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Improving nature experience in cities: What are people's preferences for vegetated streets?

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ABSTRACT

In the current context of strong urban sprawl, it becomes urgent to find urban approaches that simultaneously promote ecological functions and relationships between people and nature in cities. Streets are omnipresent urban elements that can deliver ecosystem services and facilitate people daily interactions with nature. Promoting vegetation in streets can take different forms which have to be combined with people's preferences. Based on photomontages, we assessed people's perceptions and valuations for herbaceous vegetation types associated to various managements and designs of pavements. Using a combination of a local field survey and a French national online survey, we collected a total of 3609 responses representing a large diversity of socio-demographic characteristics. The results of the field survey confirmed those of the online survey. Although there was variability among people valuations, we found that lowly managed pavements with spontaneous vegetation were in average higher valued than highly managed pavements without vegetation. Pavements with spontaneous vegetation were perceived as less kept than pavements without vegetation, but more beautiful and less boring. We found a consensus of high valuations towards pavements containing vegetation integrated in small design interventions (flowers seeded in foot of wall, design of a meadow strip along the pavement), suggesting that people generally accept vegetation with visible signs of human actions or managements. Socio-demographic characteristics partly explained variabilities in photo valuations. As expected, people frequently connected with nature had the highest preferences for vegetated pavements, spontaneous or integrated in designs. These results show that vegetated streets can become daily biodiversity-friendly urban greenspaces appreciated by urban dwellers. We provide recommendations for promoting vegetation in streets that will be useful for politics, urban designers and managers.

1. Introduction

The current strong urban sprawl causes profound changes in ecological habitats and associated biodiversity (Grimm et al., 2008). However, it is now recognized that nature experience is required for improving urban dweller health and well-being (Botzat et al., 2016; Cox et al., 2017b) and that it can change people attitudes towards pro-environmental behaviors (Soga and Gaston, 2016). In this context, it is necessary that researchers, designers and managers propose urban approaches that simultaneously promote ecological functions and relationships between people and nature (Aronson et al., 2017; Gaston et al., 2013; Soga and Gaston, 2016).

Nature in cities can be promoted at various scales in multiple public or private spaces (Aronson et al., 2017; Beninde et al., 2015). Land sparing and land sharing have been proposed as two spatial approaches located at both opposite ends of a continuum of nature conservation strategies (Lin and Fuller, 2013). Land sparing which consists in introducing large green spaces (e.g. parks) within a compact urban matrix has been shown an adapted strategy for hosting some large animals and uncommon plant species (Caryl et al., 2016; Kendal et al., 2017; Villaseñor et al., 2017) and to develop various people uses including walking, resting or jogging (Palliwoda et al., 2017). However, this approach induces a travel distance between housing and parks which can be a barrier to frequent people use (Soga et al., 2015). Moreover, this approach requires strong political and economic choices in urban planning. Another approach is land sharing where a higher fragmentation of green spaces dispersed through the urban matrix under diversified forms is proposed (e.g. pocket parks Ikin et al., 2013, vegetated streets Säumel et al., 2016, small urban grasslands Kendal et al., 2017). This approach is interesting to promote various biological

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communities associated to different local environmental and management conditions (Kendal et al., 2017) and to increase daily contact with nature (Soga et al., 2016). In addition, this strategy seems particularly relevant in old cities where high urban densities can limit space-consuming projects.

Streets are linear elements omnipresent in the whole urban matrix which are often only viewed as corridors for pedestrian and vehicle traffics. By introducing vegetation, streets can become multi-functional by delivering numerous ecosystem services (Säumel et al., 2016) and represent opportunities to facilitate incidental people daily interactions with nature (e.g looking at vegetation while walking in a street, Cox et al., 2017a). Street vegetation can take different forms according to design and management practices which have to be combined with people's perceptions and preferences to make effective decision-making (Bennett, 2016; Ives and Kendall, 2014; Wallace et al., 2016). In the largest streets and with a relatively high planning budget, planting trees can be an interesting strategy for improving people street valuations (Ng et al., 2015; Todorova et al., 2004). More simply, streets can also encompass a large variety of herbaceous plants, cultivated or spontaneous, by changing management practices or by making small interventions (Weber et al., 2014).

In this study, we assessed people's perceptions and valuations for herbaceous vegetation types associated to various managements and designs of street pavements. For that purpose, we conducted two surveys (one local in the field and one online at national scale) were people had to grade photomontages reflecting various management and design scenarios. Following previous studies which found that people generally prefer green infrastructures compared to mineral infrastructures (Botzat et al., 2016; Fischer et al., 2018; White and Gatersleben, 2011), we tested the hypothesis that street pavements with some vegetation are more preferred than pavements highly managed with no vegetation. We also examined the relationships between the valuations of our respondents and their socio-demographic characteristics.

2. Material and methods

2.1. Photomontages and valuation measures

We based our questionnaire on a visual method by producing photomontages representing different pavement vegetation types associated to various management practices and interventions (Fig. 1). We first constructed three photomontages to compare people valuations among a highly managed pavement without vegetation ('Asphalt High manag.') and two types of lowly managed pavements harboring spontaneous vegetation ('Asphalt Low manag.' and 'Sand Low manag.'). The represented vegetation on these photos reflects vegetation structure and composition that spontaneously grow on pavements as observed in France (Bonthoux et al. in revision). Represented dominant species are *Erigeron* sp. for 'Asphalt Low manag.' and *Trifolium repens* (L.) for 'Sand Low manag.' (Fig. 1). We then added two photomontages to assess people valuations for vegetation included in small designs. We first represented a vegetation strip at the foot of the wall ('Asphalt Flower') with sowed species which are often used in French cities for their colored flowers (e.g. *Iberis sempervirens* (L.), *Eschscholzia californica* (Cham.)). This type of intervention is possible in existing old pavements by using cracks or by removing a small asphalt strip along the wall. We also proposed an intervention consisting in the creation of a grassland strip between the pedestrian path and the road ('Sand Grassland'). All these photomontages reflect vegetation structure present in late spring – early summer which is the period in which vegetation differences between pavement situations is the highest and in which people are frequently outside and experience vegetated pavements. Finally, we assessed whether people's preferences depend on the visual context by incorporating the five pavement photomontages in open and closed neighborhood visual contexts (Fig. 1).

We used two measures to assess valuations and perceptions of each pavement vegetation type. First, the ten photos were presented individually in a random order to respondents which had to grade them between 1 (do not like at all) and 10 (like a lot). Second, to measure perceptions, respondents had to answer whether they found that the five pavement types (pavement without the neighborhood visual context, Appendix Fig. 4) were associated or not (i.e. yes or no response) to seven criteria: beautiful, boring, kept, useful for nature, natural, wild, valuable for the city image. Finally, we collected information about socio-demographic variables that could influence people valuations for pavement vegetation including age, gender, qualification level, job or studies in the environmental field or not, frequency of outdoor activities, house or apartment housing and practice of gardening (Table 1). We also asked the city name of residence to know whether respondents live in rural or urban areas (by informing the number of city inhabitants) and in which French region (by informing longitude and latitude, Table 1).

2.2. Surveys

A combination of field and online surveys including the same photomontages and collected information was realized between April and June 2017. Comparison of these two types of survey was used to check the robustness of our results and limit methodological biases.

Field face-to-face surveys were performed in the agglomeration of Blois (105 000 inhabitants) which is located in central France. Surveys were conducted in the inner Blois city and in several small villages in the agglomeration. This survey approach permitted us to optimize the age gradient range by interviewing teenagers and elderly persons who were only slightly addressed by the online survey. It also allowed to interview people not interested in the subject. The online survey was used to increase our response sample size. This latter approach can show results consistent with traditional sampling approaches and allows to obtain a cheap, fast and large collection of responses (Brickman Bhutta, 2012; Gosling et al., 2004; Riva et al., 2003). To disseminate the online survey and optimize the respondents variability we sent a web link to students, professors and administrative personnel of several universities with various specialties including environmental field (e.g. ecology, landscape architecture) and other disciplinary areas (e.g. mathematics, physics, computer science). We also posted the link on different social networks and employed a snowballing approach by asking to forward the survey to other networks.

2.3. Analyses

Grades associated to the ten photomontages were highly correlated between both field and online surveys (Spearman rank correlation Rho = 0.81, n = 10, Appendix Table 1). We thus pooled both dataset before analyses in order to improve the robustness of results.

We first compared means of grades associated to the ten photos using t-tests. We also calculated coefficients of variation to investigate the level of grade variability. To analyze the relationships between the five pavement types and people perceptions we performed a multiple component analysis (MCA) on the response (yes-no) * seven criteria matrix, including in the same matrix the responses for the five

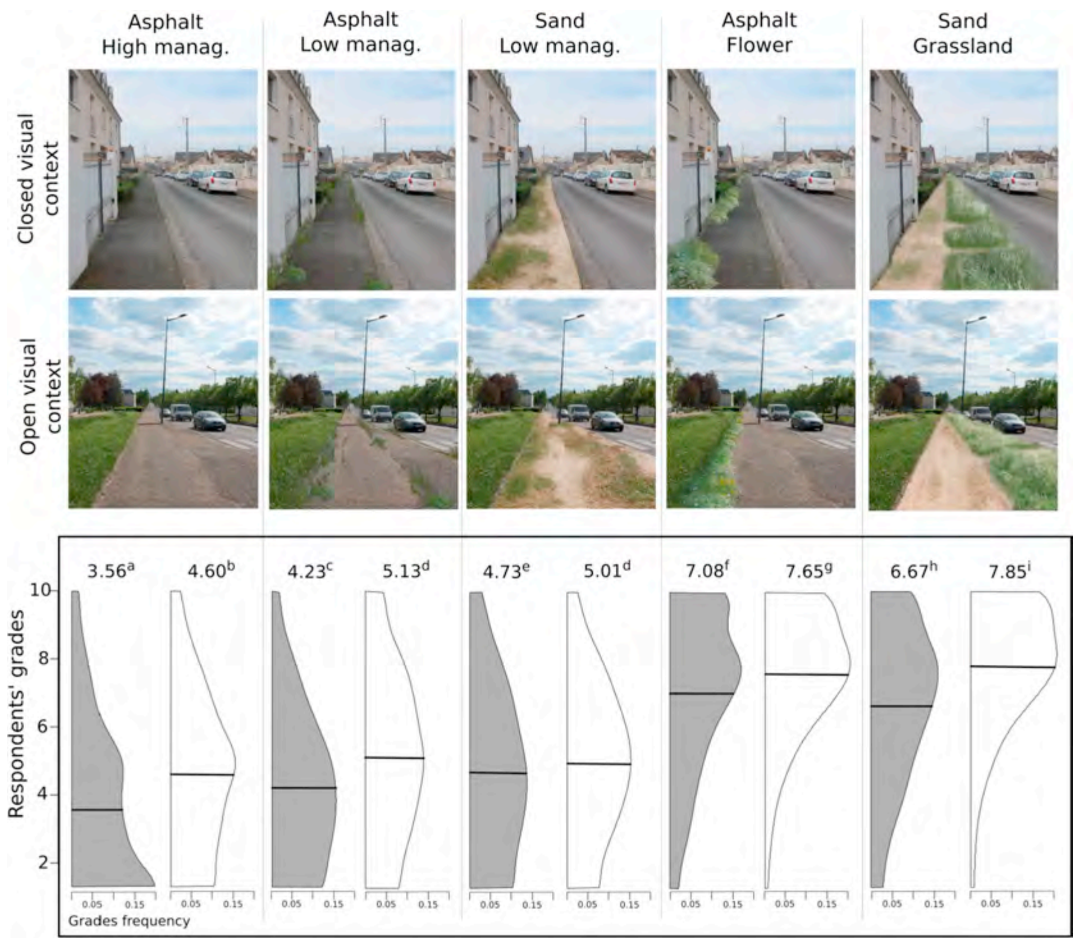

Fig. 1. Photomontages used in the questionnaire for the five pavement types and both visual contexts. Below are presented the associated distributions of respondents' grades (from 1 = lowest valuation to 10 = highest valuation, closed and open visual contexts represented in grey and white respectively, for each photo n = 3609). Horizontal black bars are average grades. Average grade values are indicated above grade distributions. Different letters indicate that the average grades are significantly different between situations. Abbreviation: management (manag.).

Table 1
Socio-demographic characteristics of respondents used as explanatory variables in models to explain photos grades.

Variable name	Description	Mean ± SD	Range
Age		37.80 ± 15.36	12–92
Gender	Two classes: man (n = 1455), woman (n = 2154)		
Qualification	Level of qualification (0 = no diploma to 5 = master level or more)	3.56 ± 1.61	0–5
Environment	Job or studies in the environmental field, 2 classes: yes (n = 1036), no (n = 2573)		
Outdoor	Frequency of outdoor activities (0 = no activities to 3 = more than once a week)	2.31 ± 0.85	0–3
Housing	Two classes: house (n = 1909), apartment (n = 1700)		
Gardening	Gardening practice, 2 classes: yes (n = 2768), no (n = 841)		
Population	Number of inhabitants living in the respondent's municipality (/1000 inhabitants)	610.33 ± 2362.64	0.1–12475
Longitude	Longitude of the respondent's municipality (Lambert 93 coordinates, in metre)	6366 ± 2191	1455–12354
Latitude	Latitude of the respondent's municipality (Lambert 93 coordinates, in metre)	66608 ± 2087	61097–70945

pavement types.

To investigate the relationships between photo grades and the ten socio-demographic variables (Table 1), we computed linear models for each of the ten photomontages. All socio-demographic variables were lowly correlated together ($r < |0.7|$, Appendix Table 2, Dormann et al., 2013) and were included in models. We standardized (mean = 0, SD = 1) the quantitative explanatory variables to facilitate comparison of parameter estimates (Schielzeth, 2010). We used a model averaging approach to take into account the uncertainty in the model selection process (Burnham and Anderson, 2003). We fitted all possible models nested within the full model and ranked them on the basis of AIC and assigned them Akaike weights (w_i). We then averaged the estimated

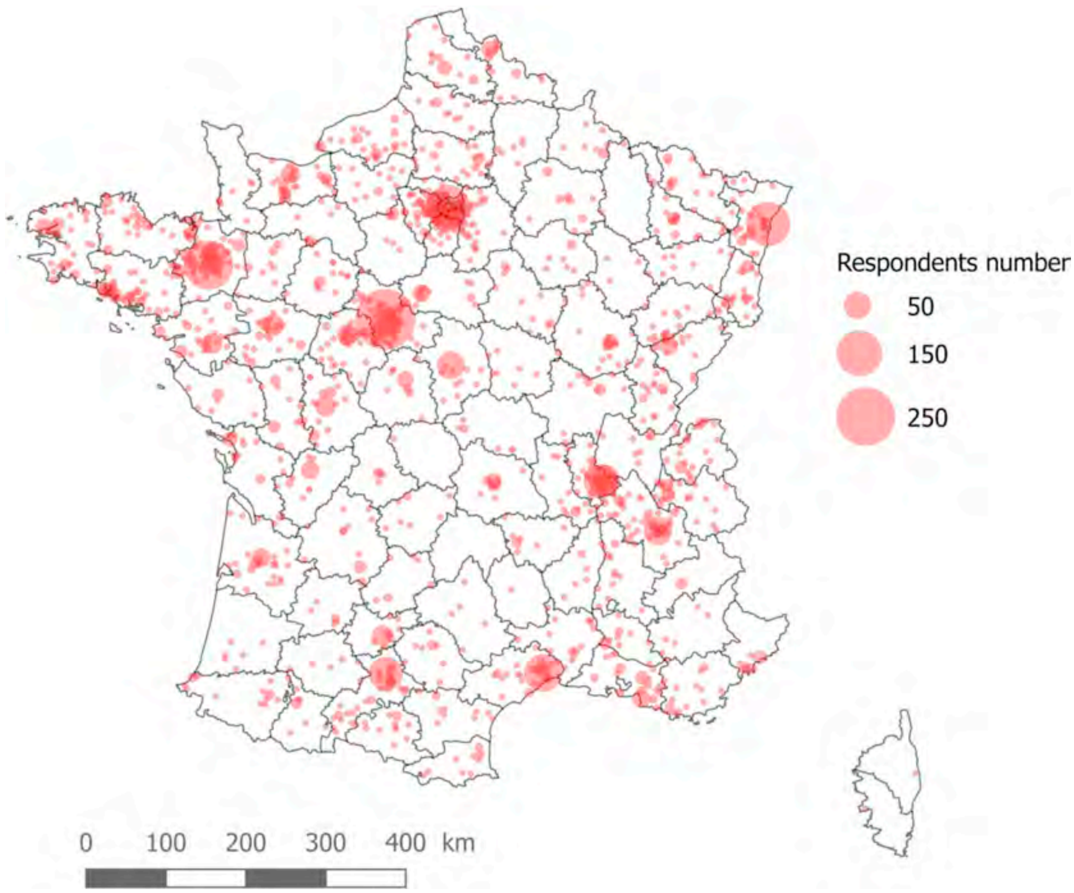

Fig. 2. National distribution of respondents' locations (n = 3609).

parameters of the 95% confidence set of models (sum of $w_i > 0.95$) weighted by w_i. We considered variables as significant when confidence intervals did not overlap zero. Finally, we calculated the percentage of explained variance for the most parsimonious model (i.e. with the smallest AIC) of the confidence set. No spatial autocorrelation was found in model residuals given that longitude and latitude of respondents' municipalities were included as explanatory variables in models.

3. Results

3.1. Diversity of respondents

A total of 271 and 3338 respondents answered the field and online surveys respectively (n total = 3609). Respondents represented a large diversity of socio-demographic groups (Table 1, See Appendix Fig. 5 for the distributions of quantitative variables) and their residence locations were relatively evenly distributed across France as across the rural-urban gradient (Fig. 2, Table 1). The age and qualification level gradients were oriented towards young people and high diploma due to our questionnaire diffusion approach towards university people but nevertheless the whole gradients were correctly represented and no important difference between field and online survey was found.

3.2. Grades and criteria associated to the photomontages

Average respondents' grades associated to situations in open visual contexts were always higher than those in closed visual contexts (Fig. 1). Despite small differences in grade orders between both survey approaches (Appendix Table 1), 'Asphalt High manag.' average grade was globally significantly lower than 'Asphalt Low manag.' and 'Sand Low manag.' average grades in both visual contexts. For these three photo grades, variations were relatively high (coefficients of variation ranging between 0.47 and 0.68, Appendix Table 1) indicating divergences in respondents' valuations. Average grades were the highest for 'Asphalt Flower' and 'Sand Grassland' in both visual contexts. Grade variations were relatively low (coefficients of variation ranging between 0.24 and 0.36) for both situations indicating convergences in respondents' valuations.

The first two axes of the MCA accounted for 45% and 26% of the total variance respectively (Fig. 3). The first horizontal axis was correlated to the 'Beautiful', 'Boring', 'Useful for nature' and 'Valuable for the city image' criteria and the second vertical axis was correlated to the 'Kept', 'Natural' and 'Wild' criteria (Fig. 3, Appendix Table 3). 'Asphat High manag.' situation had a small convex hull and was judged 'not Beautiful', 'Boring', 'Kept', 'not Useful for nature', 'not Natural', 'not Wild' and a mix across 'Valuable' and 'not Valuable for the city image'. The

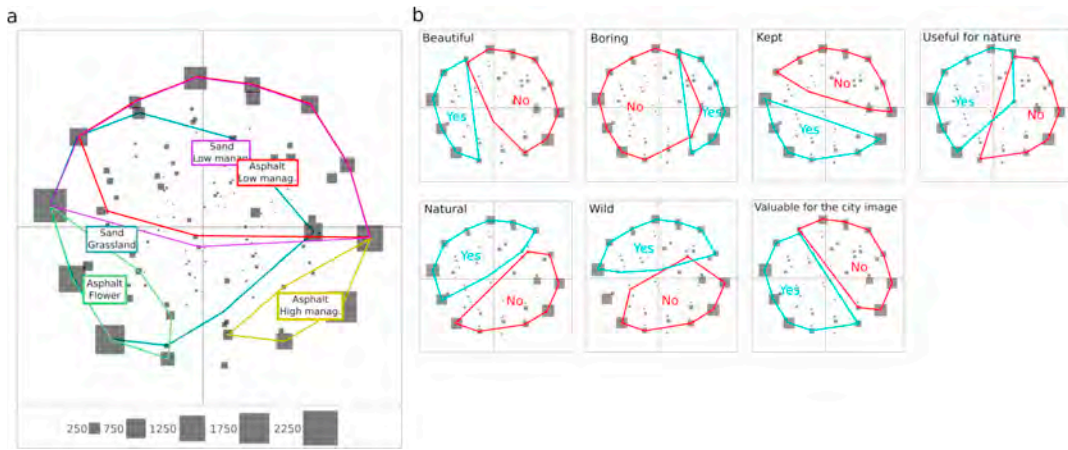

Fig. 3. Factorial map of the multiple correspondence analysis (MCA) computed with the Response (yes-no) * Criteria (n = 7) matrix grouping the responses of the five pavement types (row numbers = 5 × 3609 responses). Axes 1 and 2 explain 45% and 26% of the total variance respectively. Dot sizes are proportional to the overlayed dot numbers. Pavement names labels and response 'Yes' and 'No' labels are located on the centroids. Convex hulls include 75% of responses.

Table 2
Influence of socio-demographic variables on respondents' grades for the five pavement types in the closed visual context. Linear models (n = 3609) followed by model averaging procedures were computed for each pavement type. %R^2 is the total explained variance of the best model of the confidence set. Arrow presences indicate significant relationships and 'ns' no significant relationships. Up and down arrows indicate positive and negative effects respectively. Arrow numbers are proportional to the effect magnitude (one arrow, for 0 < estimate ≤ 0.5, two arrows for 0.5 < estimate ≤ 1 and three arrows for estimate > 1). See Appendix Table 4 for all estimates.

	Asphalt High manag. R^2 = 7%	Asphalt Low manag. R^2 = 7%	Sand Low manag. R^2 = 10%	Asphalt Flower R^2 = 11%	Sand Grassland R^2 = 8%
Age	↘	↗	ns	↗↗	↗
Genre.woman	↘	↗	ns	↗	↗
Qualification	↘	↗	↗	↗	↗
Environment.yes	↘↘	↗↗	↗↗↗	↗↗	↗↗↗
Outdoor	↘	↗	↗	ns	↗
Housing.house	ns	↘	↘	ns	↘
Gardening.yes	↘	↗	↗	↗	↗↗
Population	↘	ns	ns	ns	ns
Longitude	ns	ns	↘	↘	↘
Latitude	ns	ns	ns	ns	↗

'Asphalt Low manag.' and 'Sand Low manag.' situations had large convex hulls indicating divergent responses and were associated to the same criteria: 'not Kept', 'quite Natural' and 'Wild' and a judgement mix for the 'Beautiful', 'Boring', 'Useful for nature' and 'Valuable for the city image' criteria. 'Asphalt Flower' and 'Sand Grassland' situations were relatively associated to the same criteria: 'Beautiful', 'not Boring', 'Kept', 'Useful for nature', 'Valuable for the city image' and a judgement mixing for the 'Natural' and 'Wild' criteria (Fig. 3).

3.3. Relationships between grades and socio-demographic variables

Because results for both visual contexts were very similar, only results for the closed visual context were presented in the main text (Table 2, see Appendix Table 4 for all detailed results). There were numerous significant relationships between grades and socio-demographic variables, but the total explained variance was low in each model ($R^2 \leq 11\%$; Table 2). The 'Environment' variable had the strongest effect magnitude on respondents' grades. The 'Housing', 'Population', 'Longitude', 'Latitude' variables were the least significant. The 'Asphalt High manag.' grading was significantly and negatively related to 'Age', 'Gender.woman', 'Qualification', 'Environment.yes', 'Outdoor' and 'Gardening.yes' variables. On the contrary 'Asphalt Low manag.', 'Sand Low manag.', 'Asphalt Flower' and 'Sand Grassland' were globally positively related to these variables (Table 2).

4. Discussion

Promoting nature in cities is challenging for scientists, designers and managers, because it requires to find urban designs improving trade-offs and synergies between biodiversity conservation, associated ecosystem services and people acceptance of spontaneous nature (Threlfall and Kendal 2018; Kowarik, 2017, Botzat et al., 2016). In addition to traditionally acknowledge green spaces, streets, which are ubiquitous at the city scale, represent a good opportunity to simultaneously promote biodiversity and enhance nature daily experience (Bonthoux et al. in revision). Based on a large collection of data, we showed that people have more preferences for vegetated than for mineral street pavements, regardless of the neighborhood visual context. However, the appreciation of vegetation strongly depends on the way it is promoted.

Our study was based on complementary field and online surveys, strengthening the robustness of the results. In fact, we found that results of field survey confirm the nationwide online survey. Field survey is an interesting method to control and maximize the variability of people surveyed. However, this technique is time consuming and generally leads to modest sample sizes which are geographically restricted, with potential impacts on results robustness and transferability. Online survey can be oriented towards certain people (highly qualified people in this study) but has the advantage of covering large areas and obtaining a high response amount. In the questionnaire we used a moderate number of photos to limit survey duration and to avoid people demotivation. We chose to compare preferences for vegetation pavement reflecting late spring-early summer period when vegetation is the most developed and people are most often outside. In late summer and in autumn, vegetation with a drier or a degraded aspect may be less appreciated. This effect could be reduced by mowing at this time, the vegetation structure would be more homogeneous between pavement vegetation types and we can expect a low variability of people valuations at this period.

Although there was a high variability among people preferences, we found that lowly managed pavements with spontaneous vegetation were in average higher valued than highly managed pavements without vegetation. This result is in accordance with other studies showing that people prefer vegetated to mineral urban elements (e.g. pavement tree pits, Fischer et al., 2018; house facades and roofs, White and Gatersleben, 2011). Our criteria analysis showed that pavements with spontaneous vegetation were perceived as less kept than pavements without vegetation, but more beautiful and less boring. This finding goes against conveyed ideas in municipalities and technical services (in France at least) that strong management is important for urban dwellers. This point highlights the importance of conducting studies like this one to avoid a truncated overview of people preferences. Our results indicate a wide acceptance of spontaneous vegetation in cities that occur among inhabitants but also local decision-makers and managers (unpublished interviews with 11 municipality mayors or technical service leaders conducted in the agglomeration of Blois). In response to the increasing regulatory ban of pesticide use (e.g. prohibition since 2017 in public spaces in France), alternative methods of vegetation management used by technical agents (hand weeding or thermal/steam weeding) are often moderately effective (Bonthoux et al. in revision) and physically difficult. This forces municipalities to change their attitudes on the presence of spontaneous vegetation in public spaces.

Our results showed a strong people consensus of appreciations towards pavements containing vegetation integrated in small design interventions. This is supported by the study of Weber et al. (2014) who found a higher approval for maintained roadside vegetation compared to spontaneous vegetation in Berlin, and with the fact that people generally accept vegetation with visible signs of human actions or managements (Nassauer, 1995; Van den Berg and van Winsum-Westra, 2010). Including vegetation in designs also lead to homogeneous plant covers which are often visually preferred compared to scattered patches of vegetation, as it has been shown in other urban habitats like wastelands in which pioneer vegetation is less appreciated than grassland vegetation (Brun et al., 2018; Mathey et al., 2018). Interestingly, the grassland strip ('Sand Grassland') which can be composed of a mix of native grasses and forbs was as much appreciated than the flower strip ('Asphalt Flower') which is generally composed of exotic and/or horticultural species. This legitimates the fact of designing urban grasslands (Klaus, 2013) that can favor people experience with nature but also other ecosystem services such as plant and animal biodiversity conservation and the maintenance of pollination (Blackmore and Goulson, 2014).

We found that socio-demographic parameters partly explained variability in photo appreciations. As expected, people frequently connected with nature had the highest preferences for vegetated pavements, spontaneous or integrated in designs. This effect predominated for people working or doing studies in the environmental field. These results are in accordance with another study showing that people who have high nature relatedness spend more time in public or private green spaces (Lin et al., 2017). As other studies, we found that females, people with a high qualification level and older people, who generally have more leisure times in gardens, had the highest preferences for vegetation (Cox et al., 2017a; Fischer et al., 2018). Nevertheless, despite the various socio-demographic variables integrated in models a high part of grade variability remained not explained, indicating that other determinants such as childhood experience or education would be important to consider (Rupprecht et al., 2016).

5. Conclusion

The results of this study suggest that vegetated streets can become daily biodiversity-friendly urban greenspaces appreciated by urban dwellers. They should be taken into account by politics, urban designers and managers in different ways. In already built-up areas, we suggest to globally reduce management pressure allowing the appearance of moderate spontaneous vegetation, what should be beneficial for biodiversity and not rejected by people. In future constructions, we suggest that civil engineers and architects integrate local vegetation on pavements through innovative designs.

Acknowledgements

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Appendix

Fig. 4. Photomontages used in the surveys to explore relationships between the five pavement types and seven items (beautiful, boring, kept, useful for nature, natural, wild, valuable for the city image).

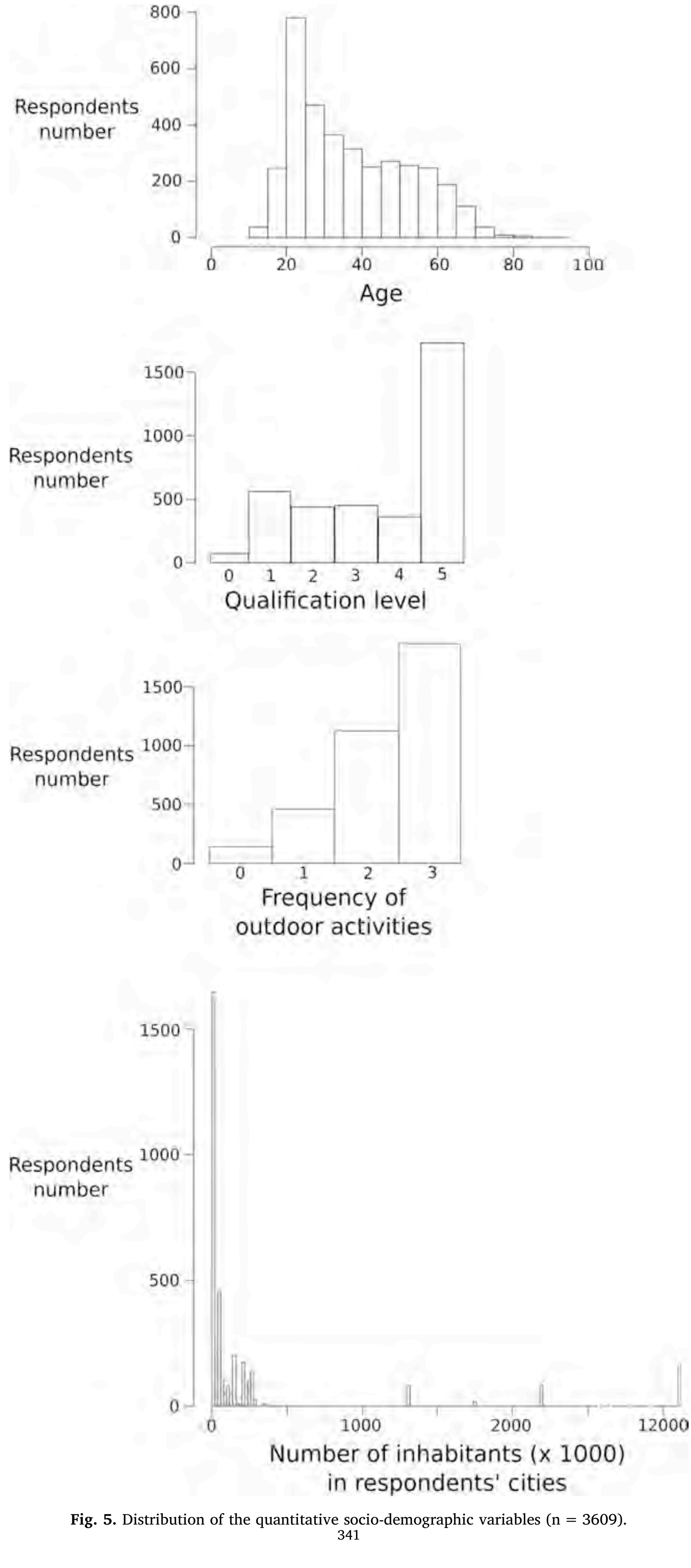

Fig. 5. Distribution of the quantitative socio-demographic variables (n = 3609).

Table 1
Comparison (mean and coefficient of variation in brackets) of respondents' grades between the field survey (n = 271), the online survey (n = 3338) and the whole dataset (n = 3609).

	Asphalt High manag. Closed	Asphalt High manag. Open	Asphalt Low manag. Closed	Asphalt Low manag. Open	Sand Low manag. Closed	Sand Low manag. Open	Asphalt Flower Closed	Asphalt Flower Open	Sand Grassland Closed	Sand Grassland Open
Field survey	4.01 (0.63)	5.25 (0.40)	2.99 (0.62)	3.94 (0.51)	3.29 (0.63)	4.49 (0.47)	5.36 (0.49)	5.97 (0.42)	5.29 (0.46)	6.75 (0.32)
Internet survey	3.53 (0.68)	4.55 (0.53)	4.33 (0.53)	5.23 (0.48)	4.85 (0.51)	5.05 (0.47)	7.22 (0.32)	7.79 (0.23)	6.78 (0.35)	7.94 (0.23)
Both surveys	3.56 (0.68)	4.60 (0.52)	4.23 (0.54)	5.13 (0.49)	4.73 (0.53)	5.01 (0.47)	7.08 (0.34)	7.65 (0.25)	6.67 (0.36)	7.85 (0.24)

Table 2
Correlations between socio-demographic characteristics. a) Correlation (η^2) between a quantitative and a qualitative variable b) Cramer's V correlation between each pair of qualitative variables and c) Pearson correlation between each pair of quantitative variables.

	Age	Genre	Qualification	Environment	Outdoor	Housing	Gardening	Population	Longitude
Genre	a) 0.00								
Qualification	c) -0.02	a) 0.00							
Environment	a) 0.06	b) 0.01	a) 0.06						
Outdoor	c) 0.01	a) 0.00	c) 0.09	a) 0.01					
Housing	a) 0.11	b) 0.00	a) 0.01	b) 0.11	a) 0.00				
Gardening	a) 0.04	b) 0.04	a) 0.00	b) 0.02	a) 0.01	b) 0.35			
Population	c) 0.00	a) 0.00	c) 0.12	a) 0.00	c) 0.01	a) 0.06	a) 0.01		
Longitude	c) -0.11	a) 0.00	c) 0.05	a) 0.00	c) 0.04	a) 0.04	a) 0.01	c) 0.04	
Latitude	c) 0.00	a) 0.00	c) -0.09	a) 0.00	c) -0.04	a) 0.00	a) 0.00	c) 0.14	c) -0.21

Table 3
Correlation between the two first axes of the Multiple Component Analysis and the seven criteria.

	Axis 1	Axis 2
Beautiful	0.71	0.07
Boring	0.59	0.00
Kept	0.16	0.54
Useful for nature	0.65	0.04
Natural	0.29	0.42
Wild	0.10	0.61
Valuable for the city	0.64	0.14

Table 4
Influence of socio-demographic characteristics on respondents' grades for the five pavement types in both visual contexts. Linear models (n = 3609) followed by model averaging procedures were computed for each pavement type. The estimated coefficients and standard deviations are indicated for each variable. The significant coefficients are in bold. %R^2 is the total explained variance of the best model of the confidence set.

Closed visual context	Asphalt High manag. R^2 = 7%			Asphalt Low manag. R^2 = 7%			Sand Low manag. R^2 = 10%			Asphalt Flower R^2 = 11%			Sand Grassland R^2 = 8%		
	Estimate ± SE		*P*-value	Estimate ± SE		*P*-value	Estimate ± SE		*P*-value	Estimate ± SE		*P*-value	Estimate ± SE		*P*-value
Intercept	**4.38**	**± 0.09**	**< 0.001**	**3.85**	**± 0.10**	**< 0.001**	**4.20**	**± 0.09**	**< 0.001**	**6.25**	**± 0.10**	**< 0.001**	**5.91**	**± 0.10**	**< 0.001**
Age	**−0.12**	**± 0.04**	**< 0.01**	**0.20**	**± 0.04**	**< 0.001**	0.05	± 0.04	0.29	**0.55**	**± 0.04**	**< 0.001**	**0.14**	**± 0.04**	**< 0.001**
Genre.woman	**−0.44**	**± 0.08**	**< 0.001**	**0.19**	**± 0.08**	**< 0.05**	0.03	± 0.08	0.67	**0.47**	**± 0.08**	**< 0.001**	**0.16**	**± 0.08**	**< 0.05**
Qualification	**−0.17**	**± 0.04**	**< 0.001**	**0.21**	**± 0.04**	**< 0.001**	**0.27**	**± 0.04**	**< 0.001**	**0.26**	**± 0.04**	**< 0.001**	**0.17**	**± 0.04**	**< 0.001**
Environment.yes	**−0.98**	**± 0.09**	**< 0.001**	**0.91**	**± 0.09**	**< 0.001**	**1.32**	**± 0.09**	**< 0.001**	**0.82**	**± 0.09**	**< 0.001**	**1.16**	**± 0.09**	**< 0.001**
Outdoor	**−0.16**	**± 0.04**	**< 0.001**	**0.15**	**± 0.04**	**< 0.001**	**0.15**	**± 0.04**	**< 0.001**	0.07	± 0.04	0.07	**0.15**	**± 0.04**	**< 0.001**
Housing.house	0.14	± 0.09	0.13	**−0.34**	**± 0.08**	**< 0.001**	**−0.35**	**± 0.09**	**< 0.001**	−0.15	± 0.09	0.08	**−0.20**	**± 0.09**	**0.02**
Gardening.yes	**−0.41**	**± 0.10**	**< 0.001**	**0.27**	**± 0.09**	**< 0.01**	**0.44**	**± 0.10**	**< 0.001**	**0.49**	**± 0.10**	**< 0.001**	**0.57**	**± 0.10**	**< 0.001**
Population	**−0.14**	**± 0.04**	**< 0.001**	0.00	± 0.04	0.95	0.05	± 0.04	0.20	0.01	± 0.04	0.79	0.03	± 0.04	0.49
Longitude	0.01	± 0.04	0.77	−0.02	± 0.04	0.64	**−0.12**	**± 0.04**	**< 0.01**	**−0.15**	**± 0.04**	**< 0.001**	**−0.09**	**± 0.04**	**0.02**
Latitude	0.06	± 0.04	0.15	0.05	± 0.04	0.20	−0.01	± 0.04	0.71	0.02	± 0.04	0.58	**0.08**	**± 0.04**	**0.04**
Open visual context	Asphalt High manag. R^2 = 8%			Asphalt Low manag. R^2 = 9%			Sand Low manag. R^2 = 8%			Asphalt Flower R^2 = 5%			Sand Grassland R^2 = 5%		
	Estimate ± SE		*P*-value	Estimate ± SE		*P*-value	Estimate ± SE		*P*-value	Estimate ± SE		*P*-value	Estimate ± SE		*P*-value
Intercept	**5.29**	**± 0.09**	**< 0.001**	**4.69**	**± 0.11**	**< 0.001**	**4.74**	**± 0.09**	**< 0.001**	**7.18**	**± 0.08**	**< 0.001**	**7.30**	**± 0.08**	**< 0.001**
Age	**−0.19**	**± 0.04**	**< 0.001**	0.02	± 0.04	0.66	−0.07	± 0.04	0.08	**0.23**	**± 0.04**	**< 0.001**	0.03	± 0.03	0.39
Genre.woman	−0.06	± 0.08	0.39	**0.30**	**± 0.08**	**< 0.001**	0.03	± 0.08	0.66	**0.45**	**± 0.06**	**< 0.001**	**0.23**	**± 0.06**	**< 0.001**
Qualification	**−0.15**	**± 0.04**	**< 0.001**	**0.28**	**± 0.04**	**< 0.001**	**0.21**	**± 0.04**	**< 0.001**	**0.23**	**± 0.03**	**< 0.001**	**0.12**	**± 0.03**	**< 0.001**
Environment.yes	**−1.21**	**± 0.09**	**< 0.001**	**1.06**	**± 0.11**	**< 0.001**	**1.07**	**± 0.09**	**< 0.001**	**0.30**	**± 0.07**	**< 0.001**	**0.50**	**± 0.07**	**< 0.001**
Outdoor	−0.08	± 0.04	0.05	**0.18**	**± 0.04**	**< 0.001**	**0.15**	**± 0.04**	**< 0.001**	0.03	± 0.03	0.40	**0.15**	**± 0.03**	**< 0.001**
Housing.house	0.14	± 0.09	0.12	**−0.37**	**± 0.09**	**< 0.001**	**−0.22**	**± 0.09**	**0.01**	−0.12	± 0.07	0.10	−0.06	± 0.07	0.41
Gardening.yes	**−0.48**	**± 0.10**	**< 0.001**	**0.23**	**± 0.10**	< 0.001	0.16	± 0.10	0.11	**0.21**	**± 0.08**	**< 0.01**	**0.37**	**± 0.08**	**< 0.001**
Population	−0.06	± 0.04	0.11	**0.10**	**0.04**	0.01	0.02	± 0.04	0.65	−0.05	± 0.03	0.10	0.01	± 0.03	0.78
Longitude	0.07	± 0.04	0.08	0.02	0.04	**0.65**	**−0.11**	**± 0.04**	**< 0.01**	−0.01	± 0.03	0.85	**−0.08**	**± 0.03**	**0.01**
Latitude	0.00	± 0.04	0.95	−0.05	0.04	0.20	−0.06	± 0.04	0.10	0.00	± 0.03	0.93	**0.07**	**± 0.03**	**0.04**

References

Aronson, M.F., Lepczyk, C.A., Evans, K.L., Goddard, M.A., Lerman, S.B., MacIvor, J.S., Nilon, C.H., Vargo, T., 2017. Biodiversity in the city: key challenges for urban green space management. Front. Ecol. Environ. 15, 189–196.

Beninde, J., Veith, M., Hochkirch, A., 2015. Biodiversity in cities needs space: a meta-analysis of factors determining intra-urban biodiversity variation. Ecol. Lett. 18, 581–592.

Bennett, N.J., 2016. Using perceptions as evidence to improve conservation and environmental management. Conserv. Biol. 30, 582–592.

Blackmore, L.M., Goulson, D., 2014. Evaluating the effectiveness of wildflower seed mixes for boosting floral diversity and bumblebee and hoverfly abundance in urban areas. Insect Conserv. Diver. 7, 480–484.

Bonthoux, S., Voisin, L., Bouché-Pillon, S., Chollet, S., More than weeds: spontaneous vegetation in streets as a neglected element of urban biodiversity (in revision).

Botzat, A., Fischer, L.K., Kowarik, I., 2016. Unexploited opportunities in understanding liveable and biodiverse cities. A review on urban biodiversity perception and valuation. Global Environ. Change 39, 220–233.

Brickman Bhutta, C., 2012. Not by the book: Facebook as a sampling frame. Socio. Meth. Res. 41, 57–88.

Brun, M., Di Pietro, F., Bonthoux, S., 2018. Residents' perceptions and valuations of urban wastelands are influenced by vegetation structure. Urban For. Urban Green. 14, 393–403.

Burnham, K.P., Anderson, D.R., 2003. Model Selection and Multimodel Inference: a Practical Information-theoretic Approach. Springer Science & Business Media.

Caryl, F.M., Lumsden, L.F., Ree, R., Wintle, B.A., 2016. Functional responses of insectivorous bats to increasing housing density support 'land-sparing'rather than 'land-sharing'urban growth strategies. J. Appl. Ecol. 53, 191–201.

Cox, D.T., Hudson, H.L., Shanahan, D.F., Fuller, R.A., Gaston, K.J., 2017a. The rarity of direct experiences of nature in an urban population. Landsc. Urban Plann. 160, 79–84.

Cox, D.T., Shanahan, D.F., Hudson, H.L., Plummer, K.E., Siriwardena, G.M., Fuller, R.A., Anderson, K., Hancock, S., Gaston, K.J., 2017b. Doses of neighborhood nature: the benefits for mental health of living with nature. Bioscience 67, 147–155.

Dormann, C.F., Elith, J., Bacher, S., Buchmann, C., Carl, G., Carré, G., Marquéz, J.R.G., Gruber, B., Lafourcade, B., Leitão, P.J., 2013. Collinearity: a review of methods to deal with it and a simulation study evaluating their performance. Ecography 36, 27–46.

Fischer, L.K., Honold, J., Cvejić, R., Delshammar, T., Hilbert, S., Lafortezza, R., Nastran, M., Nielsen, A.B., Pintar, M., van der Jagt, A.P., 2018. Beyond green: broad support for biodiversity in multicultural European cities. Global Environ. Change 49, 35–45.

Gaston, K.J., Ávila-Jiménez, M.L., Edmondson, J.L., 2013. REVIEW: managing urban ecosystems for goods and services. J. Appl. Ecol. 50, 830–840.

Gosling, S.D., Vazire, S., Srivastava, S., John, O.P., 2004. Should we trust web-based studies? A comparative analysis of six preconceptions about internet questionnaires. Am. Psychol. 59, 93.

Grimm, N.B., Faeth, S.H., Golubiewski, N.E., Redman, C.L., Wu, J., Bai, X., Briggs, J.M., 2008. Global change and the ecology of cities. Science 319, 756–760.

Ikin, K., Beaty, R.M., Lindenmayer, D.B., Knight, E., Fischer, J., Manning, A.D., 2013. Pocket parks in a compact city: how do birds respond to increasing residential density? Landsc. Ecol. 28, 45–56.

Ives, C.D., Kendal, D., 2014. The role of social values in the management of ecological systems. J. Environ. Manag. 144, 67–72.

Kendal, D., Zeeman, B.J., Ikin, K., Lunt, I.D., McDonnell, M.J., Farrar, A., Pearce, L.M., Morgan, J.W., 2017. The importance of small urban reserves for plant conservation. Biol. Conserv. 213, 146–153.

Klaus, V.H., 2013. Urban grassland restoration: a neglected opportunity for biodiversity conservation. Restor. Ecol. 21, 665–669.

Kowarik, I., 2017. Urban wilderness: supply, demand, and access. Urban For. Urban Green. 29, 336–347.

Lin, B.B., Fuller, R.A., 2013. Sharing or sparing? How should we grow the world's cities? J. Appl. Ecol. 50, 1161–1168.

Lin, B.B., Gaston, K.J., Fuller, R.A., Wu, D., Bush, R., Shanahan, D.F., 2017. How green is your garden?: Urban form and socio-demographic factors influence yard vegetation, visitation, and ecosystem service benefits. Landsc. Urban Plann. 157, 239–246.

Mathey, J., Arndt, T., Banse, J., Rink, D., 2018. Public perception of spontaneous vegetation on brownfields in urban areas—results from surveys in Dresden and Leipzig (Germany). Urban For. Urban Green. 29, 384–392.

Nassauer, J.I., 1995. Messy ecosystems, orderly frames. Landsc. J. 14, 161–170.

Ng, W.-Y., Chau, C.-K., Powell, G., Leung, T.-M., 2015. Preferences for street configuration and street tree planting in urban Hong Kong. Urban For. Urban Green. 14, 30–38.

Palliwoda, J., Kowarik, I., von der Lippe, M., 2017. Human-biodiversity interactions in urban parks: the species level matters. Landsc. Urban Plann. 157, 394–406.

Riva, G., Teruzzi, T., Anolli, L., 2003. The use of the internet in psychological research: comparison of online and offline questionnaires. Cyberpsychol. Behav. 6, 73–80.

Rupprecht, C.D., Byrne, J.A., Lo, A.Y., 2016. Memories of vacant lots: how and why residents used informal urban green space as children and teenagers in Brisbane, Australia, and Sapporo, Japan. Child Geogr. 14, 340–355.

Säumel, I., Weber, F., Kowarik, I., 2016. Toward livable and healthy urban streets: roadside vegetation provides ecosystem services where people live and move. Environ. Sci. Pol. 62, 24–33.

Schielzeth, H., 2010. Simple means to improve the interpretability of regression coefficients. Meth. Ecol. Evol. 1, 103–113.

Soga, M., Gaston, K.J., 2016. Extinction of experience: the loss of human–nature interactions. Front. Ecol. Environ. 14, 94–101.

Soga, M., Gaston, K.J., Koyanagi, T.F., Kurisu, K., Hanaki, K., 2016. Urban residents' perceptions of neighbourhood nature: Does the extinction of experience matter? Biol. Conserv. 203, 143–150.

Soga, M., Yamaura, Y., Aikoh, T., Shoji, Y., Kubo, T., Gaston, K.J., 2015. Reducing the extinction of experience: association between urban form and recreational use of public greenspace. Landsc. Urban Plann. 143, 69–75.

Threlfall, C.G., Kendal, D., 2018. The distinct ecological and social roles that wild spaces play in urban ecosystems. Urban For. Urban Green. 29, 348–356.

Todorova, A., Asakawa, S., Aikoh, T., 2004. Preferences for and attitudes towards street flowers and trees in Sapporo, Japan. Landsc. Urban Plann. 69, 403–416.

Van den Berg, A.E., van Winsum-Westra, M., 2010. Manicured, romantic, or wild? The relation between need for structure and preferences for garden styles. Urban For. Urban Green. 9, 179–186.

Villaseñor, N.R., Tulloch, A.I., Driscoll, D.A., Gibbons, P., Lindenmayer, D.B., 2017. Compact development minimizes the impacts of urban growth on native mammals. J. Appl. Ecol. 54, 794–804.

Wallace, K.J., Wagner, C., Smith, M.J., 2016. Eliciting human values for conservation planning and decisions: a global issue. J. Environ. Manag. 170, 160–168.

Weber, F., Kowarik, I., Säumel, I., 2014. A walk on the wild side: perceptions of roadside vegetation beyond trees. Urban For. Urban Green. 13, 205–212.

White, E.V., Gatersleben, B., 2011. Greenery on residential buildings: Does it affect preferences and perceptions of beauty? J. Environ. Psychol. 31, 89–98.