest is not neighbouring the nearest urban infrastructure of the Bara settlement. Therefore according to the method, the highest score has been obtained only by stands from the northern part of Torup (40% of whole surveyed area), located closer to Bara, infrastructure of the estate and bus stop. That is why the mean score of the "attainability" index here is lower. Secondly, there is a small difference between the two areas caused by recreational

reservoirs' dispositions. Neighbouring from the east of Torup estate big Lake Yddinge is located closer to recreational area of Torup compared to remote lake so-called Baikozero in cases of the Mytishchinsky lesopark.

The next index, “blood-sucking and disturbing insects’ presence”, is a parameter directly dependent on factors like: season, weather conditions during whole frost-free period and during inspection time etc. For example, while the investigation was being carried out in the Mytishchinsky lesopark from July to August a windless and warm weather conditions were prompting of mosquito (*Culex pipiens*) activity (*Figure 6*). On the other hand, mosquitoes did not show appreciable activity during a field work on the Torup territories from September to October. Though the wide presence of tick (*Ixodes ricinus*) much more dangerous for people, but less noticeable than mosquito presence, the mean score of this index in Torup area is significantly higher than in the Mytishchinsky lesopark (*Table 2*).

The “noise pollution” index had been evaluated as nearly the same in both areas (mean scores are equal to 2.09 and 2.04). There are highways with intensive traffic on around the same distance from both case study areas. Some “noise pollutants” could be taken into account in the Mytishchinsky lesopark: the highway M8, the infrastructure of Korolev city, nearby industrial territories. In case of Torup, it is the highway E65 connecting the cities of Malmö and Ystad. As a result of this neighborhood, almost at 80% and 90% of the surveyed areas (the Mytishchinsky lesopark and the Torup estate respectively) minor background noise had been noticed that is equal to “2” score by the method (Appendix 1).

The equality in results had been reached in the “air pollution” index where identical values of mean scores equal to 3.96 on both sites. Thus more than 95% of the both areas have the maximal scores. The low level of dustiness or slight objectionable odor that is equal to “3” score (see Appendix 1), had been recorded mainly near by open lands and other properties (farmlands in Torup, industrial territories, housing estates, edges of roads in the Mytishchinsky lesopark). Mean decreasing values of CC reduction (*Table 2*) do not exceed 3% of the result.

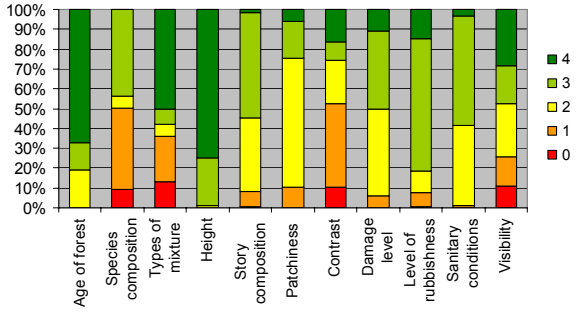

Figure 4. Distribution of the Mytishchinsky lesopark by stands area with different scores (from 0 to 4) in each index of "Attraction" category

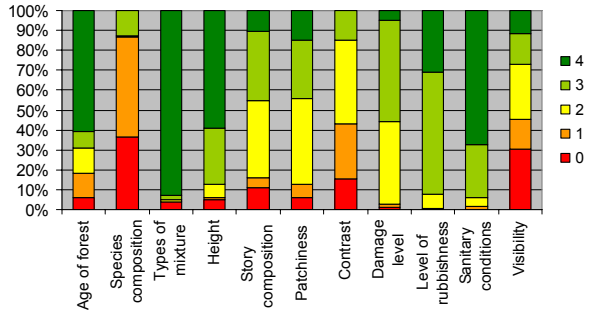

Figure 5. Distribution of the Torup forest by stands area with different scores (from 0 to 4) in each index of "Attraction" category

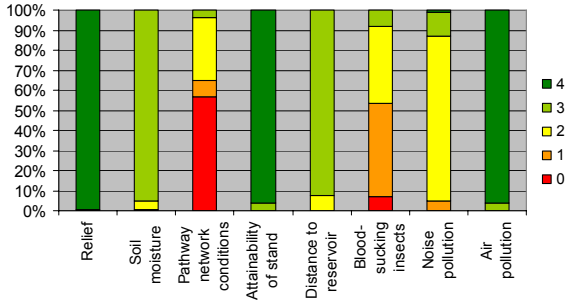

Figure 6. Distribution of the Mytishchinsky lesopark by stands area with different scores (from 0 to 4) in each index of "Comfort" category

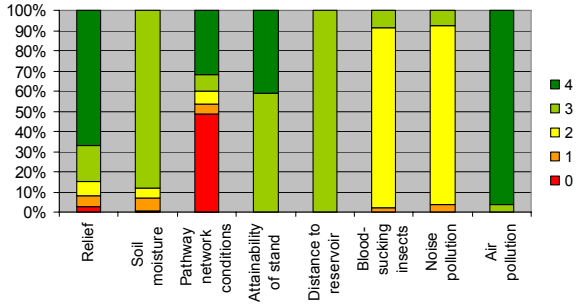

Figure 7. Distribution of the Torup forest by stands area with different scores (from 0 to 4) in each index of "Comfort" category

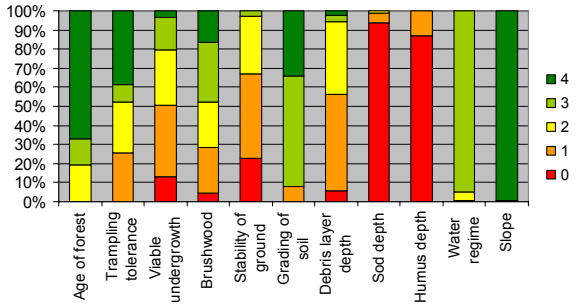

Figure 8. Distribution of the Mytishchinsky lesopark by stands area with different scores (from 0 to 4) in each index of "Stability" category

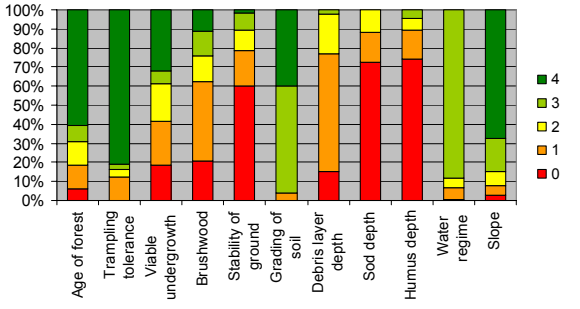

Figure 9. Distribution of the Torup forest by stands area with different scores (from 0 to 4) in each index of "Stability" category

3.3. A comparative estimation of the "stability" category

The results for three indices like "age of forest", "water regime" and "slope of ground surface" totally correspond to the results evaluated in the "attraction" category (the "age of forest" index) and the "comfort" category ("relief" and "soil moisture" indices) because of an equality of the parameters for the evaluation scales (see Appendix 1).

The biggest share of minimal and the low scores ("0" and "1") of the both areas in this category are obliged mainly to the three indices: "stability of ground vegetation", "sod depth" and "humus depth". On the other hand, the maximal and the high scores ("4" and "3") were often received for the indices "age of forest", "trampling tolerance of main tree species" (less in the Mytishchinsky lesopark), "grading of soil", "water regime" and "slope of ground surface".

One of the biggest contrasts between the study areas was observed in the "trampling tolerance of main tree species" index. The occupation of the Torup forests by tolerant noble-broadleaved species like beech and oak lets get the highest scores ("4") on 80% of the area and the mean score equal to 3.52. The result from the surveyed area of the Mytishchinsky lesopark is considerably lower (*Table 2*) due to the wide presence of spruce *(Picea abies* L.*)* in pure and mixture stands as well as pine (*Pinus sylvestris* L.*)* presence.

One more essential difference between areas according to the results belongs to the "viable undergrowth presence" estimation. Dense young-growth beech stands under shelterwoods are very typical for the Torup forest. They are the main reason of big share of the area (33%) with the highest score of this index. Only 4% of the area of the Mytishchinsky lesopark was found with nearly the same features.

The opposite situation can be noticed under close canopy of young beech stands in Torup (absence of brushwood) and less shadowed and more species variable stands of lesopark (*Table 2*) where undergrowth or brushwood could be found more often.

The calculations of the "stability (tolerance) of ground vegetation" index could be assumed as one of the most massive and complicated ones. The results showed quite low scores on both areas as well as big difference between them (*Figures 8, 9, Table 2*). The mean score of the index is 0.74 in the Torup case, which is a consequence of full absence of ground vegetation on a huge area under close canopy of young-growth and mature beech stands. The opposite situation is in the Mytishchinsky lesopark where ground vegetation is presented almost everywhere. The structures of ground vegetation of the both areas are rich in weeds and meadow grass as well as in forest species (Appendix 3). In the Mytishchinsky lesopark there is an extensive occurrence of quite sensitive species like lily of the valley (*Convallaria majalis* L.*)* or oxalis (*Oxalis acetosella* L.) which determines the low results (equal to 1.13 of the mean score). This is also the explanation for the low scores of Torup stands where the ground vegetation is composed by sensitive forest species too.

The soil observation by the method of Kachinsky on both areas didn't show significant difference in results from "grading of soil" estimation. More then 90% of stands in both cases have loam and sandy-loam soils that lead towards the high scores.
The estimation of "debris layer depth" also gives a quite wide representation of the areas. The big amount of stands with full absence of the layer (15% of the estimated area) belongs to the

clear cuts with young-growth regeneration, 80% of which are replaced by the sod layer. The big part of the surveyed area of Torup (about 60%) is composed by debris layer of less than one centimeter in depth (*Table 2*). The mean score for the Mytishchinsky lesopark (1.46) is mainly higher compared to the Torup forest (1.10), because of the occurrence of old-growth pine and spruce stands generally with thick debris layer in the first case.

The essential difference of the lowest results between the two areas occurs due to the different management systems during past centuries and modern history. For instance, mean scores of the Mytishchinsky lesopark by the "humus depth" and the "sod depth" indices are considerably smaller (0.13 and 0.07 respectively) compared to the Torup forest's results (0.41 and 0.39 respectively). Firstly, the short history (only 50-55 years) and land cultivation period of many stands in the lesopark explain this. The current management system of the Torup forest is also a reason for differences like relatively wider presence of sod layers (from one up to three centimeters in depth) on the open sites of clear cuts and locally on highly thinned stands. Such sod depth in the Mytishchinsky lesopark is rare and had been recorded on a sparse middle-aged birch stands only.

3.4. A comparative estimation of coefficients CA, CC, CS and "coefficients of recreational value" (CRV)

The diagrams showing the distribution of stand coefficients (*Figure 10*) as well as maps showing the distribution of stands with different coefficients over the study areas (*Figures 11-18*) first of all clarify the results regarding a qualitative assessment. It is easy visual way to compare the results than just a numerical assessment. Secondly, these types of data show the spatial distribution of each concrete stand with respect to not just dispersed indices, but to three categories or complexes of indices.

One of the important tendencies in the evaluation is the absence of coefficients lower than 0.21 that corresponds to "very low" qualitative value. There are values like "low" and "very high" in some categories which do not presented neither in the Mytishchinsky lesopark nor in the Torup forest.

In that way the "attraction" category is broader comprised of various qualitative values from "low" assessment up to "very high" one. The mean CA coefficients are slightly smaller than CC coefficients (*Table 2*) due to the absence of "low" evaluated stands in "comfort" category (*Figure 10*). At the same time, on the level of categories the obtained values of mean coefficients among the Mytishchinsky lesopark and Torup were almost equal to each other in all three categories (*Table 2*). The lowest values are CS coefficients which belong to the "stability" category. It is obvious that one of the consequences of such results in this category is an absence of stands with "very high" values and lack of "high" estimated stands (*Figure 10*). Thus, the locations of more representative values spread out mainly between two groups of values as "medium" and "high" (*Figures 10 - 16*). The lowest mean coefficient (CS in the Torup forest) and the highest mean coefficient (CC in the Mytishchinsky lesopark) in both areas are belongs to "medium" and "high" qualitative values (*Table 2*).

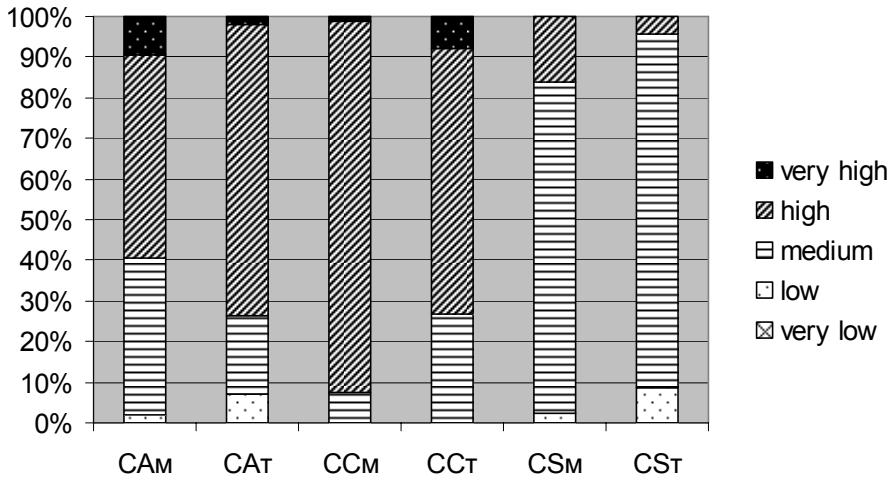

Figure 10. Distribution of the Mytishchinsky lesopark (CN_M) and the Torup forest (CN_T) by stands area with different coefficient of categories (each coefficient CA,CC, CS correspond to quality evaluation from the lowest to the highest class)

According to the method (see MATERIALS AND METHODS chapter) the recreational potential evaluation as an integral scheme of assessment is the final stage of evaluation. Due to an estimated class of recreational value (CRV) measure of recreational potential could be obtained as well as a level of limits and requirements for carrying out further managements.

Thus, it is possible to draw a conclusion based on results from both areas that their recreational use in most cases should be conducted with the certain restrictions. There is about 90% of the surveyed area of the Torup forest recommended to be under any kind of restrictions and limits (CRV III and CRV IV). And at the same time about 14% within this area (*Figure 19*) is needed to be limited in visitors' attendance while the recreational potential wouldn't be enhanced corresponding to CRV IV restriction.

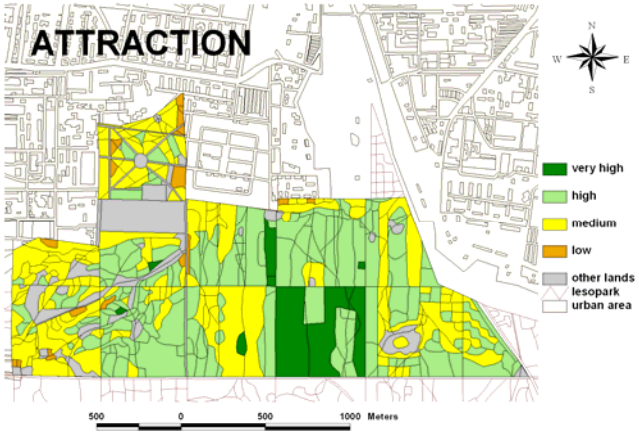

Figure 11. Map of distribution of the Mytishchinsky lesopark by stands with different quality class of the "attraction" category

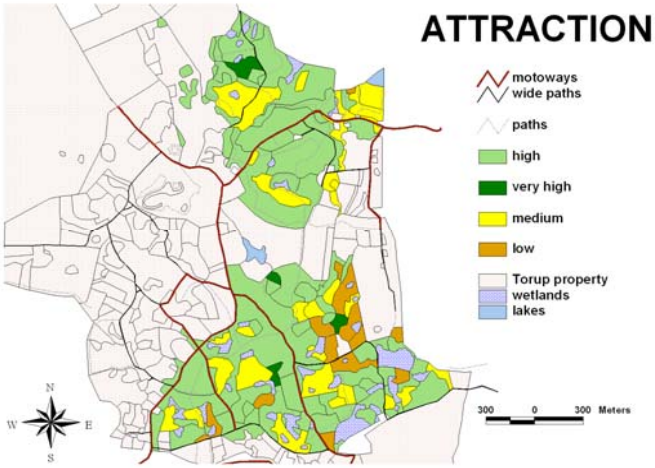

Figure 12. Map of distribution of the Torup forest by stands with different quality class of the "attraction" category

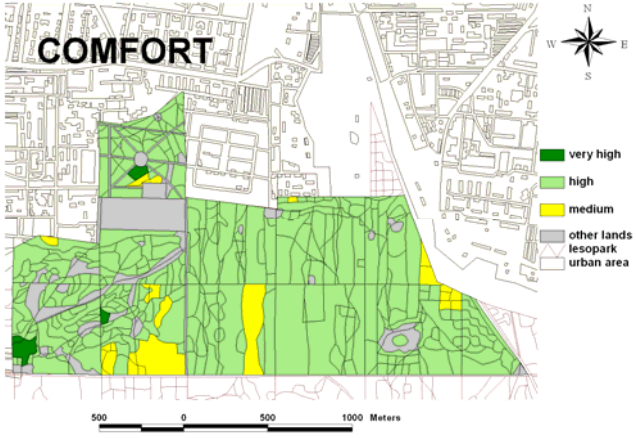

Figure 13. Map of distribution of the Mytishchinsky lesopark by stands with different quality class of the "comfort" category

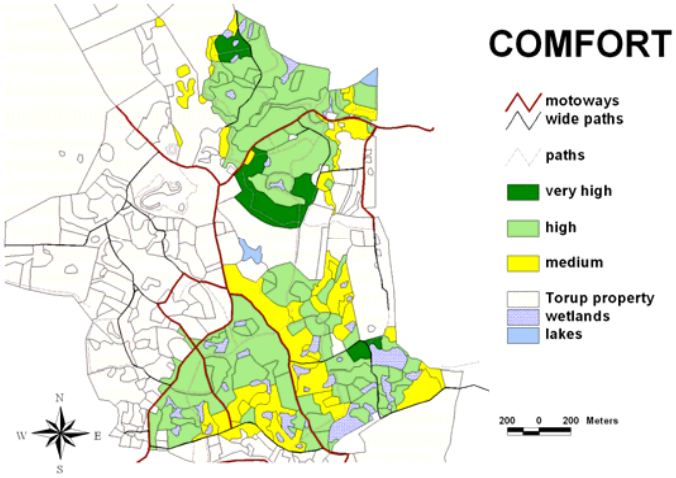

Figure 14. Map of distribution of the Torup forest by stands with different quality class of the "comfort" category

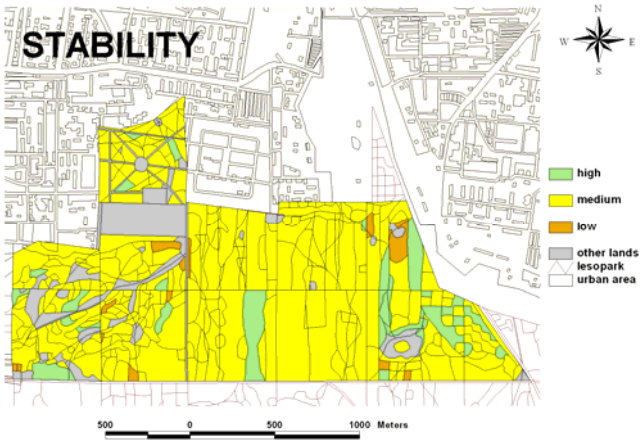

Figure 15. Map of distribution of the Mytishchinsky lesopark by stands with different quality class of the "stability" category

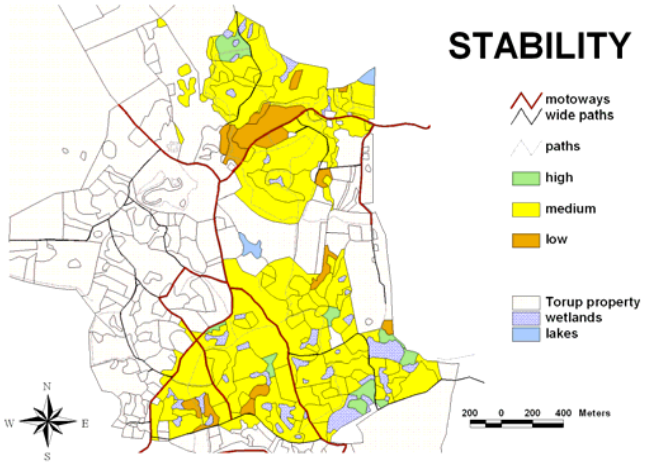

Figure 16. Map of distribution of the Torup forest by stands with different quality class of the "stability" category

Figure 17. Map of distribution of the Mytishchinsky lesopark by stands with different "class of recreational value" (CRV)

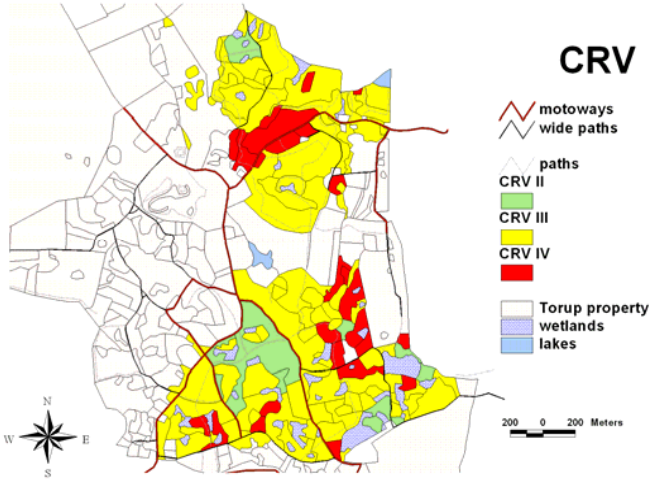

Figure 18. Map of distribution of the Torup forest by stands with different "class of recreational value" (CRV)

Compared to the Torup' results, the Mytishchinsky lesopark is less composed by CRV IV and CRV II, but have more area with CRV III (*Figures 17, 18*). It means that the results of the lesopark reflect larger territory with restrictions and regulations needs, but smaller area for visitors' attendance limits than in the Torup forest (*Figure 19*).

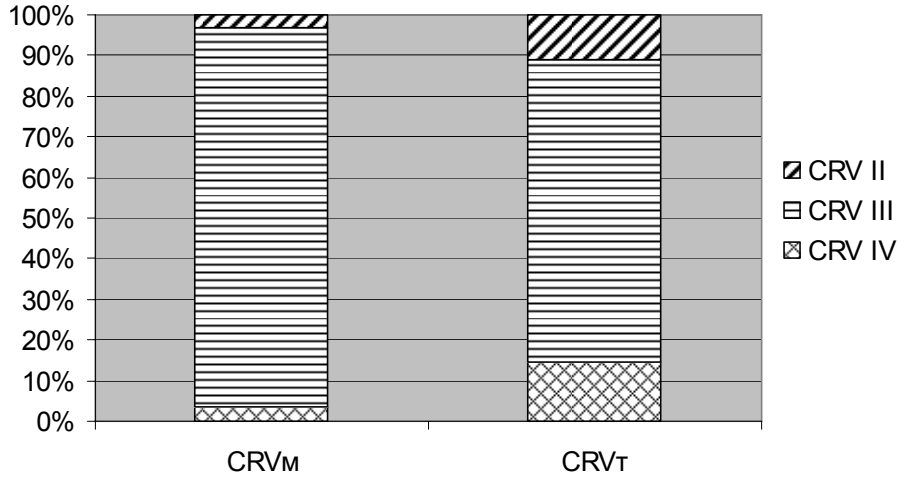

Figure 19. Distribution of the Mytishchinsky lesopark and the Torup forest by stands area with different "class of recreational value" (CRV), red- low quality (CRV IV) and green – high quality (CRV II).

Therefore, the general conclusion of the integrated evaluation of the recreation potential (CRV) is that neither the Mytishchinsky lesopark nor the Torup forest have the stands with the highest recreational potential (CRV I) in the meaning that we consider. In this respect, the mean values of CRV in both study areas are in the class CRV III. That is why the most parts of investigated areas have to be managed with carrying out the regulations for sustainable development and the best solutions for nature as well as for people. Moreover, on the level of whole case areas analysis they are almost equal to each other. The calculation of mean of all minimal coefficients' values/limitative values of each case area shows via proportion the precise value of CRV (*Table 2*). However, only more detailed analysis could display the parities and distinctions of the areas together with highlighting of individual properties that will be discussed further.

4. DISCUSSION

4.1. The “attraction” category

According to the results, both case areas have low attractive stands caused by great changes due to anthropogenic influence in some meanings. It can be seen from the map that such unattractive stands in the Mytishchinsky lesopark (see “low” attraction on *Figure 11*) are located mainly near by housing estates and other urban infrastructure. There are some features of the “attraction” category, which display the negative aspects of these artificial stands.

As far as these stands more frequently affected by different visitor's activities compared to others, the trampling effect and damages are more widespread here. It has been shown by Florgård (2000) that the closeness of environment to houses or entrances causes a big importance in terms of trampling effect on ground cover vegetation. This dependence is clear observed during the expectation of the Mytishchinsky lesopark there the negative impact of human closeness becomes evident in the level of rubbishness. For example, the rubishness of the northern stands of the Mytishchinsky lesopark (*Figure 11*) is one of the highest around the study area. Moreover gap in cultural education in issue of nature treatment is one of the basic negative aspects of recreation management in Russia that also affects the results.

Another nature of these stands is poor sanitary condition, which can be described as well as a consequence of visitors' pressure while the necessary stand treatments are not carried out at the same time. There is different kind of deadwood that quite frequently occurs in such artificial stands with row planting scheme. Not only by these methods, but also by other studies (Tjulpanov 1977, Lukjanov 1988, Hörnsten 2000, Tyrväinen et al. 2003) the lowest preferences of recreationists towards stands with deadwood have been shown. In this sense, adequate management - an anthropogenic influencing factor itself, could become an action which might reduce the impact of other negative anthropogenic factors. The deadwood is a common element of natural forest. But, according to the people preferences, the aesthetic value of stands could increase (Tyrväinen et al. 2003) even if a certain “nature” of the environment could be lost. Nevertheless, the issue of deadwood occurrence on recreational sites still is under investigation as not simple one. Thus, Hultberg (2007) shows that many visitors of the Torup forest have rather positive or natural perception of deadwood than negative. According to his study information about deadwood in forests has crucial importance.

The negative impact of anthropogenic influence in case of the Torup estate concerns more the forest management implementation than the visitors' pressure. In this respect, there is a huge area (over 80%) have to be cut down according to the management plan of the Torup forest. Hence, old-growth stands of beech (150-160 years old) transform from high crown closure mature stands into the almost open area with shelterwoods and very dense undergrowth. The selected method of investigation describe such beech stands as quiet attractive owing to taking into account variety of patchiness with remaining old trees. But it is not case then young growth of beech dominated by the area. The huge heavy thinned beech stands (up to 13 ha in size) make the impression of monotony of the case area that reduces scenic variety (Falck & Rydberg 1990 in Axelsson-Lindgren 1995). And opposite, increasing amount of forest types could diversify the scenic values (Kellomäki 1975) and increase the desire to practice different activities

(Axelsson-Lindgren 1995). Since beech forest is a high preferred species among Swedes (Hultman 1983 in Axelsson-Lindgren 1995) and old stands are very attractive (will be discussed further), the widely spread heavy treatments on beech in this popular recreational area seems to be very unlikely. On the other hand, the rotation period for the most area has been exceeded anyway, that gives some diversity and variety to the area. Besides that, shelterwood system among the Swedish practices seems to be one of the most "recreational friendly" compared to others (Bostedt & Mattsson 2005) and could be perhaps the best silvicultural choice there. However, one approach carried out by shelterwood system management on the huge stands about 10-13 ha each like in Torup could not be appreciated by the Russian system of recreational management (Tjulpanov 1977, Rodichkin 1977, Lukjanov 1988).

Figure 20. Fallow deer *(Dama dama)* in beech forest of the Torup estate. Photo: Evgeny Lepeshkin

How such treatment is reasonable for the mature beech stands is one of the difficult issue which produces the controversy between not only economical (wood production) and social (recreation) aspects that described above, but also between social and environmental (biodiversity) ones. For instance, young dense regeneration of beech is one of the elements of whole Torup estate, which keep up the population of mammals like Fallow deer (*Dama dama*) as a natural refuge for them (*Figure 20*). On the other hand, the limited visibility and accessibility of such dense undergrowth are considered as very dislike options for recreational areas (Tyrväinen et al. 2003). However, more detailed discussion of these questions does not fall within the scope of this study. The discussion about multifunctional utilization of recreational forests highlighted by Hytönen (1995) and Rydberg & Falck (1998) has to be continued.

At the same time the spruce stands are planned to be cut down by clear-felling. During the previous treatments in the southern part of the surveyed area of Torup (*Figure 12*) big amount of spruce stands was cut down, and nowadays there are mainly open unattractive landscapes comprised by dense brushwood, tall grass and still quite unsuccessful young generation. Regarding this issue T. Pukkala et al. (1994) in the study "Integrating scenic and recreational amenities into numerical forest planning" had found that "clear-felling of carefully selected stands is often a good treatment from the point of view of amenity, because it is a way of

increasing variety". It could be more respected in case of the Mytishchinsky lesopark, there the study area formed by the crown closure stands up to 71% and the area of the surrounding forest is essentially higher. But in case of the Torup forest surrounded by field landscapes, the proportion of crown closure stands up to 52% seems to be relatively low (Tjulpanov 1977, Prjakhin & Nikolaenko 1981). In this situation the clear cuts are one of the negative elements in the forest, what could be referred to other authors also (Kellomäki 1975, Axelsson-Lindgren 1995, Lindhagen 1996a.).

Due to these literature analysis and facts from both case areas we could see different point of view on recreation via interactions between society and forest in two countries. The recreation in Swedish forestry is almost always shown as only one aspect of management undivided from whole spectrum of forest utilization. It's an element carried out quite frequently as a part of multifunctional forest management in many kind of forests. But at the same time clear cuts and heavy thinnings for wood production are just normal facts even in the Torup forest surrounded by field landscapes. So, forests which seem to be the main recreation site for big city could combine multiple aims in Sweden anyway.

But forest-society interaction in the Russian case mainly has a spatial division of the multifunctionality. That causes other point of view on recreation aspect. Since forest is the closest to people or settlement then any operation for wood production processing will be found out as something unusual and even shocking. It could occur in every short-distance forest where alternatives like recreation utilization etc. are even not the purpose or under serious discussion. And vice versa, on a distance from cities and settlements the perception of forests is firstly associated with "accumulation of wood" and other goods. That is why, the landscape value of many forests became minor there.

As a consequence, the reached trends of more investigated and preferred subjects like people preferences (in Sweden) and forest sustainability (in Russia) in many cases are reflected only on scientific papers, but in reality mostly tradition and other factors act.

Regarding to the positive results in attraction, it should be stated that "high" evaluated stands by this category reflect similar features on the both surveyed areas. Since more naturalness and maturity could be registered in shape of stands, the attraction of such stands in the both surveyed areas belong to higher classes (*Figures 11, 12*). For instance, old-growth artificial stands of Norway spruce 110 years old in the Mytishchinsky lesopark obtained a nature of South Taiga due to his maturity first. Also, big beauty and healthy trunks, vital dark green story and the structure of undergrowth layers make it very attractive (*Figure 21*). The same tendency can be seen concerning the Torup forest, where 150-170 years old stands of oak or beech form the most "nature" environments (*Figure 22*). These naturalness of old-growth forest bases on features like maturity of forest that determines its height, vertical and horizontal structure, capacity of environments etc.

Figure 21. Old spruce stand (*Picea abies* L) in the Mytishchinsky lesopark.
Photo: Sergey Rysin

The state that "the older forest stands, the more appreciated they are" was respected by different authors (Kellomäki 1975, Tjulpanov 1977, Lukjanov 1988, Repshas 1994, Lindhagen 1996a, Hörnsten 2000, Donis 2003). According to the review of Axelsson-Lindgren (1995), namely "forest aesthetic", the big attention of Scandinavian researches especially of Finnish and Swedish ones was paid to this issue.

Figure 22 Old beech stand in the Torup forest
Photo: Evgeny Lepeshkin

Those facts discussed confirm that such aspects of recreation as scenic values are basically appreciated from the one level of human understanding of beauty of forest environments. The stands with typical attributes of natural forest ecosystems like mature trees, gaps inside the stand, different spatial structure etc. could be preferred well by recreants.

4.2. The “comfort” category

The results that estimate the comfort conditions of the areas are less various compared to the results of attraction or stability, but higher in general. These facts could be described by the analyzing of some indices.

For instance, the “attainability” and the “distance to recreational reservoir” indices have quite big variety of spatial scale what couldn't be reflected since the surveyed area is rather small. This fact could be related to quite predictable equal result as far as mainly recreational forests are not so big.

At the same time the objectivity of the results of the “attainability” index (the distance between housing estates or close bus stop and the forest) in case of Sweden area could be put under question. It is obvious that personal cars in Sweden are much more distributed and preferable as a main transport to recreational forest (Hörnsten & Fredman 2000) compared to public transport. Since the importance of public transport in Russia is decreasing, the cities are growing rapidly together with amount of personal cars. Hence, the formulation of the index could be changed for more adequate description of recreational areas in terms of attainability.

Another interesting fact about results which is worth mentioning is a validity of relief scale in terms of comfort of the Torup forest. It's better to start first that Rysin's method (Appendix 1) based on the idea that the more flat the area is, the more comfortable it is for visitors. That is why the flat area of the Mytishchinsky lesopark, thanks to its non-varied conditions, has been estimated as very comfortable area in terms of relief (*Figure 6*). In such a way the Torup area with altitude variety between 20 and 70 meter above see level has been estimated lower in this respect. Actually, there is no confirmation or contradiction of mentioned dependence of relief preferences has been found during the literature analysis. By the way, the fact has been noticed that some paths in Torup could be often seen crossing the rugged terrains and the different kind of visitors was choosing those paths anyway. Additionally, the study about traditional outdoor life in Sweden (Sandell 1993) shows that the promotion of physical and spiritual health is one of the first importances of Swedish society during decades. This also regards to Russian scientists’ (Drobyshev & Korotkov 2005) impression of Swedish urban forestry.

Mentioned facts lead us to the thought that the traditional utilization of recreational sites as well as modern behaviour and life-styles could act quiet serious in recreation.

The consequence about the particular relief comfortable for different groups of recreationists has to be discussed widely on the level of traditions, as well as age, sex and preferred activities for the proper area management (Font 2000). Corresponding to the structure of the method any modification is quite easy. Only validity of new modified indices has to be discussed.

As a disadvantage, individual perception during the expert evaluation could take place in such indices like “noise pollution”, “air pollution” and affect results. The periodical data changes in some indices like “blood-sucking and disturbing insects’ presence” or “soil moisture” have to be taken into account as objectively weak but representative aspects of the method anyway.

4.3. The “stability” category

The lowest qualitative values of the both areas have been shown during the stability investigation. There are only few stands that were evaluated as a quite stable, but others seem to be sensitive towards the recreational activity. The lowest results in the “stability” category in the range of all results obtained say about low potential level of the areas to meet the recreational demands without associated negative effects like damages of environments. This issue is not well-discussed in Swedish literature, but takes a first place in Russian studies concerning recreational aspects (see INTRODUCTION chapter).

According to the Rysin's method (2003) it is possible to get the maximal score for stand by the “sod depth” index in the case that the sod layer is thicker than 5 cm (Appendix 1). The depth of humus layer should be even thicker (more then 10 cm) for “the highest” scores. Such depth of humus and especially of sod can not be so frequently found in any forest. In addition, the deep sod layer is not typical at all for the forest ecosystems, but more constitutes the meadow communities. This implies a contradiction between some indices within the “stability” category: as far as sod depth on ground surface became thicker (score became higher) then possibilities for natural regeneration decrease there (scores became lower). On the other words since the forest ecosystems start to transform to more open structures with meadow element then the area become more tolerant (stable) as well as its recreation potential increase in some indices. Thus, the forest communities of the Mytishchinsky lesopark and the Torup estate are rather sensitive or not stable at least in terms of ground stability. Besides that, the goal to obtain the high or even medium scores in the “humus depth” and “debris layer depth” indices seems to be inaccessible for bigger share of the Mytishchinsky lesopark because of agriculture activity on this area during the decades before. From my point of view, any modifications of this part of the method could be executed only after detailed study of this subject.

The “stability (tolerance) of ground vegetation” index should be appreciated as complicated factor of the “stability” category, owing to heavy processing of data and detected “gaps” in implementations in some particular cases. The weaknesses of the method implementation arise at the time while the stands with shelterwoods and dense undergrowth have been under the evaluation. Since the beech undergrowth limits accessibility very well, the bare ground common for this sites could be left inaccessible by recreational activity for a long time. At the same time the method considered to assume that in every case the most sensitive ground vegetation defines by fully absence of it (Appendix 1) like an absence of any obstructive element. That caused formal low tolerance of ground vegetation under the dense beech undergrowth that in reality is not affected at all.

But there is not only one weak point of the method have been recorded here. The implementation of the “stability (tolerance) of ground vegetation” index results in contradiction with the “damage level” index of the “attraction” category. Stands which accumulated more meadow-like vegetation becomes more tolerant (the high scores by the method) towards recreational activity and vice versa (Repshas 1994, Rysin & Rysin 2003, Rysin 2006). These

authors state that the typical forest vegetation is almost always under the risk to be destroyed or transformed into another more tolerant community. Therefore, such tolerant ground vegetation modified due to visitor pressure mainly got low scores according to the "damage level" evaluation. Such contradiction of the method could be avoided by temporary exclusion from the evaluation one of the both indices or by rewriting of the indices explanation.

The stability indices described above seems to be low valuable and less variable ones compared to many indices of the attraction and comfort categories. These tendencies toward low results in the "stability" category are independent from the aspects like density of population. That was clearly displayed by the results from both case areas which are very different in the population aspect. The results of the whole "stability" category and the "damage level caused by recreational activity" index are very similar even between so different in population density areas. It confirms the state that each forest is quite sensitive environmental community which is always under the risk of damage in different conditions of population density (Drobyshev 2000, Rysin & Rysin 2003, Rysin 2006). That is why the potential of such a risk (or its absence) without any references to population and recreational pressure could be found anyway during almost every estimation of stability on natural forest ecosystems.

The values of some indices described above, however, are dynamic and could be shifted by the silvicultural methods or by itself from the low to the higher level, what is almost impossible in case of geomorphologic and hydrologic characteristics ("slope of ground surface" and "water regime" indices).

5. CONCLUSION

Due to the analyzing of the results obtained and literature study we could say that the selected and tested method could be considered as quite objective and reliable one at least for the both countries. Mainly because of literature statements of Russian and European (mainly Scandinavian) studies quite well reflected and confirmed by the method. At the same time the comparison estimation between countries performed by the method has some advantages. It allows via precise analysis to reflect specific aspects like traditional peculiarities, to find out controversies and due to the other studies' results to adapt the method with respect to tradition and specific of country or forest type.

The best confirmation of the general ideas of recreational literature and studies has shown by attraction and scenic value evaluation. Also the different features of stands in sense of their affection by nearby urban life have been highlighted as adequate ones to corresponding studies.
The similarities obtained on the both areas confirm the idea that the more attributes of maturity and naturalness stand has, the more attractive and preferred it is. At the same time, the lowest preferences of recreationists towards the stands with deadwood were found in different studies between countries (Tjulpanov 1977, Lukjanov 1988, Hörnsten 2000, Tyrväinen et al. 2003). But at the same time the survey done in Torup (Hultberg 2007) contradicts to these early studies.

Nevertheless, the differences have been recorded also that in wide meaning concerns the tradition of management system implementation. In this respects, the questions about the size of

one stand within the recreational area to be free from monotony and about the validity of clear-cuts and heavy thinnings on such sites are one of the crucial ones.

By the way, the noticed differences only confirm the hypothesis what differences could occurred in terms of tradition. The confirmation of it was found out due to the literature searching (Bostedt & Mattsson 2005, Tjulpanov 1977, Rodichkin 1977, Lukjanov 1988) as well as by personal interview of forest manager of the Torup forest (Lang 2006). That is why, it is rather the issue of forest management implementation with tradition to use clear-cuts and heavy thinnings than the visitors' pressure that causes the low attraction in case of Torup. However, the discussion of these questions has to be continued.

Owing to the method implementation for recreational potential evaluation, the fact have been recorded that the aspects of tradition act also in evaluation of comfort of recreational area. For instance, the difference in tradition of using the recreational areas for different outdoor activities in Sweden could accumulate the non-objective highlighting of the importance of rugged terrain for the big share of recreationists. So the “relief” and the “attainability” index of the method have to be adapted for Swedish case.

The hypothesis about the crucial importance of the stability evaluation of forest ecosystem for the recreational potential evaluation was confirmed as well.

The lowest values of the stability in most cases determine as a limitative factor the recreational potential of those stands. Moreover, the analysis of the results shows that each natural (un-artificial) forest ecosystem is quite sensitive towards recreation activities and always under the risk of damage.

6. RECOMMENDATION

6.1. For the method

Nevertheless, there are some places in each category of the method which have to be analyzed more carefully. The needs for further modifications, changing the meaning of indices or exclusion some of them exist, as described above.

No doubt, that implementation of the method around a wide scale of types of recreational forest, countries with their traditions will reflect more and more weaknesses for implementation. Thus, the monitoring (repeated measurements) of the recreational potential of one selected recreation area could be the best variant for implementation and further analysis of recreational potential. Otherwise, the needs of analysis for method adaptation in each particular case could exist.

6.2. For the areas

According to the aforementioned facts and statements, the most appropriate management for the both areas could be such one where qualities related to mature forest could be displayed or restored. But at the same time possible negative perception of deadwood and other unlikely

obstructive elements could be avoided by keeping it out of paths or by it removal. In this sense the Torup forest could become more pleasant in his southern part where the relief variety and presence of picturesque bogs could become more attractive scenery in case the appropriate management like proper paths and system of woody floor-like tracks will be managed. Besides that, the management planning of huge clear-cut and heavy thinned stands has to be performed with more respects to recreation purposes. The creation and keeping the maturity and variety of stands should become one of the prime tasks.

The weaknesses of the Mytishchinsky lesopark as the recreational area are also related to the management of the area. First of all, the delay of precise silvicultural treatment has to disappear. The importance of mature stands and its qualities for recreation have to be considered in management. The restorative and regulative natures of treatments for some areas close to the housing estates as well as rubbish removal are on the crucial importance.

Moreover, it should be clarified here that obtained results for the both areas show the advantages and disadvantages of the areas. No doubt, it highlights possibilities for decisionmakers to get the recreational potential higher. But the strategy or system of treatments for achievement the proper conditions on the areas are the issues which have to be discussed more precise.

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Appendix 1

SCALE OF RECREATION POTENTIAL EVALUATION

Index	Meaning of index	Score
1	2	3
ATTRACTION		
Age of forest (age class) Evaluation concerns stands of the highest volume capacity (I class - 20 years for coniferous and noble broadleaved or 10 years for softwood species)	I (-20 years for coniferous and noble broadleaved; -10 years for softwood species)	0
	II (21-40 years for coniferous and noble broadleaved; 11-20 years for softwood species)	1
	III (41-60 years for coniferous and noble broadleaved; 21-30 years for softwood species)	2
	IV (61-80 years for coniferous and noble broadleaved; 31-40 years for softwood species?)	3
	V and higher (81+ years for coniferous and noble broadleaved; 41+ years for softwood species?)	4
Species composition	Pure stands with dense brushwood presence up to 5 species	0
	Stands mixed by 2 tree species with brushwood presence up to 5 species; pure stands with very sparse brushwood or without it	1
	Stands mixed by 2 tree species with brushwood of more than 5 species	2
	Stands mixed by 3-5 tree species with brushwood presence of up to 10 species	3
	Multi-species mixed stands (more than 5 species); brushwood includes more than 10 species	4
Types of tree species mixture in artificial stands (natural stands get the highest score)	Pure artificial stands	0
	Mixture by rows	1
	Belt of trees (mixture by several rows)	2
	By single planting cells or links, chess-like positioning	3
	Biogroups or unsystematic distribution; natural stands	4
Height of stand (average). By eye evaluation	Lower than 5 m	0
	From 6 up to 10 m	1
	From 11 up to 15 m	2
	From 16 up to 25 m	3
	Higher than 25 m	4
Story composition (vertical structure)	One story stands of I–II age class; layer of undergrowth and brushwood is not presented or insignificantly presented	0
	One story stands of higher age classes without layer of undergrowth and brushwood; one story stands of I–II age class with significantly presented layer of undergrowth and brushwood	1
	One story stands of higher age classes with significantly presented layer of undergrowth and brushwood; two story stands of I–II age class	2
	Two story stands of higher age classes; multi-story stands of I–II age class	3
	Multi-story stands of higher age classes	4

1	2	3
Patchiness (horizontal structure	Young overstocked stands or understocked stands in stage of degradation	0
	Young stands with medium level of crown closure and regular stocks disposition	1
	Every stand with crown closure from 0,6 to 1,0 and group stocks disposition; middle-aged and mature dense stands with regular stocks disposition	2
	Middle-aged and mature stands with crown closure from 0,3 to 0,5 and regular stocks disposition; artificial stands with width of rows more than 5 m	3
	Mature stands with crown closure from 0,3 to 0,5 and group stocks disposition; stable understocked artificial stands with regular stocks disposition	4
Decorative effect (contrast)	Could be find out by presence (or absence) of single decorative elements like individual trees or groups, bushes, species of ground layer (herbals etc.), most decorative landscape elements	0…4
Damage level caused by recreation activity (scale of degradation of forest ecosystem)	V–IV classes of degradation: more than 10% of trample area; no undergrowth and brushwood remaining; less than 25% of the ground vegetation comprised by typical forest vegetation; the process of degradation is irreversible	0
	III class of degradation: up to 10% of trample area; 70-80% of undergrowth and brushwood reducing; up to 40% of the ground vegetation comprised by non-forest (grass light-requiring) vegetation	1
	II class of degradation: visible trample effect (appearance of paths); 20-30% of undergrowth and brushwood reducing; appearance of non-forest (grass light-requiring) vegetation	2
	I class of degradation: visible traces of any kind of damages or/and changes of elements of ecosystem are not registered	3
	No damages or/and changes	4
Level of rubbishness	High level of rubbish presence on the whole stand area	0
	More than three micro parcels with rubbish in visual field	1
	Not more than three micro parcels with a rubbish in a visual field	2
	Single parcels with a rubbish	3
	An absence of any rubbish on a stand area	4
Sanitary condition	Very high level of insect or disease damages (more than 50%); amount of dead-standing trees more than 10%.	0
	High level of insect or disease damages (not more than 50%); amount of dead-standing trees not more than 10%.	1
	Medium level of insect or disease damages (not more than 25%); amount of dead-standing trees not more than 5%.	2

1	2	3
	Low level of insect or disease damages (not more than 10%)	3
	Insect or disease damages are not registered	4
Visibility (inside the stand)*	Almost absent (less than 5 m)	0
	Low (from 6 up to 10 m)	1
	Medium (from 11 up to 25 m)	2
	High (from 26 up to 50)	3
	Excellent (more than 50 m or the whole stand)	4
Decreasing factors of the "attraction" category*	Neighbouring of urban infrastructure, fences, buildings etc. which are untypical and even ugly for any recreational purposes	0…-4
COMFORT		
Relief	Slopes of ravine, steep banks of pits, reservoirs, hollows etc.	0
	Heavy rugged terrain with slopes more than 10^{o}	1
	Rugged terrain with slopes from 5^{O} up to 10^{o}; bottoms of ravines etc.	2
	Rugged terrain with slopes from 3^{O} up to 5^{o}; flat terrains with bad drainage	3
	Slightly rugged terrains with slopes up to 3^{o}; flat terrains with good drainage	4
Soil moisture	Swampy sites	0
	Wet sites	1
	Damp sites	2
	Normal moisture sites	3
	Dry site	4
Pathway network conditions	Fully absence or low presence of path system; movement of visitors could occur everywhere within the area or impossible at all	0
	Path system exists, but movement of visitors could be found everywhere within the area	1
	Paths exists without coating; movement of visitors could be found mainly on paths, near by them and within the area	2
	Paths exists presented without coating; movement of visitors could be found mainly on paths and near by them, but not inside the area	3
	Paths exists with or without coating; movement of visitors could be found only on paths	4
Attainability: the distance between housing estates or close bus stop and the forest	More than 5 km	0
	From 3 up to 5 km	1
	From 2 up to 3 km	2
	From 1 up to 2 km	3
	Less than 1 km	4

1	2	3
Distance to recreational reservoir	More than 10 km	0
	From 7 up to 10 km	1
	From 4 up to 6 km	2
	From 1 up to 3 km	3
	Less than 1 km	4
Blood-sucking and disturbing insects' presence	Great presence during the whole frost-free season	0
	Great, but periodical presence; medium presence during the whole frost-free season	1
	Medium presence during from time to time	2
	Low and short-term presence	3
	Absence	4
Noise pollution	Permanently high level of noise	0
	Periodical high level of noise	1
	Minor background noise	2
	Periodical low level of noise	3
	Absence	4
Air pollution	Permanently high level of dustiness; strong objectionable odor	0
	Periodical high level of dustiness and/or strong objectionable odor	1
	Visible dustiness and/or objectionable odor	2
	Low level of dustiness and/or slight objectionable odor	3
	Absence of dustiness and objectionable odor	4
Decreasing factors of the "comfort category"*	The uprooted trees, leaved cut brunches and logs, irritating species as an obstruction elements for passing through the area	0…-4
STABILITY		
Age of forest (age class)	I	0
	II	1
	III	2
	IV	3
	V and higher	4
Trampling tolerance of the main tree species	No tolerance	0
	Very low tolerance (spruce, aspen, alder, ash)	1
	Low tolerance (pine, larch)	2
	Medium tolerance (lime, maple)	3
	High tolerance (beech, oak, birch)	4
Viable undergrowth presence	Absent	0
	Single trees	1

1	2	3
	Sparse density	2
	Medium density	3
	High density	4
Brushwood presence	Absent	0
	Single plants	1
	Sparse density	2
	Medium density	3
	High density	4
Stability (tolerance) of ground vegetation	Fully absence of ground vegetation	0
	Low stability	1
	Medium stability	2
	High stability	3
	Almost couldn't be affected	4
Grading of soil	Clay	0
	Clay loam (fine-loamy)	1
	Sand	2
	Loamy sand (coarse-sandy) or loam	3
	Clayey sand (fine-sandy) or sandy loam (coarse-loam)	4
Debris layer depth	Absence	0
	Less than 1 cm	1
	From 1 up to 3 cm	2
	From 4 up to 5 cm	3
	More than 5 cm	4
Sod depth	Absence	0
	Less than 1 cm	1
	From 1 up to 3 cm	2
	From 4 up to 5 cm	3
	More than 5 cm	4
Humus depth	Less than 1 cm	0
	From 1 up to 3 cm	1
	From 4 up to 5 cm	2
	From 7 up to 10 cm	3
	More than 10 cm	4
Water regime	Swampy sites	0
	Wet sites	1
	Damp sites	2
	Normal moisture sites	3

1	2	3
	Dry site	4
Slope	More than 10º	0
	From 8 up to 10º	1
	From 5 up to 7º	2
	From 3 up to 5º	3
	Less than 3 º	4

* New additional indices

Appendix 2

RECREATIONAL POTENTIAL EVALUATION
(checking form)

_____forest unit/leskhoz/lesparkhoz

_____ forest sub-unit/lesnichestvo/lesopark; compartment_____

Category	Index	Score of stand №				
		__	__	__	__	__
ATTRACTION	Age of forest					
	Species composition					
	Types of mixture					
	Height of stand					
	Story composition (vertical structure)					
	Patchiness (horizontal structure)					
	Decorative effect (contrast)					
	Damage level					
	Level of rubbishness					
	Sanitary conditions					
	Visibility (inside the stand)					
	Decreasing factors of the ”attraction” category					
COMFORT	Relief					
	Soil moisture					
	Pathway network conditions					
	Attainability of stand					
	Distance to recreational reservoir					
	Blood-sucking and disturbing insects presence					
	Noise pollution					
	Air pollution					
	Decreasing factors of the ”comfort” category					
STABILITY	Age of forest					
	Trampling tolerance of the main tree species					
	Viable undergrowth presence					
	Brushwood presence					
	Stability (tolerance) of ground vegetation					
	Grading of soil					
	Debris layer depth					
	Sod depth					
	Humus depth					
	Water regime					
	Slope					

Appendix 3.

Most frequently recorded ground vegetation in the observed areas of the Mytishchinsky lesopark and the Torup forest
* weeds and meadow grass

The Mytishchinsky lesopark		The Torup forest	
Position of frequency №	Species	Position of frequency №	Species
1	Oxalis acetosella L.	1	Stellaria holostea L.
2	Convallaria majalis L.	2	Calamagrostis epigeios (L.) Roth.
3*	Impatiens parviflora DC	3	Avenella flexuosa
4	Carex pilosa Scop.	4*	Urtica dioica L.
5	Fragaria vesca L.	5	Mercurialis perennis L.
6	Athyrium filix-femina (L.) Roth	6	Pteridium aquilinum (L.) Kuhn ex Decken
7*	Geum urbanum L.	7*	Athyrium filix-femina (L.) Roth
8	Circaea alpina	8	Melica uniflora
9	Prunella vulgaris L.	9*	Agrostis tenuis Sibth.
10	Dryopteris carthusiana (Vill.) H.P.Fuchs	10	Dryopteris filix-mas (L.) Schott.
11	Dryopteris filix-mas (L.) Schott.	11	Oxalis acetosella L.
12	Ajuga reptans L.	12	Carex vulpina
13*	Poa pratensis L.	13	Dryopteris carthusiana (Vill.) H.P.Fuchs
14	Rubus saxatilis L.	14	Galeobdolon luteum Huds.
15	Pteridium aquilinum (L.) Kuhn ex Decken	15	Milium effusum L.