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Title: **Latent preferences of residents regarding an urban forest recreation setting in Ljubljana, Slovenia**

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Highlights

- A four-class latent class model describes population preferences for forest recreation setting.
- Class membership is affected by socio-demographic characteristics and recreation habits.
- Frequent forest visitors are more in favour of changes of the recreation setting.
- Preferences recognition enables a better-tailored management of forest recreation setting.

Abstract

The goal of this study is to assess residents' preferences for a set of attributes describing the recreation setting in an urban forest (outstanding trees, forest openings, waymarks and information boards, and paved walking trails) and to explore the heterogeneity of those preferences. It was captured by a four-class latent class model used to segment a sample of residents of Ljubljana (the capital of Slovenia), who responded to a choice experiment-based poll. The survey focused on the Rožnik urban forest, for which preferences (also willingness-to-pay) for hypothetical changes in the attributes were assessed. Respondents in class 1 were invariant to changes in the recreation setting. Those in class 2 and 4 stated positive preferences for having more outstanding trees. Class 3 and 4 were in favour of increasing the area of forest openings and enhancing the maintenance of waymarks and information boards. Those in class 4 expressed positive preferences for more walking trails, whereas class 3 valued this negatively. Class membership was affected by respondent age, number of adults in the household, frequency of forest visits, income, and purpose of the visit.

Keywords

Urban forests, Preferences, Recreation setting, Choice experiment, Willingness-to-pay

1. Introduction

Urban forests, a key component of green infrastructure, are recognized as an increasingly important amenity in urban areas because they provide a suite of social, environmental, and economic benefits (European Commission, 2013, European Parliament and European Commission, 2013). One of their benefits involve the provision of recreational opportunities, which enable urban residents to exercise, recover from daily stress, and enjoy the aesthetics of the urban forest (Konijnendijk et al., 2005). Walking is the most common recreational activity in urban forests, although cycling, jogging, berry-picking, mushrooming, and picnicking are also popular (Tyrväinen et al., 2005). Recreational habits also differ by ethnicity (Gentin, 2011), recreational expectations (Eriksson and Nordlund, 2013, Tyrväinen, 2001), social status (Germann-Chiari and Seeland, 2004), and other socio-demographic characteristics (Jim and Shan, 2013). All of these factors highlight diverse interest groups (viz. stakeholders), which typically exhibit different expectations regarding recreational benefits. Naturally, such a diversity of expectations calls for approaches to urban forest management grounded on a sufficiently wide range of information regarding the needs and preferences of different groups. To avoid conflicts often generated by incomplete information on different forest recreational uses, decision makers must consider residents' recreation-related expectations. This certainly holds true for urban forests in Ljubljana, the capital of Slovenia, which serves as an example of a rapidly growing (both in population and economic terms), highly industrialized urban area (SORS, 2014).

A recreation setting may be defined as a combination of the features of urban forests (viz. attributes) which affect recreational benefits or indicate their qualities for providing recreational opportunities (Clark and Stankey, 1979). These attributes can be investigated in different ways. One approach is via an economic valuation, whereby monetary values are assigned to changes in the quantity/quality of the individual attributes, which are then related to recreational preferences. Information on preferences also enables decision makers to set priorities, essential in urban forest management planning, and to highlight those attributes that affect recreational benefits. Departing from the premise that only decisions that satisfy citizens' needs and preferences will meet their expectations, economic estimates of urban forest benefits can be used in forest management planning (Tyrväinen et al., 2005). Additionally, monetary valuation of attributes that describe the recreation setting enables better informed decision making and fund allocation as monetary values can be used in benefit-cost based appraisal of public investment policies.

A choice experiment (hereafter CE) is a stated preference method for estimating the economic value of environmental goods and services, forest recreation among them. It elicits respondents' preferences by asking them to choose their preferred option among an array of alternative scenarios, which in fact represents a change in a valued good or service (Bateman et al., 2002, Louviere et al., 2000). CE has some advantages over other environmental valuation methods. It can be used to assess attributes that relate to either use or non-use value, whereas travel cost method and hedonic pricing cannot. Furthermore, both CE and contingent valuation can overcome such issues, however CE is tailored to assign values to multiple attributes of the good or service simultaneously, which is something the contingent valuation method is unable to do.

The CE method has been utilized often for economic assessments of forest recreation (e.g. Adamowicz et al., 1998, Boxall and Macnab, 2000, Bujosa and Riera, 2009, Campbell et al., 2014, Hanley et al., 1998, Nielsen et al., 2007, Watson et al., 2004). Despite its utility, the method has been applied to recreation in urban forests in only a few studies. Still, these, as well as other forest recreation studies, provide some useful insights on the effects of demographics, use patterns, and urban forest characteristics on user preferences. Research on the relationship of user demographics to preferences are somewhat mixed. Age, for example, has varied effects. Koo et al. (2013) reported no relation between age and user preferences in a study of Korean urban forests. Conversely, Hanley et al. (1998) showed that age affected user preferences for various public woodland attributes. Moreover, they also reported that having children affected user preferences, which is somewhat related to the findings of Bujosa and Riera (2010) who showed that individuals with children in their households visit forests for recreational purposes more often than those without children. On the contrary, Koo et al. (2013) reported that visiting forest for relaxation and having children is negatively correlated for one segment of users. Income also provides mixed results. Although some studies reveal that household income affect recreation-related preferences (e.g. Nielsen et al. (2007)), some claim otherwise (Koo et al., 2013, Tyrväinen and Väänänen, 1998).

Use patterns have also been shown to affect use preferences. Many studies have highlighted the effects of crowding on the quality of outdoor recreation (Manning, 2007, Sayan et al., 2013, Vaske et al., 1996), however only a few have addressed this issue in urban forests. Among them Arnberger et al. (2010) used an image-based CE to demonstrate that the number of people encountered by a visitor on the forest trail can be perceived as positive when there are fewer encounters, but changes to negative when six or more people are within the field of view. They compared data for two geographically distinct samples (Vienna, Austria and Sapporo, Japan) and reported significant differences in perceptions of congestion (i.e. number of people) among various users (e.g. walkers, cyclists, joggers). However, the authors did not find any relation with the socio-demographics, activities and past experiences. Similarly, Nordh et al. (2011) assessed the impact of congestion and some biophysical aspects on recreational attractiveness of a small urban park. They discovered that respondents assign most importance on coverage of grass, followed by abundance of trees, frequency of other people, size of water features, presence of flowerbeds and abundance of bushes. The analysis also revealed the relation between respondent preferences for listed features and their age, gender, and past experiences.

Finally, forest characteristics or improvements can affect preferences. Koo et al. (2013) explored preferences regarding six urban forest attributes, namely trail length, biodiversity, accessibility, environmental education programmes, entrance fee and terrain slope, among Korean urban residents. Biodiversity, which was defined as species variety and richness in the forest (use value), was the most significant for choosing an urban forest. Other studies have demonstrated that characteristics of trees in a forest can affect recreation values in a variety of aspects. Edwards et al. (2010), for example, referring to the Delphi study that dealt with the attributes affecting recreation in the European context, reported that size of trees in forest stands is an important attribute affecting recreational attractiveness. Similarly, reviewing the findings from Finland, Norway and Sweden, Gundersen and Frivold (2008) asserted that people generally prefer forest stands with larger trees and that they also rank higher forest stands with varying tree heights. Koo et al. (2013) reported an increase in utility for one group of visitors if they have at their disposal either signs near walking trails or signs and opportunities for guided programmes. The importance of recreation infrastructure was also explored by Roovers et al. (2002), who concluded that among different user groups, walkers feel most strongly that information boards are necessary. Schipperijn et al. (2013) also explored the importance of signposting and information in urban green areas and found that it ranks relatively low among 17 different attributes. Christie et al. (2007) reported a significant preference heterogeneity among different forest user groups (walkers, horse riders, cyclists and nature watchers) and within groups for the available levels of information on forest, trails, and wildlife. More specialized forest users, such as downhill cyclists and endurance horse riders, prefer more detailed information. No previous study of urban forests has focused on preference for forest openings, although some studies have addressed either forest openings in forests in general (Hanley and Ruffell, 1993) or harvest clearings. Regarding the latter, they mainly evaluate the effect of forestry activities on recreation value (Edwards et al., 2010, Gundersen and Frivold, 2008, Holmes and Boyle, 2003).

In this study we examined the preferences of Ljubljana residents regarding the attributes of the city's urban forest that could affect recreation. The study covered forest environment attributes, recreational infrastructure, and an additional cost attribute, enabling an economic valuation of the hypothetical changes in the recreational setting. In this sense, the study explored a wider range of thematic and management-related attributes than its predecessors, focusing specifically on urban forests and utilizing CE assessments such as Arnberger et al. (2010). It dealt with only one group of attributes. Although Koo et al. (2013) covered both forest and infrastructure-related attributes, the levels used for some attributes such as walking trails (in minutes of walking time) and biodiversity (poor, average and rich) make it difficult to assess management applicability. Thus, the working approach of this study attempts to complement this previous work. Additionally, we assessed if heterogeneity in preferences exist and whether it can be explained through group segmentation, which can be relevant for policy making in cases in which urban forest managers need to be aware of different subpopulations, and their respective size and preferences. Furthermore, we evaluated which socio-demographic characteristics and recreation habits affect preferences. Finally, we explored the advantages and disadvantages of the approach and discuss the role of the results in urban forest management.

2. Material and methods

2.1. Choice experiment

The CE technique is grounded in Lancaster's consumer theory (Lancaster, 1966), which states that the utility of a good is the sum of the utilities of its attributes. CE is also linked to the random utility model (RUM), which is derived from Luce (1959) and McFadden (1973), and presents the theoretical background for CE. It provides a basis for empirically modelling respondent choices, revealing trade-offs among the attributes of the good (Bateman et al., 2002, Hanley et al., 2001). Accordingly, goods being assessed by CE are described as bundles of attributes. By varying the levels of those attributes, different bundles (alternatives) can be derived. Since CE is a survey-based approach, each respondent in a survey is presented with a set of different alternatives organized in so-called choice sets. In each choice set, one alternative presents the current state (business-as-usual; BAU) of the good and others indicate hypothetical scenarios in which the attribute levels are changed with respect to the current situation.

Typically, each alternative has an additional cost attribute, indicating the amount of money that would need to be allocated for implementing the hypothetical scenarios. Obviously the BAU alternative is assigned a zero cost, as no additional funds are needed to preserve the current state. In the survey, each respondent is asked to select one preferred alternative from each choice set and, by doing so, the respondent implicitly makes a trade-off between levels of attributes among alternatives (Hensher et al., 2005). It should be noted that the aim of having a cost attribute within the survey is to assess the marginal values for the changes in the levels of attributes.

According to RUM, the utility (U) derived from a good is modelled as a function (i.e. indirect utility function) of two sets of components: 1) a deterministic component (V), which depends on observable attributes of the good, and 2) a random component (ε) representing the error term, which comprises of all non-observable features that affect the choices of the respondents, but are not observable by the researcher:

$$U_{ij} = V_{ij} + \varepsilon_{ij} = \beta_i x_{ij} + \varepsilon_{ij} \quad (1)$$

β is a vector of parameters, x is a vector of attributes, and ε is assumed to be of a type 1 extreme distribution (Boxall and Adamowicz, 2002). Subscript i denotes an individual respondent and j stands for an alternative being observed. Under this assumption the probability of an individual choosing an alternative can be modelled by a conditional logit model (McFadden, 1973), which assumes that the preferences are homogenous among individuals. However, since uniformity of preferences is an assumption, we aimed to challenge it by testing an alternative assumption of segmented preferences, employing a latent-class model (hereafter LCM). It is an alternative to the random parameter logit model (hereafter RPL), which assumes continuous distribution of preferences across the population (Hensher et al., 2005, McFadden and Train, 2000) and thus may not be optimal if the population tends to be segmented in a limited number of groups of within-group homogenous preferences (Bujosa et al., 2010). Furthermore, RPL requires a prior definition of the distribution of the random parameters (Hynes et al., 2008) and as Fosgerau (2006) reported, their misspecification can lead to significant bias. LCM can be employed without such prior assumptions, because the heterogeneity of preferences is modelled by a discrete distribution, or set of classes (Boxall and Adamowicz, 2002, Greene and Hensher, 2003), which can provide a more clear representation of heterogeneous preferences than a RPL model (Koo et al., 2013).

The LCM assumes that the sample of respondents consists of a finite set of C classes for which an individual's membership is latent or unobserved by the researcher. Thus, a probabilistic function explaining the assignment of each individual i into each class (c) must be defined. It is based on one's socio-demographic characteristics, perceptions, and attitudes (z_i), and represents one of the two components into which the deterministic portion of the utility function is divided. The membership likelihood function is formulated as a multinomial logit model and provides unconditional class membership probabilities:

$$\pi_{\mathrm{ic}} = \frac{e^{\theta_c' z_i}}{\sum_{m=1}^{C} e^{\theta_m' z_i}} \quad (2)$$

where θ_c' are specific class-related coefficients (Boxall and Adamowicz, 2002).

The second component of the deterministic part of the utility function is related to choices of alternatives. Choice probabilities (following RUM) are probabilities that an individual selects an alternative which yields the highest level of utility from a set of j = 1 , … , I known and mutually exclusive offerings in a given choice situation (Ben-Akiva and Lerman, 1985):

$$\pi_{\mathrm{ij}} = \mathrm{Prob}\{V_{ij} + \varepsilon_{ij} > V_{ik} + \varepsilon_{ik}; j \neq k, \forall k \in I\} \quad (3)$$

These choice probabilities are conditioned on class-membership and if it is feasible to assume that the choices are independent over the situations (if iid assumption holds), conditional choice probability can take the logit form:

$$\pi_{\mathrm{ij}\,|\mathrm{c}} = \frac{e^{\beta_c' x_{ij}}}{\sum_{k=1}^{I} e^{\beta_c' x_{ik}}} \quad (4)$$

where x_{ij} represents the vector of attributes associated with each alternative and β_c' is the vector of estimated coefficients. The conditional probability that individual i chooses alternative j can be written as:

$$\pi_{ij} = \sum_{c=1}^{C} \pi_{ic}\pi_{ij\,|c} \quad (5)$$

Finally, the estimation goal is to find parameter values that best explain the choices, which means to obtain π_{ic} and $\pi_{ij\,|\,c}$ that maximize the log likelihood function:

$$ln\,L = \sum_{n=1}^{N} ln\left[\sum_{c=1}^{C} \pi_{ic}\left(\prod_{j=1}^{I} \left(\pi_{ij\,|c}\right)^{y_{ij}}\right)\right] \quad (6)$$

where y_{ij} equals one when individual i chooses the alternative j and zero otherwise.

By using the Bayes theorem, posteriori conditional class-membership probabilities (i.e. individual i being in a class c as a function of his characteristics and conditional on his responses) can be formulated (Boxall and Adamowicz, 2002):

$$\pi_{ic}^{'*} = \frac{\pi_{ic}\prod_{j=1}^{I}\left(\pi_{ij\,|c}\right)^{y_{ij}}}{\sum_{c=1}^{C}\pi_{ic}\left(\prod_{j=1}^{I}\left(\pi_{ij\,|c}\right)^{y_{ij}}\right)} \quad (7)$$

and by utilizing the previously calculated $\pi_{ij\,|\,c}$ and π_{ic}, a new set of individual-specific (posteriori) estimates of $\pi_{ic}'^{*}$ is obtained. With this new information, the individual-specific posterior estimates of the parameters can be derived:

$$\beta_i' = \sum_{c=1}^{C} \pi_{ic}^{'*}\beta_c' \quad (8)$$

where β_c' are class-specific parameters. The attribute-related β_i's are estimated iteratively by varying the number of classes, c. The model with the optimal number of classes can be defined upon model fit criteria such as BIC (Bayesian Information Criterion) as well as other indications, such as the expected sign of the coefficients and distribution of the respondents among classes (Swait, 2007).

Conditional class-membership probabilities are used not only to compute the estimates of coefficients, but also to define attribute's marginal values, which are exhibited by WTP for changes in the attributes. According to Boxall and Adamowicz (2002); Greene and Hensher (2003) the class-specific estimates of WTP are:

$$WTP_{i|c} = -\frac{1}{\beta'_{payment,c}}\left[ln\left(\sum_{k=1}^{I} exp\left(\beta_c' x_k^0\right)\right) - ln\left(\sum_{k=1}^{I} exp\left(\beta_c' x_k^1\right)\right)\right] \quad (9)$$

where x_k^0 denotes the status quo value of the attribute and x_k^1 refers to its alternative value. β_c is the c-class specific coefficient for the attribute levels, and $\beta_{payment\,,\,c}$ is the payment coefficient for class c.

2.2. Site and study design

The urban forest of the Rožnik area served as our study site. It is located in the western part of Ljubljana (46°3’37.86”N, 14°29’18.44”E). Rožnik is a 335 ha forest complex that is primarily (56%) privately owned. It is home to 6 forest types and to about 30 tree species among which European beech, Norway spruce, Scots pine, and sessile oak are most common. The area is popular among residents and hosts approximately 1.75 million visits per year, mostly walkers, joggers and people wanting to socialize in a natural setting (Smrekar et al., 2011), making it ideal to explore in terms of outdoor recreation. The area has 28 km of paved walking trails and at least twice that in unpaved trails. Access is free.

The valuation questionnaire related to Rožnik was developed in accordance with CE requirements. The recreation setting was described with attributes that were selected upon a separate pre-survey, in which 108 respondents from the general public assessed attributes which they commonly associate with the quality of forest recreation. Individuals assigned ranks to each of 12 forest-related and 5 infrastructure-related attributes according to the magnitude of their effect on recreation. The attributes were presented with images and short text description. The four highest-ranking attributes were selected for the CE (Table 1). In this way we assured higher reliability of responses as those attributes, to which respondents could most easily relate were selected for the main survey. Next, attribute levels were identified in a two-step Delphi process. First, a field inventory was conducted to define the current state of the attributes, which present the result for BAU forest management. Next, two rounds of focus group discussions were organized with forest management professionals, representatives of forest owners, and policy makers to define feasible alternative levels of the selected attributes. Those levels could, in their expert opinion, be achieved with additional management measures.

Table 1. Attributes and their levels used in designing a CE.

Attributes	Definition the attribute's levels	Levels
Paved walking trails	Length of maintained paved walking trails in kilometres	28[a], 42, 56
Forest openings	Percentage of forest openings in overall forest area in a 20 m wide strip on either side of a walking trail	0.5[a], 2.0, 3.5
Waymarks and information boards	Maintenance of information boards and waymarks along walking trails	Neither waymarks nor information boards are maintained[a], waymarks are maintained, information boards are maintained
Outstanding trees	Percentage of outstanding trees among all trees in a 20 m wide strip on either side of a walking trail	6[a], 12, 18
Payment	Annual personal monetary contribution to a special fund in EUR	0[a], 2, 4, 6, 8, 10, 12

[a] levels used in BAU management outcome; alternative levels presumably present improvement of recreation a setting.

Paved walking trails are trails that are hardened with at least a layer of gravel or sand so that they are safe to use even in wet conditions. Forest openings are patches with no trees, overgrown mostly with grasses or brush. They are located within the forest and are caused either by tree-fall or small-scale felling. Waymarks are located beside walking trails and mark different routes so that visitors are aware of the direction to take. Information boards offer visitors information on historical sites and cultural features within the forest or forest-educational trails. Outstanding trees were defined as those noticeable for their size, shape of crown, or appearing old due to cavities in the trunk. In addition, the monetary attribute was designed as the yearly personal contribution from all citizens of at least 18 years of age into a special fund, which would be used by the municipality to invest in improvements in the recreation setting. Its levels were also defined through the Delphi process.

Given the attributes and both BAU and non-BAU levels, a sequential fractional factorial design was employed to obtain 54 alternatives and design choice sets. BAU levels were also considered in the non-BAU alternatives. Alternatives were coupled into 18 choice sets of three alternatives, in which one alternative always presented the BAU scenario and the other two indicated possible alternative outcomes, which consistently assumed positive changes (i.e. improvements) of attributes. An example of a choice set is given in the Appendix A. Choice sets were divided into two blocks to minimize the cognitive burden so each respondent was presented with nine choice sets and asked to sequentially select their preferred option from each choice set. This choice exercise presented the core section of the valuation questionnaire. Prior to that, definitions of the attributes and a set of warm-up questions were given to the respondent to aid them in familiarizing themselves with the concept of attributes and their levels. Respondents were asked for their preferred recreational activities, how often they notice the attributes in a forest, how important those attributes are for their recreational experience, and what their desired levels of those attributes are. After the choice exercise a section with two debriefing questions were included, one to identify biased answers and one to detect protests (see Bateman et al. (2002)). Next, questions on attitudes regarding the city's investment policy in relation to the recreational setting of urban forests were given. The final part contained questions on socio-demographic characteristics.

The questionnaire was administered in July and August 2013 as a computer-assisted survey on 262 respondents of 18 or more years of age residing in Ljubljana. The sample was drawn from a larger panel of a major market research company and was stratified according to gender and age ratios to achieve representativeness for the Ljubljana population. Individuals were selected randomly from those strata for the survey. The survey was conducted in a mixed mode of web-based and face-to-face interviews. A part (72%) of respondents completed the web survey and the rest (28%) who chose not to, were approached by face-to-face interviews.

Referring to the two aforementioned debriefing questions; the first one was posed only to those respondents who had not always chosen the BAU-alternative. The question wording was "What drove you to choose the alternatives you have chosen?" and the responses were treated as biased and removed from further analysis if the respondent selected one of the pre-prepared options listed below:

"I do not agree with the suggested programmes because I feel we should invest in all forests, not just the proposed one."

"I always chose a possibility that seems better for the forest."

"I feel good when I contribute to the community."

"I do not really believe I will have to make the suggested monetary contributions."

"I like to take part in activities where money is being raised."

The first response indicates strategic bias, the second one the amenity specification bias, the third and the last one indicate compliance bias, and the fourth response indicate the context specification bias (according to Bateman et al. (2002)).

The second debriefing question was posed only to those who had always selected the BAU-alternative in the choice exercise. Specific responses to the question “Why did you always choose the alternative, which presents the current state?” which indicated protests, afterwards removed from subsequent analysis, were:

“I object to payments for this programme.”

“Investments should be done on all forests and not only the proposed one.”

“Everyone should pay for this, not just local people.”

“The state or the municipality budget would have to cover the suggested expenses.”

“I would need more information/time to answer the question.”

The revision of responses to both debriefing questions revealed that 58 (22.1%) responses were biased and 24 (9.2%) were identified as protests. Those were removed from the sample, which resulted in a 180 valid responses for the analysis. The structure of the sample was not statistically different from the population average according to gender and age at the 95% confidence-level; however, respondents did report significantly lower income (Table 2), as in some other studies (e.g. Mavsar et al., 2013, Riera and Mogas, 2004).

Table 2. Socioeconomic characteristics of the sample, averages for the population of the municipality of Ljubljana and z-test of the differences between both.

	Sample	**Population average[a]**	**z-score**
Gender (% of women)	57.2	52.7	1.18
Age (mean)	49.5	47.9	1.14
Net personal monthly income in EUR (mean)	987.2	1108.2	3.29

[a] (SORS, 2014) for people of 18 or more years of age.

Choice exercise data were analysed with Nlogit (2012) software. Variables used in the estimation of the indirect utility function (Table 1), such as outstanding trees, forest openings, paved walking trails and payment were assumed to have linear effects and were design coded, whereas waymarks and information boards were treated as categorical variables and were recoded as one dummy variable per each level.

3. Results

The number of classes of the model was determined upon the minimum value of BIC (Table 3) followed by an expert judgement where the four-class model without covariates proved to be optimal. In addition to BIC, plausibility of the results and the size of classes were considered because they are additional aspects of an analyst's judgement recommended by some authors (e.g. Boxall and Adamowicz, 2002, Scarpa and Thiene, 2005). Compared to the four-class model, the three-class alternative meant losing information on preference heterogeneity for paved walking trails, as two classes (3 and 4) merged into one. On the other end, the five-class model resulted in an additional class with less than 2% of respondents. This all led to selecting the four-class model.

Table 3. Test results for different number of classes of the latent class model.

Number of classes	Number of observations (N)	Number of parameters (K)	Log-likelihood (LL)	BIC[a]
Model with no covariates				
1	1620	7	− 1671.09	3393.92
2		15	− 1274.54	2659.94
3		23	− 1183.21	2536.39
4		31	− 1140.29	**2509.68**
5		39	− 1123.38	2534.98
6		47	− 1094.57	2571.56

[a]BIC = (-2 * LL) + (ln(N) * P).

Covariates such as the socio-demographic characteristics of the respondents and their recreation habits were gradually introduced into the model. Six of them significantly affected respondents' class membership (one; income-low was not significant) and those are reported in the lower part of the Table 4. Parameters for the six covariates were normalized to zero for class 4, so that classes 1–3 are interpreted relative to class 4. Along with those covariates, coefficients of the estimated indirect utility function of LCM are given in the upper part of the Table 4. According to calculated class-membership probabilities, the respondents were classified into classes 1–4 as follows, 28.4%, 19.1%, 19.5% and 33.0% respectively.

Table 4. Estimation results of the latent class model.

	Coefficients of the estimated indirect utility function							
Variable	**Class 1**		**Class 2**		**Class 3**		**Class 4**	
	Coeff.	**t-rat.**	**Coeff.**	**t-rat.**	**Coeff.**	**t-rat.**	**Coeff.**	**t-rat.**
Paved walking trails	0.05	0.46	0.02	1.01	− 0.02**	6.52	0.01*	3.24
Forest openings	− 0.24	0.30	0.08	0.14	0.21**	5.95	0.09*	2.67
Waymarks	0.82	0.38	− 0.29	0.24	1.33***	12.12	0.76***	10.67
Information boards	1.12	0.43	− 0.20	0.14	0.82**	5.72	0.89***	23.00
Outstanding trees	0.02	0.02	0.09*	2.89	0.00	0.02	0.03*	2.74
Payment	− 0.49**	4.53	− 0.81***	41.22	− 0.20***	29.99	− 0.06***	7.79

Variable	Coefficients of the estimated indirect utility function							
	Class 1		Class 2		Class 3		Class 4	
	Coeff.	t-rat.	Coeff.	t-rat.	Coeff.	t-rat.	Coeff.	t-rat.
ASC[a]	− 2.96*	3.28	4.57***	33.77	0.21	0.20	2.42***	34.76
	Coefficients of the estimated latent class membership function							
Variable	Class 1		Class 2		Class 3		Class 4: reference class	
Constant	− 3.69***	7.38	− 2.17	1.29	− 1.74	0.97		
Age	0.05***	9.01	0.00	0.00	0.02	0.49		
Personal income — low (dummy[b])	0.86	1.60	1.86	2.46	− 0.68	0.69		
Personal income — medium (dummy[c])	0.45	0.39	2.29**	3.96	0.37	0.20		
Visiting any forest	0.00	0.00	− 0.43**	4.08	− 0.39*	2.83		
Number of adults in the family	0.34	1.16	0.46	1.76	0.54*	2.76		
Taking a walk (dummy[d])	0.30	0.25	0.71	0.48	1.87**	4.56		
Meeting other people (dummy[d])	− 1.29**	5.18	0.04	0.00	− 0.97	1.95		

Note: estimated coefficients are significantly different from zero at 10% (*), 5% (**) or 1% (***) significance level.

[a] Alternative specific constant.

[b] (1 if ≤ 800 EUR, 0 if otherwise); [c](1 if 801–1200 EUR, 0 if otherwise) [d](1 if very often OR often, 0 if seldom OR never).

The adjusted-ρ^2 was 0.375, which is equivalent to a ρ^2 of approximately 0.7 for linear models (Domencich and McFadden, 1975). According to Louviere et al. (2000) values of adjusted-ρ^2 between 0.2 and 0.4 indicate a very good model fit.

Respondents in class 1 could be labelled as “passive” as they expressed negative preferences for paying for changes in the recreational setting and clearly rejected all deviations from the current state, which is indicated by a negative and significant coefficient for ASC. Their utility seemed not to be linked with any of the recreation-related attributes, which is indicated by non-significant parameter estimates for the attributes. Those who are older were more likely to be in this class than in class 4. Conversely, respondents who visit forest often or very often to meet other people were less likely to be in this class than in class 4. With a 28.4% share this was the second largest class.

Positive preferences for having more outstanding trees were expressed by respondents in class 2. They also preferred not to pay for proposed changes in the recreational setting but clearly supported deviations from the current state (positive and significant ASC). This class can be characterized as "change-reserved". Respondents who have a medium monthly income (801–1200 EUR) were more likely to be in class 2 as in class 4. On the other hand those who visit any forest more frequently were less likely to be in class 2 as in class 4.

Class 3, as well as class 2, holds just under a fifth of all respondents. Respondents from class 3 expressed positive preferences for having more forest openings, having waymarks and information boards maintained, but have on the other hand expressed negative preferences for having more paved trails or for paying for proposed changes. Those can be labelled as "inbetweeners" Respondents who visit any forest more frequently were less likely to be in class 3 than in class 4, which is the same as in class 2. Moreover, those who live in households with a higher number of adults and the ones who visit forest for taking a walk often or very often are more likely to belong to this class as to class 4.

Respondents in the largest class, class 4, expressed positive preferences for having more outstanding trees, more forest openings, more paved walking trails and for having both, information boards and waymarks maintained. They have also expressed support for deviations from the current state (positive and significant ASC) and can be thus labelled as "change-supportive". Similarly as respondents from the previous three classes, those from class 4 have also expressed negative preferences for having to pay for changes in the recreational setting. The results that reveal respondents' negative preferences for paying for changes, stands out as a general pattern throughout all four classes. The fact that respondents do not trade on the most important attribute, the cost, is consistent with the hypothetical market situation where respondents were asked to trade-off.

Estimates of mean WTP and 95% confidence intervals (Table 5) were calculated by using the Delta method (Greene, 2012). The values can be compared among classes, which is not the case of parameter estimates from the utility function where the effect of the scale parameter is still present. Thus, comparison of WTP estimates can be done within an attribute, and their examination further indicates heterogeneity of preferences across classes. Respondents in class 1 seem to be clearly insensitive to changes in all recreation-related attributes, which is confirmed by non-significant WTP estimates. Those in class 2 were willing to pay 0.12 EUR per year for each additional 1% of outstanding trees. In the case of forest openings, respondents belonging to class 3 and 4 were willing to pay 1.07 and 1.43 EUR per year, respectively, for each additional 1% of the area. Respondents in class 4 were willing to pay significantly more for having waymarks and information boards maintained, compared to members of class 3 (11.83 vs. 6.71 and 13.87 vs. 4.12 EUR per year). Interestingly, the ratios of WTPs for both are reversed between classes. Respondents from class 3 valued maintaining waymarks more than maintaining information boards, whereas this was reversed for members of class 4. In the case of paved walking trails, respondents from class 3 preferred to be compensated by 0.13 EUR per year for each additional kilometre of trails.

Table 5. Mean WTPs with 95% Delta confidence intervals in parenthesis.

Variable	**Latent class model**			
	Class 1	**Class 2**	**Class 3**	**Class 4**
	WTP			

Variable	Latent class model			
	Class 1	Class 2	Class 3	Class 4
Paved walking trails	0.10 [− 0.15, 0.35]	0.02 [− 0.02, 0.06]	− 0.13** [− 0.23, − 0.02]	0.16 [− 0.06, 0.37]
Forest openings	− 0.49 [− 2.04, 1.06]	0.10 [− 0.40, 0.60]	1.07** [0.15, 1.99]	1.43* [− 0.17, 3.03]
Waymarks	1.68 [− 3.50, 6.86]	− 0.36 [− 1.78, 1.05]	6.71*** [3.06, 10.35]	11.83*** [5.96, 17.71]
Information boards	2.28 [− 3.98, 8.54]	− 0.24 [− 1.50, 1.02]	4.12* [− 0.06, 8.31]	13.87*** [4.26, 23.47]
Outstanding trees	0.04 [− 0.45, 0.53]	0.12* [− 0.01, 0.24]	0.02 [− 0.26, 0.30]	0.49 [− 0.25, 1.22]

Note: WTP estimates are significantly different from zero at 10% (*), 5% (**) or 1% (***) significance level.

Note, that there are two WTP estimates (for outstanding trees and paved walking trails in class 4), which are not significant despite significant model estimates for both parameters (Table 4), upon which they are calculated, are. The Delta method, which was used for estimating the standard errors, and subsequently the confidence intervals, considers not only the variances of both the attribute and the cost parameter estimates used for calculating the WTP estimate, but also their covariance. Large variances and covariances of the parameter estimates can cause the WTP estimate to be not significant.

4. Discussion

4.1. Heterogeneity of preferences for recreation setting

The study reveals the heterogeneity of the preferences of Ljubljana residents regarding the urban forest recreational setting. A four-class LCM was employed to explain the heterogeneity by segmenting respondents into four classes whereby each class is assigned a unique set of preferences for five different attributes of a recreational setting. Preferences were also related to specific socio-demographic characteristics and recreation-related habits.

Respondents in class 2 and 4, were (positively) sensitive to the abundance of outstanding trees which supports the idea that increasing the frequency of outstanding trees nearby walking trails increases recreational attractiveness of the forest. Those from class 2 exhibited a significant willingness to pay 0.12 EUR for each additional percent of outstanding trees. The importance of different aspects of trees for visual preferences has been linked to recreation and aesthetics in general by previous research as well. Gundersen and Frivold (2008) reviewed 53 studies of forest landscape preferences within Finland, Norway, and Sweden and found that the perceived quality of forest recreation setting increases with increasing tree size. Very similar findings were reported by Edwards et al. (2010), where a European-wide Delphi survey of 46 experts from four regions (Nordic, Iberia, Central Europe and Great Britain) concluded that tree size is one of the most important attributes affecting recreational value – larger trees are preferred.

More forest openings were preferred by respondents in classes 3 and 4, however their WTP estimates were significantly different. Higher values (1.43 EUR) were expressed by those in class 4, compared to respondents in class 3 (1.07 EUR). This could be related to higher forest visitation rates by class 4. The fact that forest openings affect preferences was addressed in other studies as well. In fact, several studies have revealed that natural openings in a forest, like non-productive forest lands, peat bogs, and lakes, are preferred by respondents over clear-cuts (Gundersen and Frivold, 2008). Since there were no clear-cut openings in our study area at the time of the survey and we dealt with only naturally occurring openings, or those resulting from a small-scale logging, our findings support this previous research. Conversely, Hanley and Ruffell (1993) could not relate the amount of open space in forests with willingness to pay to enter British public forests.

Both waymarks and information boards were important factors affecting the recreational setting in our survey. Respondents in classes 3 and 4 expressed positive preferences for having them maintained. Despite the fact that Schipperijn et al. (2013) concluded that signposting and information are less important to respondents in a Danish study on urban green areas, several other studies reported that this is in fact important. Koo et al. (2013) reported that having either information signs or signs coupled with an opportunity for guided programmes in an urban forests increases utility for a part of the respondents. This supports our findings of positive WTP estimates in both classes of respondents for both attributes. However the estimates for the same attribute differs significantly between both classes. Larger values were expressed by those in class 4 compared to those in class 3 (11.83 vs. 6.71 for waymarks and 13.87 vs. 4.12 for information boards). One of the explanations could be that respondents in class 4, who tend to visit forests more often than those in class 3, also support the maintenance of waymarks and information boards more. This is also in line with the research by Hanley et al. (1998) and Bernath and Roschewitz (2008) who found that active forest users tend to favour improvements of the recreational setting more. Similarly, Christie et al. (2007) found that improvements increase forest use. Another interesting aspect is that respondents from classes 3 and 4 valued maintenance of waymarks and information boards conversely. Those from class 3 valued maintenance of waymarks more than that of information boards, whereas respondents from class 4 reported the reversely. Respondents who visit the forest to walk frequently are more likely to be in class 3 than class 4. It could be that waymarks are more important for those walkers who do not visit forest as frequently, and waymarks aid in navigation. On the other hand, respondents from class 4 tend to be more frequent forest visitors and appreciate well-maintained information boards more than waymarks, since they are more familiar with the area and are more interested in additional information (e.g., educational trails, historic facts).

In the case of paved walking trails, respondents in classes 3 and 4 were sensitive to changes in trail length, however both had opposing preferences. Those in class 3 expressed negative preferences for increased trail length, whereas those from class 4 preferred increasing the length of trails. Respondents in class 3 were more likely to visit the forest often or very often for walking and may not appreciate more walking trails as this could increase overall use, causing congestion and deteriorating their recreational experience; already pointed out by previous research (Arnberger et al., 2010, Manning, 2007, Nordh et al., 2011, Sayan et al., 2013). A significant and negative WTP for increasing the length of trails (− 0.13 EUR per each additional kilometre) for those respondents supports this conclusion.

Age was a significant factor in class 1, where older respondents tended to concentrate. They seemed very reserved to all changes, which is somehow similar to findings of Tyrväinen and Väänänen (1998), who showed that older respondents are less willing to pay for preventing recreation forests in Joensuu to be converted for construction.

Income did not have a consistent effect on respondents' preferences as only a covariate for medium income was significant in the second class, and the covariate for low income was not significant at all. This is in line with findings of Tyrväinen and Väänänen (1998) and Koo et al. (2013) and could suggest that recreation forests in our case are not regarded as a superior good, but rather as a freely available public good (Ottitsch and Krott, 2005), which it does not need to be paid for.

Respondents in class 1 were not sensitive to changes in the attributes evaluated. In addition, those respondents were the only ones who wanted no changes in the current state (negative and significant ASC). Conversely, those in class 2 and 4 expressed support for deviating from the current state, whereas those in class 3 remained indifferent to this.

4.2. Implications for urban forest management

The outcomes of the study have important implications for urban forest management. Respondent preferences demonstrate how they perceive the importance of different attributes of the forest recreation setting. Additionally, the study reveals which recreation attributes should be considered as priorities for financing. Spending funds on increasing the abundance of outstanding trees and forest openings would benefit to 52.1% respondents in case of outstanding tress (class 2 and 4), and 52.5% in case of forest openings (class 3 and 4). Very similarly, investing in maintenance of waymarks and information boards would increase the satisfaction of 52.5% of respondents (class 3 and 4), but would not bring additional benefit to the rest. Management implementations are, however, quite different in the case of paved walking trails. Increasing their length might not be a priority because only one-third (33.0%) of respondents (class 4) would benefit from this. Moreover, approximately one-fifth (19.5%; class 3) would actually be negatively affected by this measure. From an urban forest management perspective, spatially-defined information would be needed to better support the preferences of both classes. More concretely, if classes 3 and 4 generally utilize different areas of Rožnik, managers could increase the length of trails in the area frequented by members of class 4, while maintaining, or even reducing, the length in the area favoured by those from class 3.

Another contribution of this study is that it assessed both forest environment and infrastructure attributes. This approach enriches the studies addressing only one of the two types of attributes (e.g. Arnberger et al. (2010)). Additionally, a process of attribute selection that encompassed two phases was also emphasized. In the first phase individuals from the general public helped define the attributes, while in the second phase focus groups consisting of experts from forestry, landscape planning, and nature conservation defined possible alternative levels of the previously selected attributes. Therefore, the questionnaire designed from this process allowed for a representative survey for both urban forest users and non-users.

4.3. Concluding remarks

The study also possesses some limitations. Although crowding affects recreation (Arnberger et al., 2010, Nordh et al., 2011), this aspect was not considered. Also, the effects of some important factors, such as the quality of different types of walking trails, availability of outdoor fitness facilities, and presence of sightseeing spots, were not considered and will have to be explored by further research. In addition, a significant proportion of the respondents were included into the study via a web-based survey, which increases the risk of different understanding of the valuation questions. For the results presented above, we assumed that these surveys have the same degree of reliability as those administered through face-to-face interviews (Gosling et al., 2004, Lindhjem and Navrud, 2011, Nielsen, 2011, Windle and Rolfe, 2011). Finally, the results are not spatially explicit, which certainly limits the applicability of the findings for managing urban forests.

To conclude, although urban forests and forests in general provide a suite of ecosystem services to residents and visitors, urban forest management planning has not sufficiently accommodated their preferences regarding the recreation setting in the study site. However, this study and many others demonstrate that a bottom-up approach, where information on societal preferences is collected as a part of the management planning process, is worthwhile. Information on preferences and their heterogeneity not only assists in planning, but it also promotes sustainable societal development through public participation. Finally, knowledge of societal preferences is essential for improving and further developing of ecosystem services management in urban forests.

Appendix A. Representation of a choice set.

Question	**Which one is your preferable among the three options** (*the images are only to illustrate the attribute and do not correspond to actual values)		
	No additional measures	With additional measures	
	Current state	Alternative A	Alternative B
Annual payment	0 €	6 €	2 €
Outstanding trees	 6 %	 12 %	 6 %
Forest openings	 0.5 %	 2 %	 0.5 %
Maintenance of way-marks and information boards	 None	 Way-marks	 Info-boards
Paved walking trails	 28 km	 42 km	 56 km
Please mark your pick	☐	☐	☐

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