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Is an Environment with High Biodiversity the Most Attractive for Human Recreation? A Case Study in Baoji, China

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Abstract: Evidence has been accumulating of the psychological and physiological benefits and well-being gained by individuals from recreational activities in urban green spaces due to their ability to sustain biodiversity, but maximizing both biodiversity and recreational values of green spaces has become increasingly difficult in practice. In order to better maximize the biodiversity and recreational value of urban green space, this study was conducted through the utilization of an onsite questionnaire to understand people's perceptions of and preferences for biodiversity and recreational values of urban green spaces in Baoji City, China. The results showed that respondents were able to correctly perceive biodiversity and preferred to engage in recreational activities in the high biodiversity environment. However, the respondents' perceptions of the eight perceived sensory dimensions (PSDs) in the different habitats were divergent, and an environment which is high in biodiversity does not necessarily have higher PSDs. Moreover, 'living environment' and 'frequency to the park' had significant impacts on perception of and preference for urban biodiversity. In addition, 'education level', 'living environment', 'age', and other indicators were more likely to influence the perception of the eight PSDs. Therefore, the presented findings can be applied by urban landscape planners to assess the qualities of urban green spaces in order to maintain urban biodiversity and meet the satisfaction of human recreation in the future.

Keywords: urban green space; biodiversity; perceived sensory dimensions; landscape preference; landscape perception

1. Introduction

With the rapid development of urbanization and the pursuit of high-quality living conditions for inhabitants, urban green spaces have played a significant role in ecology, economy, socio-culture, health, and environmental benefits [1–5]. The ways in which urban green spaces can benefit cities and their inhabitants have become key issues in urban planning [6]. Evidence has been accumulating of the psychological and physiological benefits and well-being gained by individuals from recreational activities in urban green spaces due to their ability to sustain biodiversity [7,8], but maximizing both biodiversity and recreational values of green spaces has become increasingly difficult in practice [9]. Many conservation biologists have found that it is challenging to mesh conservation priorities with recreational motivations for maintaining and enhancing green spaces [10], mainly due to the lack of knowledge about the relationship between biodiversity and recreational values in urban green spaces.

Uzzell [11] claimed that environmental issues are often derived from human emotions and perceptions of the environment. Stokes [12] noted that much of the world's biodiversity can survive if people choose to protect it, which implies that human preference could be an important determinant of many species' prospects for survival. In a certain sense, human biodiversity preferences not only play a significant role in the implementation of biodiversity conservation, but also can predict which aspects of biodiversity appeal to people and which aspects repel them [13]. In order to better maximize the biodiversity and recreational value of urban green space, it is important to understand people's perceptions of and preferences for biodiversity. Although landscape perception and preference has gradually formed a set of systems, research on the perception of and preference for biodiversity in urban green spaces is not abundant. Moreover, the relationship between biodiversity and recreational preference is unclear [14]. In a study of urban green space in Sheffield, England, Fuller et al. [15] found that species richness had a positive relationship with human well-being, while the results of Dallimer et al. [16] were the opposite. Qiu et al. [13] found that although respondents could correctly perceive biodiversity, they preferred low biodiversity scenes of open areas with groups of bushes and trees rather than high biodiversity scenes of dense vegetation in the forest. These inconsistencies require further attention to reveal the reasonings and driven factors of human perceptions of green spaces.

People seeking different recreational experiences may require different environmental conditions for their satisfaction [9], while people's perceptions and experiences can shape and define different environments [10]. The characteristics of the environment thus depend on the interaction between people's cognition and the environment, which can shape and be shaped by the interactive process [9]. Previous studies of landscape perception and preference suggested that people's perceived value of green space can be classified into specific characteristics [17–19], which largely correspond to different human recreational needs. In recent decades, these perceptive attributes have often been regarded as a tool for green space assessment, green space planning and design, recreational experience mapping of green space, and related planning policy guidance [20–22]. One of these classifications that has been developed over the last 40 years has become widely applied in green space assessment. The latest version is referred to as the eight perceived sensory dimensions (PSDs), which is based on the results of a questionnaire used to survey over a thousand randomly selected participants in four Swedish cities who reported their preferences from a long list of qualities of green space [20]. These eight PSDs include: Serene, Nature, Rich in species, Space, Prospect, Refuge, Social and Culture. In this study, the eight PSDs were used as tools for a recreational-values assessment of urban green space based on the legitimacy that several studies have tested the eight PSDs in urban environmental settings within different cultural contexts [20,23,24]. For urban biodiversity (a complex concept involving different levels and scales), this study reflected the level of urban biodiversity through well-defined, quantifiable, and easily monitored biodiversity, mainly focusing on the number of vascular plants [25,26].

In order to explore the specific relationship between biodiversity and recreational preference in Chinese urban environmental settings, this study was conducted using an interdisciplinary research of trade-offs and synergies between biodiversity conservation and human recreation. The specific objectives were to investigate:

1. Measurement of biodiversity in the study area.
2. Residents' perceptions of and preferences for biodiversity in different types of urban green spaces.
3. Residents' perceptions of the eight PSDs (Serene, Nature, Rich in species, Space, Prospect, Refuge, Social, and Culture) in different urban green spaces.
4. Relationship between biodiversity and the eight PSDs in urban green spaces.
5. Factors influencing the perceptions of and preferences for biodiversity and the eight PSDs in urban green spaces.

2. Materials and Methods

2.1. Study Area

The study was conducted at the People's Park of Baoji City, Shaanxi Province. The park was opened in 1979 and covers a total area of 34.60 hm^2, with 9.33 hm^2 of water accounting for approximately 27% of the entire park. The park has a high level of management and is mainly composed of lawns, shrubs, and woods, with an artificial lake and islet. The People's Park attracts a large number of visitors annually, making it one of the most popular recreational areas in Baoji (Figure 1). After a comprehensive field survey of the green spaces was conducted with varying vegetation structure and main landscape features of the People's Park, six typical types of habitats were selected with similar sizes (Table 1).

Table 1. Characteristics of the study area.

Land Cover	Type	Characteristics of Habitat
Grey space	Habitat 1	Public square, abiotic coverage rate 90%–100%, mainly covered with little or no greenery.
Grey space	Habitat 2	Playground, abiotic coverage rate 75%–90%, Greening is dominated by middle-aged broad-leaved trees and shrubs.
Green space	Habitat 3	Closed one-layered mixed green space, mainly composed of *Metasequoia glyptostroboides*.
Green space	Habitat 4	Lakeside, semiclosed multilayered mixed green area, mainly composed of *Ligustrum lucidum* and *Fatsia japonica*.
Green space	Habitat 5	Open lawn with perennial grass trimming, mainly composed of *Cynodon dactylon* and *Eleusine indica*.
Green space	Habitat 6	Islet, closed multilayered mixed green space, mainly composed of *Ligustrum lucidum* and *Pinus tabuliformis*.

Habitat 1 is a public square in the entrance of the park which is paved with rigid materials; a few rows of trees line the two sides of the square along with some cultural sculptures and flower beds.

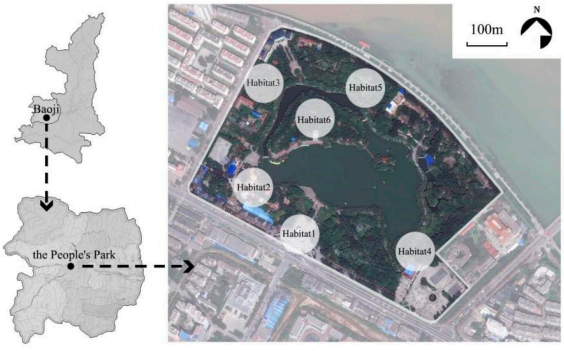
Habitat 2 is a playground, which includes a large number of recreational facilities and benches, but the greening in the area is not too lush, containing only shrubs.

Habitat 3 is a closed one-layered mixed grove with paths and some benches where people can move around freely.

Habitat 4 is a semiclosed multilayered mixed woodland, surrounded by a road along the lake and some benches placed under the *Cedrus deodara*.

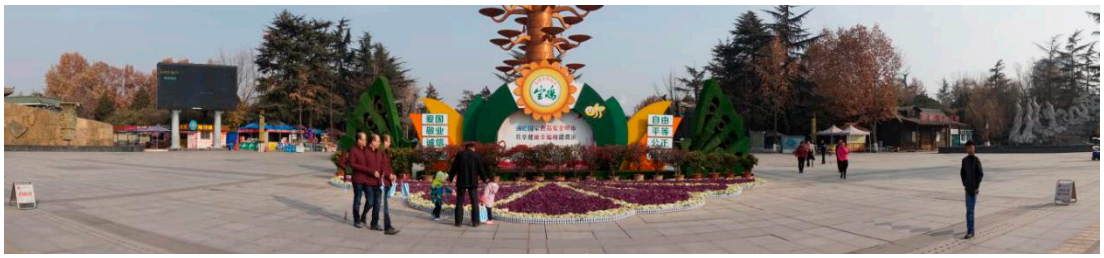
Habitat 5 is the largest perennial manicured open lawn containing some animal sculptures made from discarded tyres. This habitat contains some pavilions on the north side where visitors often perform with musical instruments, chorus training, and singing performances.

Habitat 6 is an islet with closed multilayered mixed woodland and is densely covered with plants; there exists artificial rockery and some pavilions for tourists to watch and relax (Figure 1).

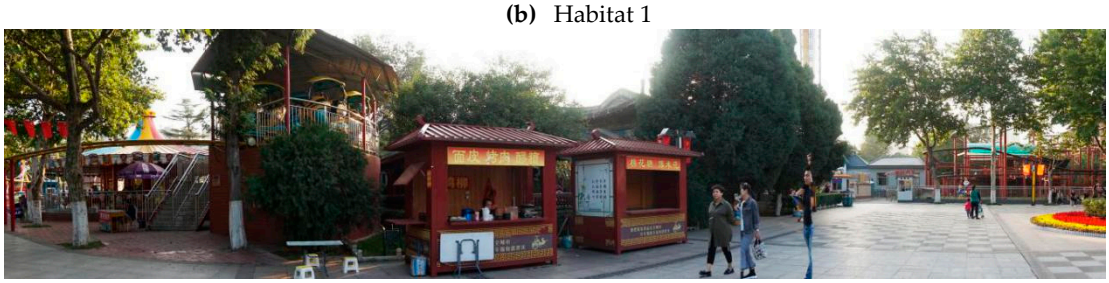


(a) The study area

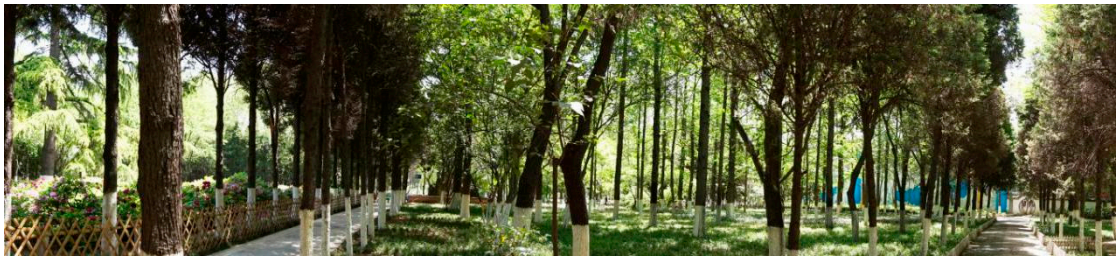
Figure 1. *Cont.*



(b) Habitat 1



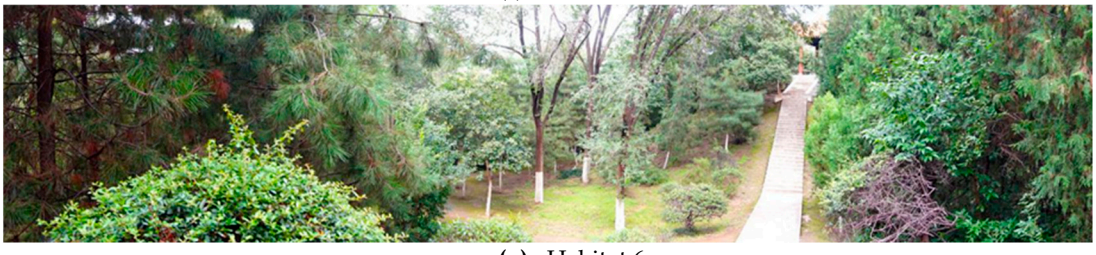
(c) Habitat 2



(d) Habitat 3

(e) Habitat 4

(f) Habitat 5



(g) Habitat 6

Figure 1. The study area with panoramic photos of the six different habitats in People's Park.

2.2. Measurement of Biodiversity

In this study, the species survey of vascular plants was carried out on the selected six habitats using a linear measurement method. Three parallel or "*" lines with a spacing of 20 m and a length of 60 m were utilized in each habitat to set the center of each plot, excluding peripheries of five meters. Every species of vascular plant which was exposed within 2 m of each strip at 4 m intervals was recorded, including those that were touched by the strip and vertically projected above and below the strip. The species of vascular plants that came into contact with lines and the frequency of their occurrence in the plot were recorded. The total frequency of the species was the sum of the frequencies of the species on the three lines. Therefore, the number of vascular plant species in each green space was obtained.

2.3. Data Collection

In this study, we used eight PSDs. The eight PSDs were used by Grahn and Stigsdotter [19] and they include:

1. Serene: An undisturbed, silent and safe environment where one can completely relax, without too many disturbances.
2. Nature: An experience of the inherent force and power of nature, designing and displaying intrinsic vitality, inaccessible and wild.
3. Rich in species: Sensation of finding a wide range of expressions of life, such as abundant flowers, birds, and butterflies.
4. Space: An environment experienced as spacious and free, one which has a certain quality of connectedness and lots of trees, and is not disturbed by too many roads and paths.
5. Prospect: An area containing open and plane views, e.g., flat and well-cut lawns with scattered trees.
6. Refuge: An enclosed and safe environment with many bushes. People can sit down and watch other people being active.
7. Social: An environment in which social activities can be performed, such as gatherings, exhibitions, etc.
8. Culture: A cultural and historical environment with fountains, statues, and exotic plants, etc.

Before the design of the questionnaire, in order to understand whether local Chinese residents understand the meaning of the eight PSDs, an interview survey was conducted. The results showed that the vast majority of interviewees could correctly understand the meanings of the eight PSDs. Then, respondents were randomly selected from the six habitats in which they were for recreational purposes. The questionnaire was distributed after their consent was obtained. Before filling in the questionnaire, the scope of the venue was explained to the respondents to ensure that their answers could accurately reflect their feelings at the time. The study was conducted on both weekdays and weekends during September and October of 2017 when the weather was sunny and windless.

The questionnaire contains three parts: (1) Personal basic information, including gender, age, education level, living environment, and ecological background knowledge. (2) Usage of green space in the park, including the distance of residence from the park, the frequency of park use, and how respondents reach the park. (3) Perception of and preference for species richness and the eight PSDs. The perceptive degree of species richness is represented by "1, 2, 3" representing "low, medium, high". The eight PSDs are described in text, accompanied by the corresponding photos. Perception of the eight PSDs is measured using a five-point Likert scale. The score of "1, 2, 3, 4, and 5" represents "none, weak, medium, strong, and very strong" of the perception level. According to the method of Tosun [27], a mean value of the five-point Likert scale of the eight PSDs between 1 and 2.4, indicates that the degree of perception is low, a mean value between 2.5 and 3.4 indicates a moderate degree of perception, and a mean value between 3.5 and 5 indicates a high degree of perception.

2.4. Data Analysis

This study used the number of vascular plant species (NVPS) to represent the level of species richness in each habitat. A reliability analysis of the five-point Likert scale used by respondents to rate the eight PSDs in different habitats was utilized by the researchers using SPSS 17.0 (Statistical Package for the Social Sciences version 17.0) software. The total Cronbach's α coefficient of the scale is 0.774 (>0.7), which means that the evaluation project has a high correlation and the internal reliability is quite reliable.

Correlation analysis among actual biodiversity, perceived biodiversity, and the eight PSDs in different habitat types was conducted using the Pearson correlation analysis (CORR) in SAS 9.4 (Statistical Analysis System 9.4) software. A one-way analysis of variance (ANOVA) was used to analyze the variance of preferences in different habitats to test the significance of any differences. The generalized linear model (GLM) was used to determine the factors influencing the perception and preference of biodiversity and the eight PSDs, respectively, and the significant factors were identified.

3. Results

A total of 1119 respondents filled out the questionnaire, with incomplete responses obtained from 30 respondents. Thus, the final total of valid questionnaires received was 1089 (Table 2), of which 119 were conducted in Habitat 1 (119), 133 in Habitat 2 (133), 269 in Habitat 3 (269), 109 in Habitat 4 (109), 270 in Habitat 5 (270), and 189 in Habitat 6 (189). Through field investigation and statistical analysis, the species richness (NVPS) of the six habitat types was obtained; the habitats were ranked from lowest to highest including Habitat 1 (5 species), Habitat 2 (18 species), Habitat 3 (20 species), Habitat 4 (24 species), Habitat 5 (27 species), and Habitat 6 (31 species) (Tables 3 and A1 in Appendix A).

Table 2. Major personal basic information of respondents within the six habitats.

Factors Category	Habitats						Sum	(%)
	1	2	3	4	5	6		
Gender								
Women	53	68	99	62	94	91	467	43
Men	66	65	170	47	176	98	622	57
Age								
<12	0	2	9	2	4	0	17	2
13–17	5	16	12	8	21	23	85	8
18–25	36	46	62	35	49	93	321	29
26–40	30	35	61	26	48	24	224	21
41–60	25	24	67	21	70	34	241	22
>60	23	10	58	17	78	15	201	18
Education level								
Basic education	52	50	123	51	139	72	487	45
Higher education	63	79	137	53	119	110	561	52
Postgraduate education and above	4	4	9	5	12	7	41	4
Living environment								
Without greening	17	17	28	14	36	34	146	13
Without supporting greening but has municipal greening	23	30	72	21	40	30	216	20
Without municipal greening but has supporting greening	10	17	42	8	41	37	155	14
With supporting greening and municipal greening	67	68	1266	63	149	88	561	52
With private garden	2	1	1	3	4	0	11	1

Table 2. *Cont.*

Factors Category	Habitats						Sum	(%)
	1	2	3	4	5	6		
Frequency to the park								
Almost none	10	12	25	20	18	39	124	11
Two or three times a year	11	19	22	5	27	26	110	10
Once a month	25	35	59	28	55	52	254	23
Once a week	26	27	42	19	36	36	186	17
Two or three times a week	21	23	48	19	44	15	170	16
Everyday	26	17	73	18	90	21	245	22
Attitude towards public green spaces								
Very important	76	73	169	66	181	115	680	63
Comparatively important	41	54	90	39	80	69	373	34
Not essential	0	1	6	2	2	4	15	1
Have not considered	2	5	4	2	7	1	21	2
How to get to the park								
On foot	59	46	141	56	142	63	507	47
By bike	7	12	14	6	11	7	57	5
By car	6	13	22	9	31	21	102	9
By bus	38	61	84	30	74	83	370	34
Other	9	1	8	8	12	15	53	5
Ecological knowledge								
more	18	10	20	14	32	20	114	10
some	23	25	72	37	58	52	267	25
less	62	73	149	52	150	102	588	54
none	16	25	28	6	30	15	120	11

Table 3. One-way analysis of variance between each preference in different habitats.

Habitat Type	Preference				
	Duncan Grouping		Mean	Number	Rank
Habitat 4		A	3.96	109	1
Habitat 5		A	3.94	270	2
Habitat 3	B	A	3.89	269	3
Habitat 6	B	C	3.77	189	4
Habitat 1	B	C	3.76	119	5
Habitat 2		C	3.65	133	6

3.1. Perception and Preference of Biodiversity

Correlation analysis showed that there was a significant correlation between perceived biodiversity and actual biodiversity ($R = 0.08$, $P < 0.05$), and indicated that respondents were able to correctly perceive biodiversity among the different habitat types.

The results of a one-way analysis of variance (ANOVA) suggested that respondents' preferences of each habitat significantly differed ($F = 4.34$, $P < 0.01$). Habitats 4 and 5 were the most popular of the six habitats, while Habitat 2 was the most disliked. Habitats 1, 3, and 6 were in the middle of the preference list (Table 3).

Correlation analysis also showed a significant positive correlation between perceived biodiversity and preference ($R = 0.448$, $P < 0.0001$), which indicated that the respondents preferred the habitats with the highest levels of biodiversity (Figure 2).

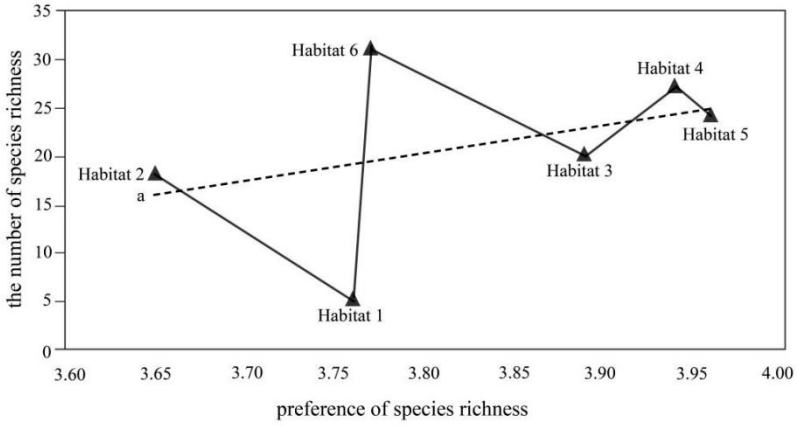


Figure 2. The relationship between perceived biodiversity and preference; "a" represents the trendline of perceived biodiversity and preference.

3.2. Perception of the Eight Perceived Sensory Dimensions and the Relationship with Recreational Preference

3.2.1. Perception of the Eight Perceived Sensory Dimensions

It was found that respondents were able to perceive different recreational attributes in each of the six habitats. Environments with more natural and abundant vegetation structures (Habitats 3, 4, 6) provided the highest number of experiences of Serene, Nature, and Space, while the environments with high artificial management and hard pavement (Habitat 1, 2) accounted for the majority of experiences of Social and Culture. Social was also highly perceived in the open lawn with some pavilions (Habitat 5). In addition, the respondents did not frequently perceive Rich in species, Prospect, and Refuge in these six habitats (Table 4).

Table 4. Perception of the eight perceived sensory dimensions in different habitats.

The Eight Perceived Dimensions	Habitat Type					
	Habitat 1	**Habitat 2**	**Habitat 3**	**Habitat 4**	**Habitat 5**	**Habitat 6**
Serene	2.92	3.11	3.70 *	3.74 *	3.29	3.60 *
Nature	2.91	3.14	3.62 *	3.65 *	3.45	3.70 *
Rich in species	2.93	3.02	3.15	3.19	3.19	3.26
Space	3.32	3.49	3.44	3.70 *	3.30	3.38
Prospect	3.16	3.03	2.82	3.24	2.97	3.28
Refuge	2.77	3.02	3.19	3.26	3.04	3.22
Social	3.97 *	3.96 *	3.38	3.43	3.65 *	3.19
Culture	3.80 *	3.39	3.25	3.39	3.36	3.11

"*" high degree of respondents' perception of the eight perceived sensory dimensions.

3.2.2. Relationship between Preference and the Number of Highly Rated PSDs in the Different Habitats

In order to identify the relationship between recreational preference and recreational values of environment in different habitats, correlation analyses between preference and the number of highly rated PSDs in each habitat were conducted (Figure 3). However, the correlation analyses found that there were not significant correlations between them ($R = 0.435$, $p = 0.389$).

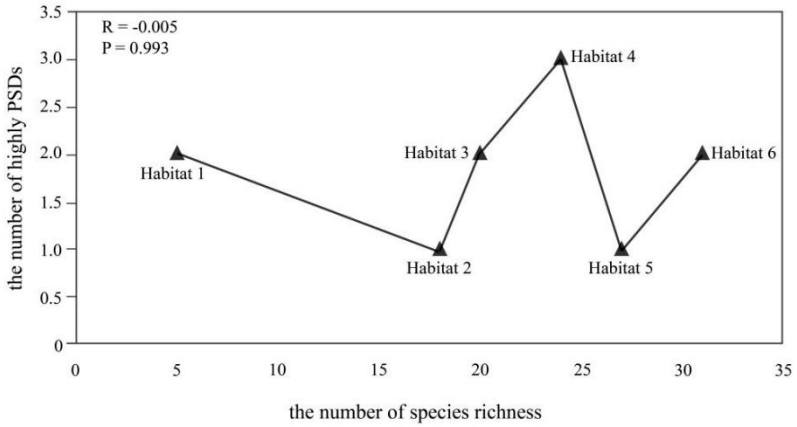


Figure 3. The relationship between the preference and the number of recreational attributes.

3.3. Relationship between Biodiversity and the Number of Eight PSDs

The species richness number and perception of the eight PSDs in different habitats can be found in Figure 4. The correlation analyses found that a correlation did not exist between them (R = −0.005, $p = 0.993$), indicating that an environment with high biodiversity is not necessarily to be perceived as having many recreational attributes, and vice versa.

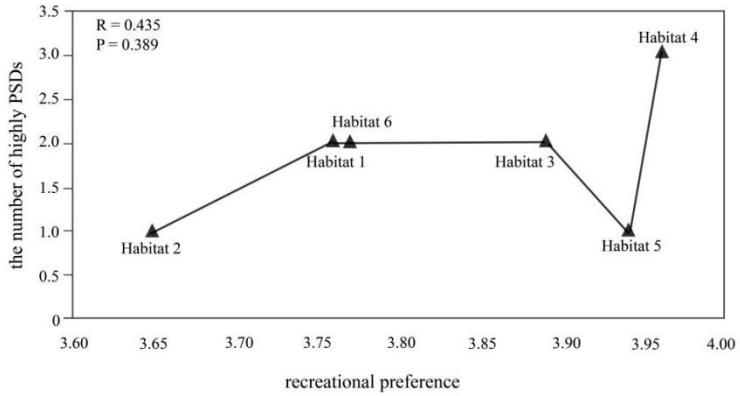


Figure 4. The relationship between the species richness and the number of recreational attributes.

3.4. Factors Influencing Perception of and Preference for Biodiversity and Eight PSDs

3.4.1. Factors Affecting Perception and Preference of Biodiversity

There exists a significant correlation between respondents' attributes and the perception and preference of biodiversity ($p < 0.05$). Specifically, 'living environment' and 'frequency to the park' had significant influences on the perception of and preference for urban biodiversity, which indicates that people who live in an environment containing more green spaces and who often visit the park are able to more easily perceive biodiversity and appreciate it (Table 5).

Table 5. Factors affecting the preference and perception of biodiversity.

Factors	Category	Preference		Perception	
		Estimated Value	*p*	Estimated Value	*p*
Living environment			0.00		0.04
	Without greening	0.02		−0.19	
	Without supporting greening but have municipal greening	0.02		−0.18	
	Without municipal greening but have supporting greening	−0.01		−0.28	
	With supporting greening and municipal greening	0.19 *		−0.12	
	With private garden	0.00		0.00 *	
Frequency to the park			<0.0001		0.02
	Almost none	−0.38		−0.21	
	Two or three times a year	−0.42		−0.18	
	Once a month	−0.24		−0.14	
	Once a week	−0.25		−0.07	
	Two or three times a week	−0.00		0.05 *	
	Everyday	0.00 *		0.00	

"*" represents the strongest influence factor.

3.4.2. Factors Affecting Perception of the Eight PSDs

The generalized linear regression showed that the perception of each PSD was influenced by the different factors. 'Education level', 'living environment', 'age', 'ecological knowledge', 'attitude towards public green spaces', 'frequency to the park', 'how to get to the park', 'distance between home and park', and 'number of companions' more easily influenced the perception of the certain PSDs. Respondents who have received basic education, who drive, or those who come to the park two or three times a week were more likely to perceive the sensory dimension of Nature; Rich in species was more frequently perceived by respondents with basic education levels and private gardens; Prospect was more frequently perceived by respondents who were 13–17 years old, who had a basic education, and those whose living environment contained a private garden; respondents living 0–100m from the park and individual activity could better perceive the sensory dimension of Refuge; Culture was more frequently perceived by respondents who were 13–17 years old, those who had a basic level of education and those who had some ecological knowledge. The difference in perceptions of Serene and Social was not obvious (Table 6).

Table 6. Influencing factors that have significant differences in the perception of the eight perceived sensory dimensions.

Factors	Category	Estimated Value of the Eight PSDs					
		Nature	Rich in Species	Prospect	Culture	Refuge	Space
Education level	Basic education	0.41 **	0.57 **		0.84 ***		
	Higher education	0.24	0.32		0.67		
	Postgraduate education and above	0.00	0.00		0.00		
Living environment	Without greening		−0.34	−0.55			−0.27
	Without supporting greening but have municipal greening		−0.32	−0.59			−0.29
	Without municipal greening but have supporting greening		−0.45	−0.62			−0.43
	With supporting greening and municipal greening		−0.15	−0.34			−0.17
	With private garden		0.00 **	0.00 **			0.00 *
Age	<12			0.40	0.60		
	13–17			0.48 **	0.80 ***		
	18–25			0.45	0.39		
	26–40			0.01	0.17		
	41–60			0.00	0.10		
	>60			0.00	0.00		
Ecological knowledge	None				−0.36		
	Less				0.06		
	Some				0.21 ***		
	More				0.00		
Attitude towards public green spaces	Have not considered				0.36 ***		
	Not essential				−0.70		
	Comparatively important				−0.18		
	Very important				0.00		
Frequency to the park	Almost none	0.03					
	Two or three times a year	−0.33					
	Once a month	−0.07					
	Two or three times a week	0.20 **					
	Once a week	−0.02					
	Everyday	0.00					
How to get to the park	On foot	0.06					
	By bike	−0.22					
	By bus	0.17					
	By car	0.28 **					
	Other	0.00					
Distance between home and park	0–100m					0.16 *	
	100–500m					−0.26	
	500–1000m					−0.08	
	>1000m					0.00	
Number of companions	Separate activity					0.05 *	
	Two people					0.01	
	Three or five friends					−0.15	
	Small family					−0.23	
	Big family					0.00	

* indicates significant at 0.05 level, ** at 0.01, and *** at 0.001.

4. Discussion

4.1. Perception and Preference of Biodiversity in the Different Habitats

In more controlled settings, such as experimental plant arrays or grassland patches, there has been shown to be a significant positive association between perceived and actual plant species richness [28]. This study found that the respondents could also correctly perceive species richness in urban green spaces, indicating that the Chinese inhabitants are not disconnected from an experience of green biodiversity in the urban environment. Fuller and his colleagues [15] considered that this was because plants are the most visible and static component of biodiversity. Some studies have found that people have perceived colorful plants as having higher species richness than those with single colors [29,30], and other researchers have found that lush plants, private gardens, and old trees were often used to describe high species richness, while lawns and bare ground were thought to be characteristics of low species richness [13]. Perceived species richness was positively associated with vegetation height, evenness, and color, suggesting that these may be the cues used to estimate species richness in a related study [30]. In general, our findings are consistent with other studies, confirming that the actual biodiversity of urban green space can indeed be estimated to some degree of precision by urban inhabitants [13,15,23,28].

Studies by Qiu et al. [13] and Dallimer et al. [16] showed that people's recreational preferences are not related to biodiversity, but some studies have found that people preferred an environment with rich and diverse plants [15,31,32]. This study found that people's preferences have a positive correlation with species richness, and the degree of preference significantly differed in the different habitats. In general, respondents preferred green spaces to grey spaces. Comparing to Habitat 6 with the highest species richness but a jumble of plants, Habitat 4, which was located around the lake with an open view, and Habitat 5, which contained an open lawn, were more popular places for recreation. This is perhaps because people preferred green spaces with open lawns and shrubbery than the jungle [33–35]. People often have different understandings of nature and their picturesque notion of nature (i.e., 'natural') as a landscape that looks tended, demand a certain level of visible care and order rather than wild, but truly ecologically rich environments are often considered 'messy' [13]. Therefore, although Habitats 4–6 were the environments with high species richness, people still preferred Habitat 4 and 5 with high management and orderliness. Moreover, the lake in the park could be another reason why visitors were attracted [29], which reflected individuals' inherent sentiment of water. That is why Habitat 4 is one of the most favored places of respondents. Habitat 1 and 2 were grey spaces and were the most disliked places due to the low presence of plants and less recreational facilities for the respondents' relaxation. Although there were a few plants in Habitat 2, ceaseless noise from the children's amusement equipment could possibly influence the respondents' social communication and recreation. In this study, we found that respondents were able to accurately perceive biodiversity and preferred the habitats high in biodiversity among the different habitat types for recreation. Therefore, in Chinese urban environmental settings, it may be a greater challenge of trade-offs and synergies between biodiversity conservation and human recreation, thereby requiring greater reason and caution when planning and designing urban green spaces.

4.2. Perception of the Eight PSDs in the Different Habitats

The personal perception of local respondents has an important impact on shaping environmental characteristics [19,36]. This study found that people could frequently experience the sensory dimension of Social in Habitats 1, 2, and 5. Habitat 1 provides an open space for social activities, such as public square dancing which has become a common open-air fitness practice across China in the recent decade with many middle-aged and elderly participants. Habitat 2 contains many recreational facilities for people's recreation, such as a roller coaster and a pirate ship. Habitat 5 has some pavilions, wherein some people gathered together to perform musical instruments, exercise chorus, and watch others. The sensory dimension of Culture can be embodied by the cultural elements of human artifacts such as

stone, artificial fountains, and ornamental plants, history, myths, and the living conditions of human beings [20]. In Habitat 1, respondents strongly perceived the Culture sensory dimension, because it includes large artificial landscape sculptures, fountains, and walls which are set up in the center and on both sides, reflecting the characteristics of culture. In Habitats 3, 4, and 6 both Serene and Nature sensory dimensions can be perceived. Those inhabiting environments inclusive of many plants are more likely to experience calm and peaceful feelings than those in the environment containing hard pavement in the grey spaces and the environment with many tourists [37]. These three habitat types are all woodlands with more trees and shrubs, mainly covered by herbaceous species, and the whole atmosphere is serene and peaceful. Among them, Habitat 4 is located on the lakeside of the park with some benches located under the trees. The respondents would have a leisurely feeling of entering another world and could perhaps feel and perceive more Space there. Urban parks not only provide residents with a peaceful, spacious, and natural environment, but also provide places for a full variety of social and cultural activities. Therefore, it is easy for respondents to feel the dimensions of Serene, Space, Nature, Social, and Culture in the park. Respondents were not easily able to perceive Prospect, Rich in species, and Refuge in the People's Park probably due to the limited amount of green spaces with seldom complex structures and higher levels of management.

People in different habitats can perceive different PSDs and have diverse experiences [20]. Serene, Nature, and Space were perceived in Habitat 4, but Social was perceived in Habitat 5. In Habitats 1, 3, and 6, although respondents perceived the greatest number of highly rated PSDs (Table 4), the degree of preference varied, which indicated that people's preferences were not related to the number of highly rated PSDs. This could be attributed to the distinctive characteristics of each habitat, such as the certain specific elements or the setting configurations [13]. Interestingly, Habitats 2 and 5 were both highly perceived as Social, but they received vastly different preferences. Habitat 2 was the most disliked habitat, while Habitat 5 was the most liked, perhaps because people have different understandings of the Social dimension due to these two habitats' features. The parents would like to accompany their kids playing on the playground in Habitat 2, but where the noise of amusement equipment existed, they were annoyed. Respondents in Habitat 5 were willing to participate in all kinds of social activities including instrumental performance, chorus, and watching people.

4.3. Analysis of Relationship between Biodiversity and the Eight PSDs

Biodiversity plays a positive role in urban ecological protection and improves residents' well-being [29]. The eight PSDs are reliable tools for urban green space assessment and planning, which can help planners plan and design for public recreational needs and expectations [21]. However, this study showed that the relationship between biodiversity and the number of highly rated PSDs is irrelative. A green space's attributes, surrounding environment, as well as people's internal cognition of green space can all influence the perceptions of the PSDs [21]. The biodiversity in the different habitats may affect people's perceptions of the certain PSDs, and an environment high in biodiversity does not necessarily provide a lot of PSDs for human recreation. On the contrary, not all recreational values of urban green space should be represented in an environment with high levels of biodiversity. The perceptions of biodiversity also depend on the respondents' own attributes [35]. In our study, the results showed that education level and living environment could affect the perception of Rich in species (Table 6). Ecological education and green living environments might be some ways by which the merging of ecological and recreational benefits could be achieved through green space planning and management.

4.4. Factors Influencing Perception and Preference of Biodiversity and the Eight PSDs

When discussing biodiversity and how people perceive, experience, and evaluate it, one has to consider people's understanding of natural landscapes and nature, because each person's perception and evaluation of the environment is based upon their personal and cultural backgrounds [29,38–40]. High frequency to the green spaces affects people's environmental awareness and preference [41].

Respondents who came to the park two or three times a week and had private gardens were generally satisfied with the park and easily perceived the high level of biodiversity [42]. This indicates that the more green spaces exist in people's living environment and more frequent their visits to the park, the stronger people's perceptions of and preferences for biodiversity are. These results can be used as a theoretical support for public awareness and conservation of biodiversity.

Due to different social and cultural backgrounds, people's perception and assessment of the natural environment vary [40]. The perception of various landscapes also depends on the respondents' own attributes, such as gender, age, social status, childhood environment, and frequency of green space use [24,35,43]. This study showed that for the different PSDs, respondents with varying personal backgrounds had different perceptions of the park, which is of great importance to planning and designing a specific recreational environment. Respondents from different backgrounds have different perceptions of Rich in species, Nature, Prospect, Refuge, Culture, and Space, depending on their different natural experiences [40]. Interestingly, in this study, we found that Serene and Social were the two perceived dimensions that could be generally perceived by respondents in the context of the urban parks in China, that is, respondents had frequent experiences of Serene and Social in urban parks and there was no significant difference in the perception of them among the respondents. Thus, we suggest that in order to provide urban residents with more recreational activities, urban parks with certain PSDs (e.g., Nature, Rich in species, and Prospect) could be added in process of the urban green space planning and design. Meanwhile, the corresponding provisions of potential recreational activities should have less impact on urban biodiversity in order to fulfil the maximum biodiversity and recreational values in the Chinese urban environmental settings. For example, chatting, playing chess, gathering, meditation, etc. could be tentative options.

5. Conclusions

This study was the first to explore the perception and preference of residents for biodiversity and PSDs in the Chinese urban environmental settings, and aimed to provide a scientific theoretical basis and practical methods for balancing urban biodiversity conservation and human recreation. We found that respondents were able to accurately perceive biodiversity and preferred to engage in recreational activities in the higher biodiversity environments. However, the respondents' perceptions of the eight PSDs in the different habitats were divergent, and there were no specific correlations between biodiversity and the number of highly rated PSDs, that is, an environment with higher biodiversity does not necessarily have more highly valued PSDs. In addition, environments with more natural and abundant vegetation structures (Habitats 3, 4, 6) provided the most experiences of Serene, Nature, and Space, while the environments with high artificial management and hard pavement (Habitats 1, 2) provided the greatest experiences of Social and Culture and the environment containing an open lawn with some pavilions (Habitat 5) can be perceived as having a high degree of the Social dimension as well. The PSDs were quite closed related to biophysical landscape features and spatial properties [21], since the recreational values provided by the different levels of biodiversity environment were divergent. Therefore, we should determine the specific aims of the actual green space planning (biodiversity conservation or human recreation) to construct urban green spaces in future. Moreover, personal information can also affect respondents' perception and preference of green space. For instance, 'living environment' and 'frequency to the park' were the most important two factors influencing people's perception of and preference for biodiversity. The accessibility of green space has thus a great impact on people's perceptions and preferences. Compared with the quality of a green space, close proximity to the green space should be taken more into account in urban green space planning [44]. More attractive green spaces within walking distance should be added in the urban environmental settings. We also found that 'education level', 'living environment', 'age level', and other indicators were easier to influence the perception of the eight PSDs, which could be used for guiding the human-oriented planning and design of urban green spaces. Understanding people's perceptions and preferences of the green space environment is conducive to improving the quality

of residents' urban green space experiences and recreation, thereby increasing their well-being, but more importantly stimulated the awareness of the urban residents to recognize and support urban biodiversity and ecosystem services in green spaces.

In order to identify the specific relationships between biodiversity, PSDs, and preference for the trade-offs and synergies of urban biodiversity conservation and human recreation, further comparison investigations within different types of urban green spaces combined with the collection of more demographic information should be examined. In addition, although most people have higher ecological knowledge by self-test, the results showed that there was no significant correlation between ecological knowledge and preference. This result is not in line with previous studies [13,29] and needs further examination.

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Appendix A

Table A1. Total species of plants found in the People's Park.

Number	Species	Frequency	Life Form	Origin	Growth Pattern
1	*Veronica persica*	7	Annual herb	From abroad	Spontaneous
2	*Artemisia argyi*	2	Perennial herb	Local	Spontaneous
3	*Amaranthus lividus*	3	Annual herb	From abroad	Spontaneous
4	*Fatsia japonica*	17	Shrubs	From abroad	Cultivated
5	*Trifolium repens*	12	Perennial herb	From abroad	Cultivated
6	*Fraxinus chinensis*	1	Tree	From abroad	Cultivated
7	*Echinochloa crusgalli*	1	Annual herb	Local	Spontaneous
8	*Platycladus orientalis*	6	Tree	Local	Cultivated
9	*Potentilla supina*	1	Annual or biennial herb	Local	Spontaneous
10	*Plantago asiatica*	5	Biennial or perennial herb	Local	Spontaneous
11	*Rumex dentatus*	1	Annual	Local	Spontaneous
12	*Ailanthus altissima*	7	Tree	Local	Cultivated
13	*Broussonetia kazinoki*	1	Shrub	From home	Spontaneous
14	*Salix babylonica*	2	Tree	Local	Cultivated
15	*Juniperus formosana*	8	Tree	Local	Cultivated
16	*Robinia pseudoacacia*	7	Tree	From abroad	Cultivated
17	*Calystegia hederacea*	1	Annual herb	Local	Spontaneous
18	*Hemerocallis middendorfii*	1	Perennial herb	From abroad	Cultivated
19	*Rehmannia glutinosa*	1	Perennial herb	Local	Spontaneous
20	*Euphorbia humifusa*	2	Annual herb	Local	Spontaneous

Table A1. *Cont.*

Number	Species	Frequency	Life Form	Origin	Growth Pattern
21	*Euonymus japonicus*	4	Shrub	From abroad	Cultivated
22	*Eucommia ulmoides*	1	Tree	Local	Cultivated
23	*Stellaria media*	2	Annual or biennial herb	Local	Spontaneous
24	*Yucca gloriosa*	1	Shrub	From abroad	Cultivated
25	*Trigonotis peduncularis*	2	Annual or biennial herb	Local	Spontaneous
26	*Phyllostachys sulphurea*	2	Bamboo	Local	Cultivated
27	*Setaria viridis*	11	Annual herb	Local	Spontaneous
28	*Cynodon dactylon*	14	Perennial herb	Local	Spontaneous
29	*Broussonetia papyrifera*	8	Tree	Local	Cultivated
30	*Magnolia grandiflora*	1	Tree	From abroad	Cultivated
31	*Sophora japonica*	2	Tree	Local	Cultivated
32	*Pittosporum tobira*	1	Shrub or small tree	From home	Cultivated
33	*Rorippa indica*	1	Annual or biennial herb	Local	Spontaneous
34	*Salix matsudana*	1	Tree	Local	Cultivated
35	*Lolium perenne*	6	Perennial herb	From abroad	Cultivated
36	*Oxalis corymbosa*	1	Perennial herb	Local	Cultivated
37	*Photinia serrulata*	1	Shrub or small tree	From abroad	Cultivated
38	*Ancuba japonica*	3	Shrub	From abroad	Cultivated
39	*Eragrostis pilosa*	2	Annual or biennial herb	Local	Spontaneous
40	*Youngia japonica*	4	Annual herb	Local	Spontaneous
41	*Artemisia annua*	1	Annual herb	Local	Spontaneous
42	*Pyracantha fortuneana*	2	Shrub	Local	Cultivated
43	*Celosia cristata*	1	Annual herb	From abroad	Cultivated
44	*Paederia scandens*	18	Perennial vine	Local	Spontaneous
45	*Acer palmatum*	2	Tree	From home	Cultivated
46	*Populus* × *canadensis*	4	Tree	From abroad	Cultivated
47	*Nerium indicum*	1	Shrub	From abroad	Cultivated
48	*Equisetum ramosissimum*	1	Annual herb	Local	Spontaneous
49	*Arthraxon hispidus*	18	Annual herb	Local	Spontaneous
50	*Sonchus arvensis*	1	Perennial herb	Local	Spontaneous
51	*Melia azedarach*	1	Tree	From home	Cultivated
52	*Indocalamus latifolius*	1	Bamboo	From home	Cultivated
53	*Chimonanthus praecox*	3	Shrub	Local	Cultivated
54	*Chenopodium album*	4	Annual herb	Local	Spontaneous
55	*Eclipta prostrata*	2	Annual herb	Local	Spontaneous
56	*Forsythia suspensa*	4	Shrub	Local	Cultivated
57	*Paspalum conjugatum*	6	Perennial herb	Local	Spontaneous
58	*Sabina chinensis*	16	Tree	Local	Cultivated
59	*Solanum nigrum*	2	Annual	Local	Spontaneous
60	*Sophora japonica*	1	Tree	Local	Cultivated

Table A1. *Cont.*

Number	Species	Frequency	Life Form	Origin	Growth Pattern
61	*Humulus scandens*	1	Perennial herb	Local	Spontaneous
62	*Verbena officinalis*	3	Perennial herb	Local	Spontaneous
63	*Portulaca oleracea*	1	Annual herb	Local	Spontaneous
64	*Kalimeris indica*	2	Perennial herb	Local	Spontaneous
65	*Digitaria sanguinalis spp.sanguinalis*	9	Annual herb	Local	Spontaneous
66	*Dichondra repens*	1	Perennial herb	From home	Spontaneous
67	*Ophiopogon japonicus*	39	Perennial herb	Local	Cultivated
68	*Swida walteri*	21	Tree	From home	Cultivated
69	*Hibiscus mutabilis*	1	Shrub or small tree	Local	Cultivated
70	*Chaenomeles sinensis*	2	Shrub or small tree	Local	Cultivated
71	*Osmanthus fragrans*	1	Shrub or small tree	From home	Cultivated
72	*Nandina domestica*	7	Shrub	Local	Cultivated
73	*Araucaria cunninghamii*	3	Tree	From abroad	Cultivated
74	*Eleusine indica*	15	Annual	Local	Spontaneous
75	*Cynanchum auriculatum*	1	Perennial herb	Local	Spontaneous
76	*Achyranthes bidentata*	4	Perennial herb	Local	Spontaneous
77	*Galinsoga parviflora*	1	Annual herb	From abroad	Spontaneous
78	*Ligustrum lucidum*	46	Shrub or small tree	Local	Cultivated
79	*Plantago depressa*	18	Annual or biennial herb	Local	Spontaneous
80	*Veronica didyma*	1	Annual	Local	Spontaneous
81	*Taraxacum mongolicum*	8	Perennial herb	Local	Spontaneous
82	*Senecio scandens*	3	Perennial herb	Local	Spontaneous
83	*Pharbitis nil*	1	Annual herb	Local	Spontaneous
84	*Rubia cordifolia*	3	Perennial herb	From abroad	Spontaneous
85	*Bromus japonica*	3	Annual	Local	Spontaneous
86	*Cerasus serrulata var.* lannesiana	3	Tree	From home	Cultivated
87	*Acer buergerianum*	5	Tree	From home	Cultivated
88	*Platanus orientalis*	7	Tree	From home	Cultivated
89	*Sabina vulgaris*	1	Shrub	Local	Cultivated
90	*Pilea japonica*	1	Annual herb	Local	Spontaneous
91	*Amygdalus davidiana*	4	Tree	Local	Cultivated
92	*Duchesnea indica*	17	Perennial herb	Local	Spontaneous
93	*Punica granatum*	9	Shrub or small tree	From abroad	Cultivated
94	*Photinia serrulata*	3	Shrub or small tree	Local	Cultivated
95	*Metasequoia glyptostroboides*	13	Tree	From home	Cultivated
96	*Hydrocotyle sibthorpioides*	10	Perennial herb	From home	Spontaneous
97	*Chaenomeles speciosa*	2	Shrub	Local	Cultivated
98	*Acalypha australis*	17	Annual	Local	Spontaneous

Table A1. *Cont.*

Number	Species	Frequency	Life Form	Origin	Growth Pattern
99	*Tagetes erecta*	3	Annual	From abroad	Cultivated
101	*Cayratia japonica*	5	Perennial vine	Local	Spontaneous
102	*Kyllinga brevifolia var.* leiolepis	2	Perennial	Local	Spontaneous
100	*Coleus scutellarioides*	1	Annual	From abroad	Cultivated
103	*Acer mono*	3	Tree	Local	Cultivated
104	*Parthenocissus quinquefolia*	2	Perennial vine	From abroad	Cultivated
105	*Cyperus rotundus*	1	Perennial	Local	Spontaneous
106	*Ligustrum sinense*	31	Shrub or small tree	From home	Cultivated
107	*Armeniaca vulgaris*	1	Tree	From home	Cultivated
108	*Inula japonica*	2	Perennial	Local	Spontaneous
109	*Cedrus deodara*	57	Tree	From abroad	Cultivated
110	*Artemisia lavandulaefolia*	4	Perennial	Local	Spontaneous
111	*Dendranthema indicum*	1	Perennial	Local	Spontaneous
112	*Erigeron annuus*	6	Annual or biennial	From abroad	Spontaneous
113	*Platanus occidentalis*	24	Tree	From abroad	Cultivated
114	*Ginkgo biloba*	2	Tree	From home	Cultivated
115	*Prunus Cerasifera*	5	Shrub or small tree	Local	Cultivated
116	*Jasminum nudiflorum*	4	Shrub	Local	Cultivated
117	*Pinus tabuliformis*	7	Tree	Local	Cultivated
118	*Ulmus pumila*	7	Tree	Local	Cultivated
119	*Amygdalus triloba*	1	Tree	Local	Cultivated
137	*Brassica oleracea var.* acephala	8	Biennial herb	From abroad	Cultivated
120	*Magnolia denudata*	1	Tree	From home	Cultivated
121	*Iris tectorum* spp. tectorum	4	Perennial herb	Local	Cultivated
122	*Sabina chinensis*	3	Tree	Local	Cultivated
123	*Malva rotundifolia*	2	Perennial herb	Local	Spontaneous
124	*Pharbitis purpurea*	1	Annual herb	From abroad	Spontaneous
125	*Rosa chinensis*	3	Shrub	From home	Cultivated
126	*Poa annua*	25	Perennial herb	From home	Cultivated
127	*Viola inconspicua*	1	Perennial herb	Local	Spontaneous
128	*ixeris chinensis*	3	Perennial herb	Local	Spontaneous
129	*Rumex crispus*	1	Perennial herb	Local	Spontaneous
130	*Catalpa ovata*	1	Tree	Local	Cultivated
131	*Syringa oblata*	2	Shrub or small tree	Local	Cultivated
132	*Viola yedoensis*	11	Perennial	Local	Spontaneous
133	*Cercis chinensis*	2	Shrub	Local	Cultivated
134	*Lagerstroemia indica*	2	Shrub or small tree	Local	Cultivated
135	*Trachycarpus fortunei*	10	Tree	From home	Cultivated
136	*Oxalis corniculata*	22	Perennial herb	Local	Spontaneous

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