forests

MDPI

Article

Diversity of Spontaneous Plants in Eco-Parks and Its Relationship with Environmental Characteristics of Parks

Yifan Yang [1,†], Qingqing Yu [2,†], Dongshi Fu [1], Yuting Hou [1], Yanfan Chen [1], Tingting Guo [1], Hao Chen [1], Hai Yan [1], Feng Shao [1,*] and Yinke Zhang [3,*]

1 School of Landscape Architecture, Zhejiang Agriculture and Forestry University, Hangzhou 311300, China
2 School of Architecture, China Academy of Art, Hangzhou 310024, China
3 Hangzhou Botanical Garden, Hangzhou 310012, China
* Correspondence: shaofeng@zafu.edu.cn (F.S.); zykedu@outlook.com (Y.Z.); Tel.: +86-1345-682-9121 (F.S.); +86-1585-815-8022 (Y.Z.)
† These authors contributed equally to this work.

Abstract: Suburban areas connect the city and the natural land. This kind of area is subject to high ecological sensitivity. To give full play to the ecological value of spontaneous plants, it was applied to the construction of suburban parks. We need to explore the influence factors of park characteristics on spontaneous plants. This study takes Jiangyangfan Ecological Park as the main research object. We have investigated the spontaneous plants in it and the surrounding parks. Hence, 16 kinds of park environmental characteristic factors were selected to explore their effects on the composition and diversity of spontaneous plants. The results showed that: (1) There were 138 species of spontaneous plants belonging to 126 genera and 62 families in Jiangyangfan Ecological Park. Native plants accounted for 88.10%. (2) The Shannon-Wiener diversity index of spontaneous plants was ranked as Jiangyangfan Ecological Park > White Pagoda Park > Eight Diagrams Field Relic Park > Haiyue Waterscape Park. (3) Among the overall characteristic factors, the park perimeter and the actual accessible area had the most significant positive correlation to the diversity of spontaneous plants ($p < 0.05$). Among the environmental element characteristic factors, the Shannon-Wiener diversity index of cultivated plants had the strongest positive correlation with the diversity of spontaneous plants ($p < 0.01$). The number of water bodies presented the strongest negative correlation ($p < 0.01$). This study provides a useful reference for the rational planning of parks in suburban areas and the construction of sustainable urban and rural landscapes. The research results will contribute to the restoration of the ecological environment.

Keywords: suburban areas; ecological park; spontaneous plants; species diversity; park characteristics

Citation: Yang, Y.; Yu, Q.; Fu, D.; Hou, Y.; Chen, Y.; Guo, T.; Chen, H.; Yan, H.; Shao, F.; Zhang, Y. Diversity of Spontaneous Plants in Eco-Parks and Its Relationship with Environmental Characteristics of Parks. *Forests* **2023**, *14*, 946. https://doi.org/10.3390/f14050946

Academic Editors: Bo Hong, Zhe Li, Yike Hu, Liang Li and Kai Wang

Received: 30 March 2023
Revised: 27 April 2023
Accepted: 29 April 2023
Published: 4 May 2023

1. Introduction

The composition of the urban ecological environment results from the interaction between human activities and the natural environment [1]. With the acceleration of urbanization, compared with rural areas, the landscape in urban areas is more complex and mottled [2]. Urbanization leads to the intensification of urban landscape fragmentation and obvious landscape segmentation. Even seriously threatened is the air quality and water environment [3]. There is a lack of connectivity between the remaining natural patches inside the city and the nature reserves outside the city. Moreover, ecological connectivity is very important for maintaining urban biodiversity [4]. Different urbanization models have different effects on landscape patterns. The strongest reaction to urbanization is in suburban areas, with strong ecological sensitivity [5]. In the context of dynamic time, the landscape change in the suburban environment is also the most significant [6]. It can be seen that it is most urgent and necessary to improve the landscape pattern and ecological environment in suburban areas. The promotion of biodiversity and the stability of the

ecosystem in the suburbs will contribute to ecological restoration and improve people's quality of life.

In the urban environment, the ecological plant allocation scheme enables the region to obtain the most prominent key factor of sustainable development [7]. Restoring the broken ecological network requires the blessing of ecological design techniques to keep the nature reserve and the city interconnected [8]. More and more designers have begun to advocate the construction of parks with diverse natural and native plants as the mainstay. This has gradually led to an upsurge in building ecological parks. The design concept of ecological parks should focus on protecting local species, rather than creating a completely new habitat [9]. With the passage of time, the natural restoration function of ecological parks has been proven in continuous practice. People gradually realize that ecological parks have irreplaceable ecological functions. Therefore, it is necessary to carry out plant-related research on ecological parks, especially those in the natural succession stage. This can support a better understanding of the growth law and distribution characteristics of plants. The results obtained can be effectively applied to the ecological restoration construction in suburban areas.

The management intensity of ecological parks is weak. Compared with other types of parks, there are more autogenous plants. Spontaneous plants are usually regarded as weeds and have been removed by human beings. These naturally occurring and constantly growing plants are everywhere. Spontaneous plants in roofs [10], walls [11], parks [12], and ponds [13] all have high species richness and most of them are native species. The ecological potential of such plants should not be underestimated. The composition and distribution of spontaneous plants are closely related to environmental conditions. Many scholars have discussed the influence of abiotic factors, such as soil, water, and light on spontaneous plants [14–16]. Some scholars also study the diversity pattern of spontaneous plants from the perspectives of urban growth and topographic factors [17]. In fact, for the spontaneous plants in the park, the environmental characteristics of the park will also affect their growth and reproduction to a certain extent. At present, there is a lack of research on the characteristics of spontaneous plants and park environments.

With the development of ecological thoughts, Hangzhou Jiangyangfan Ecological Park (hereinafter referred to as Jiangyangfan Park) has become the first ecological park in China based on the "wild" concept [18]. Since its development and construction, the plants in the park wetland have experienced natural succession for more than 20 years. Now, a large-scale natural plant community has been formed. In order to master the key factors that affect the growth and distribution of spontaneous plants in the ecological park, this study takes Jiangyangfan Park as the main investigation object. More specifically, the following contents were analyzed: (1) the composition of spontaneous plants in and around different types of parks in Jiangyangfan Park; (2) the main environmental characteristics that affect the composition and diversity of spontaneous plants are clarified through the horizontal comparison of different park characteristics; and (3) the response degree of spontaneous plants to different park characteristics. Spontaneous plants are reasonably applied to ecological restoration and park construction in suburban areas, which provides useful references for building sustainable and low-maintenance park landscapes.

2. Materials and Methods

2.1. Study Area

Hangzhou, Zhejiang Province is located on the southern edge of the Yangtze River Delta and the Qiantang River Basin. Hangzhou has a subtropical monsoon climate with four distinct seasons and abundant rainfall. The average annual temperature in the urban area is 18.4 °C, and the total precipitation is 1721 mm. Jiangyangfan Park, located in the southeast of the Hangzhou West Lake Scenic Area, is the main research object. The park is located on a valley surrounded by mountains on three sides, covering a total area of 19.8 hm^2, at (30°12′ N, 120°8′ E). The park was originally a silt bank for dredging the West

Lake. With the natural drying of the silt surface, it gradually changed from a lake to a swamp, and now it has become a secondary wetland.

Yuhuang Shannan Fund Town Scenic Area is adjacent to Jiangyangfan Park, located on the core area of world cultural heritage, including Eight Diagrams Field Relic Park, White Pagoda Park, and Haiyue Waterscape Park. Eight Diagrams Field Relic Park was once the seat of the Southern Song Dynasty's royal birthplace. White Pagoda Park is an urban cultural park with the "Zhakou White Pagoda" as its core and focusing on the protection and utilization of historical buildings and industrial railway remains. Haiyue Waterscape Park was renovated from a farm. It now forms a large-scale water landscape.

2.2. Study Method

2.2.1. Sample Selection

In order to ensure comparability among the research objects and control hydrometeorology and other factors, we investigated the self-growing plants and park characteristic factors in three parks in Jiangyangfan Park and Yuhuang Shannan Fund Town Scenic Area in August 2022.

In the investigation of the spontaneous plants in Jiangyangfan Park, the park was divided into two types: wetlands and other green spaces. Because the wetland contains many habitat types and is rich in spontaneous plants, the wetland area was investigated in detail to grasp the basic information about spontaneous plants more comprehensively and accurately. The rest of the park was classified as other green spaces. Spontaneous plants in Eight Diagrams Field Relic Park, White Pagoda Park, and Haiyue Waterscape Park were investigated by random sampling.

2.2.2. Quadrat Selection

We investigated the spontaneous plants in the wetland of Jiangyangfan Park. GPS recorded the geographical coordinates of the research sample. A 40 m × 40 m grid was laid in the wetland. 20 m × 20 m quadrat was set at the intersection, and 10 m × 10 m arbor irrigation quadrat was set at the center (Figure 1). In order to meet the requirement of containing the most diverse squares, 71 intersections were selected to investigate the spontaneous plants. After removing the non-plant distribution samples and out-of-bounds samples, such as waters and roads, 334 quadrats were finally retained, including 279 herb quadrats and 55 arbor and shrub quadrats. In addition, considering the accessibility of green space and the longest spreading distance of seeds, the green space 50–100 m away from the wetland was selected around the wetland to investigate the spontaneous plants. In each direction, an investigation section with a length of 240 m was selected. Each section contains seven sampling points with a spacing of 40 m. The size and number of sample points were the same as those of wetlands. Finally, 334 wetland quadrats and 168 other green quadrats were obtained, totaling 502.

In the horizontal investigation of the spontaneous plants in four parks, the minimum spacing of sampling points was appropriately widened with increased green area. The number of sampling points was selected according to the actual plant growth in parks. In order to ensure the maximum response to the current situation of spontaneous plants in the area, 132 quadrats of Eight Diagrams Field Relic Park, 132 in White Pagoda Park, 108 in Haiyue Waterscape Park, and 156 in Jiangyangfan Park were determined. In addition to the repeated quadrats in Jiangyangfan Park, 874 quadrats were investigated in this study.

2.2.3. Plant Identification and Classification

In this study, spontaneous plants were recorded as plants that grow spontaneously without human cultivation. They included the renewed seedlings of artificially introduced plants through secondary reproduction. The investigated spontaneous plants were photographed by Sony DSC-RX10M4 (with telephoto lens) and iPhone 12. Common plants are identified by the authors themselves, and rare plants are identified by experts. The investigation section on the east side of the wetland was outside the scope of Jiangyangfan

Park. So, the investigation data were only used for species source analysis and was not included in the analysis scope of plant data in the park.

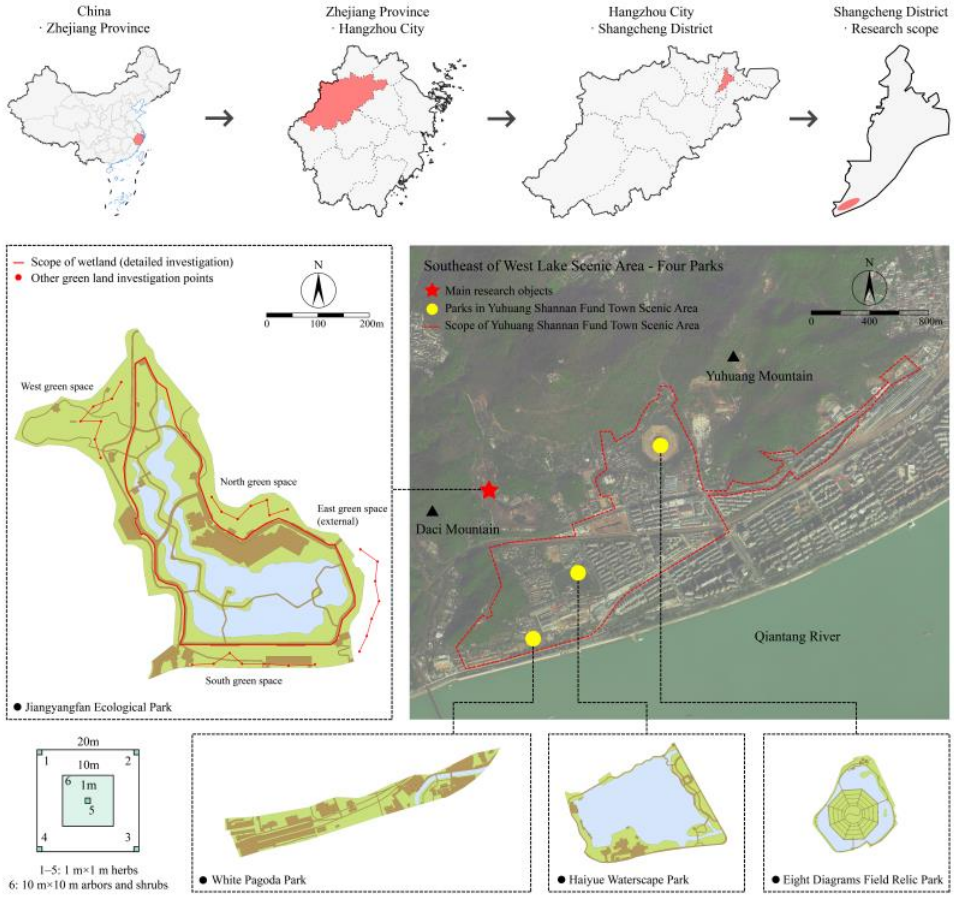


Figure 1. The location, sample distribution and quadrat setting in study.

Spontaneous plants in this study were determined according to Flora of China (http://www.iplant.cn/, accessed on 5 October 2022). All plants were classified to species level. Based on this, the fruits of spontaneous plants were divided into 18 types. The source of the species (whether it was indigenous or not) was determined according to the Flora of Hangzhou (http://db.hzbg.cn/hzflora/flora/, accessed on 5 October 2022). Invasive plants and non-invasive plants were identified according to the list of alien invasive plants in China published by the Ministry of Ecology and Environment of the People's Republic of China (https://www.mee.gov.cn/, accessed on 5 October 2022), and related studies, such as the work of Yan et al. [19] and Zhang et al. [20].

2.3. Statistical Analysis

(1) When calculating the important value (IV), based on the existing literature [21], we also considered the particularity of the site. The calculation of important values of trees is different from that of herbs and shrubs.

$$S_i(\text{trees}) = \frac{(RA_i + RF_i + RC_i)}{3} \quad (1)$$

$$S_i(\text{herbs and shrubs}) = \frac{(RA_i + RF_i + RD_i)}{3} \quad (2)$$

where S_i is the importance value for the *i*th species, and RA_i, RF_i, RC_i, and RD_i represent the relative abundance, frequency, coverage, and dominance, respectively, for the *i*th species.

(2) There were 16 park characteristic factors, which could be divided into two categories: general characteristics (7) and environmental factor characteristics (9). Firstly, the park characteristics were extracted according to the original plan in AutoCAD 2018. The characteristic values, such as perimeter, area, and quantity, were generated. Then, the characteristic factor data were obtained by combining the following formulas [22].

In the overall characteristics of parks, the management intensity is classified according to the weeding frequency: once every three months is 1, once every three months is 2 and once every three months is 3; area ratio of perimeter (%) = perimeter (m)/park area (m^2); actual accessible area rate (%) = actual accessible area (m^2)/ park area (m^2). Among the characteristics of environmental factors, green space rate (%) = the total area of green patches (m^2)/park area (m^2); green space fragmentation (‰) = the number of green land patches (pieces)/total area of green land patches (m^2); water area rate (%) = total water area (m^2)/park area (m^2); water fragmentation (‰) = the number of water bodies (pieces)/total area of water bodies (m^2). The Shannon-Wiener diversity index of cultivated plants is formulated as follows:

$$H = -\sum_{i=1}^{S} P_i \ln P_i \quad (3)$$

where H is Shannon-Wiener diversity index, S is the number of species, and P_i is the important value of species i.

(3) Diversity index calculation and redundancy analysis (RDA) of spontaneous plants were analyzed and mapped by using vegan package [23] in R language. The rdacca.hp package [24] was used to run variation decomposition and hierarchical segmentation. Spearman correlation between the diversity of spontaneous plants and the characteristic factors of parks was analyzed by SPSS 26.

3. Results

3.1. Composition and Source of Spontaneous Plants in Jiangyangfan Park

3.1.1. General Situation of the Composition of Spontaneous Plants

According to the investigation, there were 138 species of spontaneous plants belonging to 126 genera and 62 families in Jiangyangfan Park. Among them, Asteraceae, Poaceae, and Rosaceae contained many kinds of spontaneous plants, with 15 species, 14 species and 10 species. Spontaneous plants were divided into 10 life forms. There were 62 perennial herbs, accounting for 44.92% of the total. There were three life forms containing only one plant (Table 1). *Alternanthera philoxeroides* (Mart.) Griseb.(93), *Phragmites australis* (Cav.) Trin. (92), and *Hydrocotyle verticillata* Thunb.(75) were the top three spontaneous plants with frequencies of 7.55%, 7.43%, and 6.10%.

In the wetland area, 117 species of spontaneous plants were recorded, belonging to 107 genera and 57 families, accounting for 84.78% of the whole park. There were two families with more than ten species, namely Asteraceae (14) and Gramineae (12). Among the eight life forms, perennial herbs were obviously higher than other life forms. The important values of *Phragmites australis* and *Salix rosthornii* were both more than 40%. They were the main dominant species in wetlands. There were 70 species of spontaneous plants found in other green areas, belonging to 68 genera and 43 families, mainly in Gramineae (6) and Asteraceae (5). The plant species on the south side (42) were slightly higher than those on the north side (37) and the west side (34). This is likely due to the different illumination and habitats. Due to a large number of individuals in the wetland, such as *Phragmites australis*, *Hydrocotyle verticillata*, and *Alternanthera philoxeroides*, Shannon and Simpson's diversity index values were lower than for other green spaces.

Table 1. Spontaneous plants life forms and representative species in Jiangyangfan Park.

Life Form		Number of Families	Number of Genera	Number of Species	Representative Species
Herb	Annual herb	16	24	26	*Lemna minor* L., *Humulus scandens* (Lour.) Merr., *Oplismenus undulatifolius* (Arduino) Beauv.
	Annual or biennial herb	2	4	4	*Stellaria media* (L.) Villars, *Orychophragmus violaceus* (Linnaeus) O. E. Schulz,
	Biennial herb	1	1	1	*Erigeron annuus* (L.) Pers. *Trigonotis peduncularis* (Trev.) Benth
	Perennial herb	30	56	62	*Hydrocotyle verticillata, Phragmites australis, Oenanthe javanica* (Bl.) DC.
	Perennial herbaceous vine	4	4	4	*Gynostemma pentaphyllum* (Thunb.) Makino, *Cayratia japonica* (Thunb.) Gagnep., *Paederia foetida* L.
Woody	Arbor	13	20	21	*Salix rosthornii* Seemen, *Salix magnifica* Hemsl., *Broussonetia papyrifera* (L.) L'Hér.
	Shrub	11	15	16	*Boehmeria nivea* (L.) Gaudich., *Rubus hirsutus* Thunb., *Hedera nepalensis* K. Koch
	Rattan shrub	2	2	2	*Rubus lambertianus* Ser., *Euonymus fortunei* (Turcz.) Hand.-Mazz.
	Subshrub	1	1	1	*Sambucus javanica* Blume
	Woody vine	1	1	1	*Parthenocissus tricuspidata* (Siebold & Zucc.) Planch.

3.1.2. Source Analysis of Spontaneous Plants

The sources of spontaneous plants in the park are mainly divided into native plants and exotic plants. There were 111 native plants, accounting for 88.10%, mostly Poaceae (11) and Asteraceae (11). There were 27 species of alien plants, which could be divided into 15 species from other parts of China and 12 species from abroad. Among the alien plants, only *Cyperus involucratus* Rottboll originated from Africa. Another 11 species came from America (nine) and Europe (two). Among them, *Alternanthera philoxeroides*, *Bidens pilosa* L., *Erigeron canadensis* L. and *Helianthus tuberosus* L. were all invasive plants, accounting for 33.33% of foreign alien plants. Spontaneous plants in the wetland were mainly native plants, with 92 species accounting for 78.63%. *Alternanthera philoxeroides* was the most frequent alien invasive species, followed by *Bidens pilosa*. There were 59 species of native plants in other green spaces, accounting for 84.29%, which was slightly higher than in wetlands (Table 2). The frequency of *Oplismenus undulatifolius* was the most (7.14%); *Oxalis corniculata* L. (6.07%) and *Alternanthera philoxeroides* (6.07%) followed. *Erigeron canadensis* and *Helianthus tuberosus* as alien invasive plants, only appeared once each.

Table 2. Source analysis of spontaneous plants in Jiangyangfan Park.

Scope of Investigation		Number of Families	Number of Genera	Number of Species	Origin of Species			
						Alien Plants		
					Native Plants/%	Domestic Alien Plants/%	Foreign Alien Non-Invasive Plants/%	Alien Invasive Plants/%
Wetland		57	107	117	92 (78.63)	13 (11.11)	8 (6.83)	4 (3.42)
Other green spaces	North	28	34	36	28 (77.78)	6 (16.67)	1 (2.78)	1 (2.78)
	West	28	32	33	30 (90.90)	2 (6.06)	0 (0.00)	1 (3.03)
	South	28	40	40	34 (85.00)	2 (5.00)	0 (0.00)	4 (10.00)
	Total	43	68	70	59 (84.29)	6 (8.57)	1 (1.43)	4 (5.71)

3.2. Composition and Diversity of Spontaneous Plants in Different Parks

The selected sampling sites in Jiangyangfan Park recorded the most spontaneous plants. There were 102 species belonging to 97 genera and 52 families. Eight Diagrams Field Relic Park was similar to White Pagoda Park in the number of species. Haiyue Waterscape Park had the fewest (16) (Table 3). Moreover, 11 species of spontaneous plants were recorded in each park. *Hydrocotyle sibthorpioides* Lam., *Alternanthera philoxeroides*, and *Oxalis corniculata* appeared in two or more parks as high-frequency species.

Table 3. Composition of spontaneous plants and representative species with high and low frequency in parks.

Park Name	Number of Families	Number of Genera	Number of Species	High Frequency Representative Species	Low Frequency Representative Species
Jiangyangfan Park	52	97	102	*Phragmites australis*, *Alternanthera philoxeroides*, *Salix rosthornii*	*Rhus chinensis* Mill., *Senecio scandens* Buch.-Ham., *Nelumbo nucifera* Gaertn.
Eight Diagrams Field Relic Park	31	46	48	*Alternanthera philoxeroides*, *Hydrocotyle sibthorpioides*, *Gynostemma pentaphyllum*	*Farfugium japonicum* (L. f.) Kitam., *Cocculus orbiculatus* (L.) DC., *Oenanthe javanica*
White Pagoda Park	27	48	50	*Hydrocotyle sibthorpioides*, *Alternanthera philoxeroides*, *Oxalis corniculata*	*Broussonetia papyrifera*, *Trachelospermum jasminoides* (Lindl.) Lem., *Euphorbia humifusa* Willd.
Haiyue Waterscape Park	12	15	16	*Hydrocotyle sibthorpioides*, *Oxalis corniculata*, *Digitaria sanguinalis* (L.) Scop.	*Cinnamomum camphora* (L.) Presl, *Boehmeria nivea*, *Lophatherum gracile* Brongn.

Perennial herbs accounted for the highest proportion in the four parks. The perennial herbaceous plants in White Pagoda Park accounted for half of the total species. As a semi-shrub, *Sambucus javanica* only appeared in Jiangyangfan Park. The proportion of species from all sources in the four parks was similar, among which White Pagoda Park had the least proportion of exotic plants at home and abroad. All the exotic plants in Eight Diagrams Field Relic Park were alien invasive plants. They were *Alternanthera philoxeroides*, *Erigeron annuus*, *Hydrocotyle verticillata*, *Stellaria aquatica* (L.) Scop., and *Echinacea purpurea* (L.) Moench.

Generally speaking, the Simpson diversity index, Shannon-Wiener diversity index and Margalef richness index of spontaneous plants from high to low were Jiangyangfan Park > White Pagoda Park > Eight Diagrams Field Relic Park > Haiyue Waterscape Park. It was consistent with the number of species of spontaneous plants in the park. Because the richness of Margalef was closely related to the number of species, the richness index of Jiangyangfan Park was much higher than for other parks. The Pielou evenness index of Haiyue Waterscape Park was the highest, indicating that the species were evenly distributed in this park (Figure 2).

3.3. Correlation between Spontaneous Plants and Environmental Characteristics of Parks

After obtaining the characteristic factor data of parks (Table 4), only 19 common species (frequency > 3%) of park plants were selected as the research objects for correlation analysis. In the relationship between the individual spontaneous plants and the overall characteristics of parks, the common wetland plants, such as *Phragmites australis*, *Hydrocotyle verticillate*, and *Salix rosthornii*, were negatively correlated with the management intensity. They had a strong positive correlation with the park area. *Oplismenus undulatifolius* had the strongest correlation with the perimeter of the park. Common species in parks, such as *Alternanthera philoxeroides*, *Gynostemma pentaphyllum*, and *Boehmeria nivea*, were often negatively correlated with the park's construction years. In the relationship with the

characteristics of environmental factors, the characteristics of a wet and large-scale reproduction of *Hydrocotyle verticillata* made it most closely related to the total area of green space, followed by the total area of water. It is negatively correlated with the number of water bodies, the number of green patches, and the fragmentation of green space (Figure 3). *Ophiopogon japonicus* (L. f.) Ker-Gawl., *Ulmus parvifolia* Jacq., and *Setaria viridis* (L.) Beauv., which were widely used, were suitable to grow in the environment with a high Shannon-Wiener diversity index and water fragmentation.

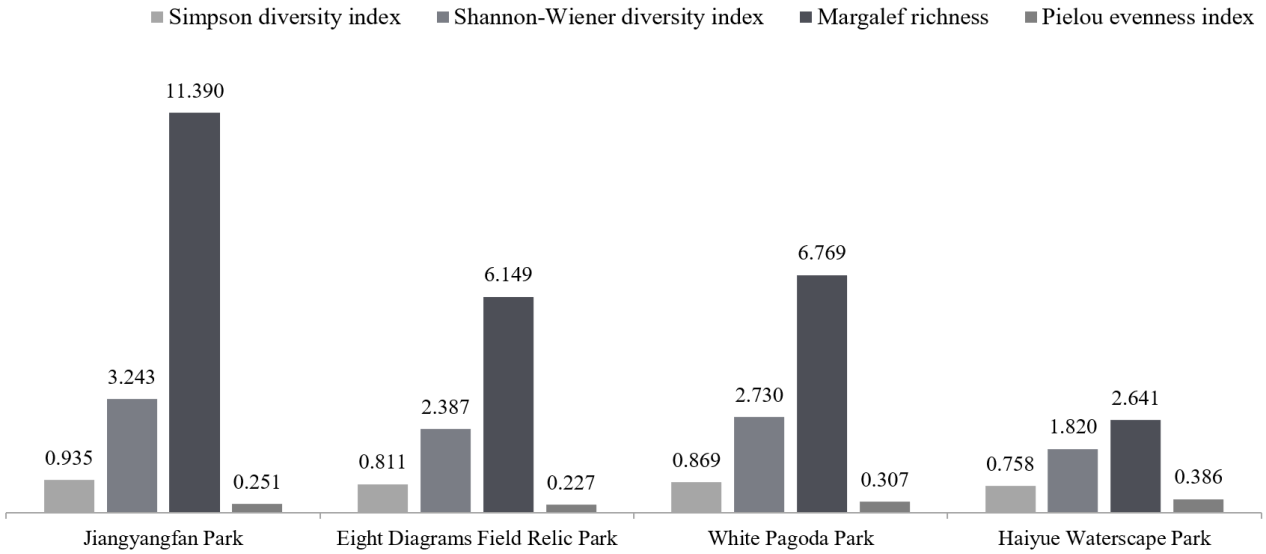
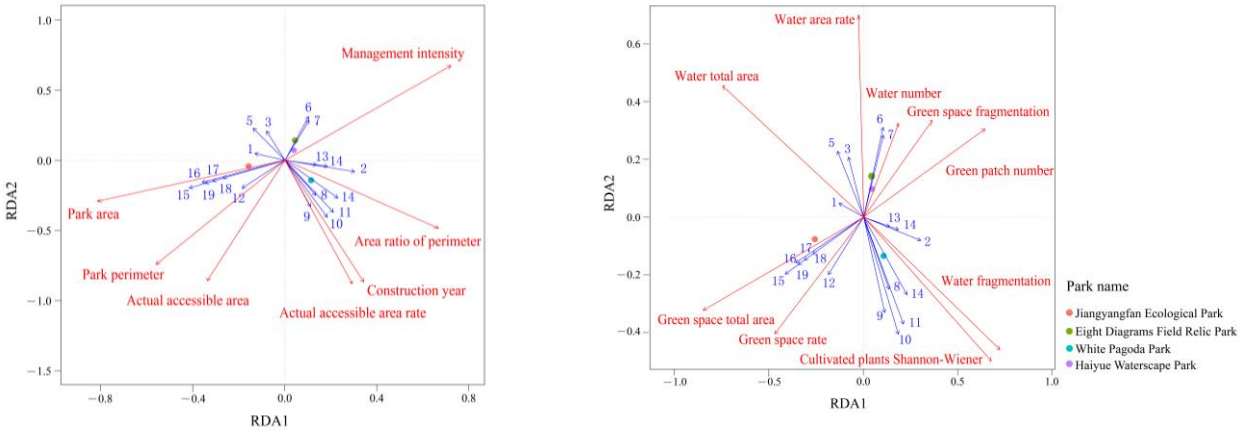


Figure 2. Diversity index of spontaneous plants in parks.

Table 4. Environmental characteristic factors of parks.

Characteristic	Characteristic Factor	Park name			
		Jiangyangfan Park	**Eight Diagrams Field Relic Park**	**White Pagoda Park**	**Haiyue Waterscape Park**
Overall characteristic	Construction year/year	2010	2007	2014	2011
	Management intensity	1	3	2	3
	Park perimeter/m	2592	1272	2140	883
	Park area/m^2	198,152	98,334	91,779	41,445
	Area ratio of perimeter/%	1.31	1.29	2.33	2.13
	Actual accessible area/m^2	34,688	8252	34,261	3582
	Actual accessible area rate/%	17.51	8.39	37.33	8.64
	Green space total area/m^2	113,081	46,441	44,523	9147
	Green space rate/%	57.07	47.23	48.51	22.07
Environmental element characteristic	Green patch number/number	33	48	42	34
	Green space fragmentation/‰	2.92	10.33	9.43	37.17
	Water total area/m^2	48,860	40,076	4420	27,078
	Water area rate/%	24.66	40.75	4.82	65.33
	Water number/number	1	1	1	5
	Water fragmentation/‰	0.2	0.25	2.26	1.85
	Cultivated plants Shannon-Wiener	2.72	3.08	3.63	2.61



(**a**) (**b**)

Figure 3. RDA ordination diagram of 19 common spontaneous plants in parks with the overall characteristics of parks (**a**) and environmental element characteristics (**b**). 1. *Alternanthera philoxeroides*; 2. *Hydrocotyle sibthorpioides*; 3. *Gynostemma pentaphyllum*; 4. *Digitaria sanguinalis*; 5. *Boehmeria nivea*; 6. *Euphorbia humifusa*; 7. *Stellaria media*; 8. *Oxalis corniculata*; 9. *Setaria viridis*; 10. *Ophiopogon japonicus*; 11. *Ulmus parvifolia*; 12. *Oplismenus undulatifolius*; 13. *Celtis sinensis* Pers.; 14. *Erigeron annuus*; 15. *Phragmites australis*; 16. *Hydrocotyle verticillata*; 17. *Salix rosthornii*; 18. *Humulus scandens*; 19. *Achyranthes bidentata* Blume..

Spearman correlation analysis was carried out between the diversity of spontaneous plants and the characteristic factors of parks (Table 5). In general, the park perimeter and actual accessible area had the most significant positive correlation to the diversity of spontaneous plants ($p < 0.05$), followed by the park area ($p < 0.05$). Among the characteristics of environmental factors, the Shannon-Wiener diversity index of cultivated plants had the strongest positive correlation with the diversity of spontaneous plants ($p < 0.01$). The number of water bodies and the rate of water bodies had the strongest negative correlation with the diversity of spontaneous plants ($p < 0.01$).

Table 5. Spearman correlation between spontaneous plants diversity and park characteristic factors in parks.

Characteristic	Characteristic Factor	Correlation Coefficient	Characteristic	Characteristic Factor	Correlation Coefficient
Overall characteristic	Construction year/year	−0.078	Environmental element characteristic	Green space rate/%	0.215 *
	Management intensity	−0.119		Green patch number/number	0.201
	Park perimeter/m	0.215 *		Green space fragmentation/‰	−0.215 *
	Park area/m^2	0.212 *		Water total area/m^2	−0.003
	Area ratio of perimeter/%	−0.078		Water area rate/%	−0.304 **
	Actual accessible area/m^2	0.215 *		Water number/number	−0.411 **
	Actual accessible area ratio/%	0.102		Water fragmentation/‰	0.003
Environmental element characteristic	Environmental element characteristics	0.212 *		Cultivated plants Shannon-Wiener	0.385 **

Note: **, $p < 0.01$; *, $p < 0.05$.

We decomposed the variance of the interpretation rate of the characteristic factors (explanatory variables) of each park by using the hierarchical segmentation theory (Figure 4).

The results were visualized by UpSet matrix diagram. Seven general characteristic factors of parks all affected the composition and distribution of spontaneous plants through interaction, with a total explanation rate of 26.28%. The single interpretation rate of park area was the largest, followed by management intensity. The years of construction had the least independent explanation rate for spontaneous plants. The total interpretation rate of nine environmental factors was as high as 78.58%. In terms of the individual interpretation rate of spontaneous plants, the top three were the total area of green space, the total area of the water body, and the Shannon-Wiener diversity index of cultivated plants.

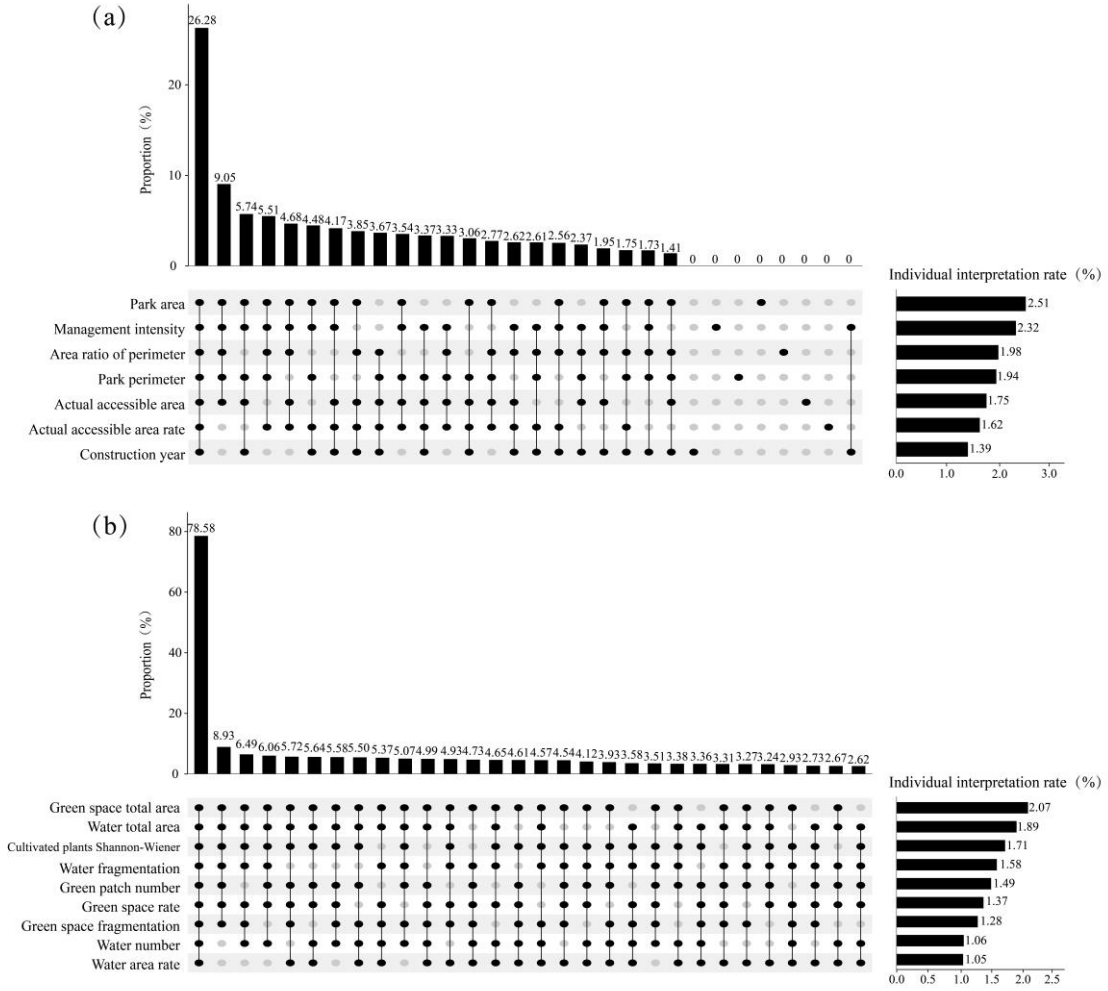


Figure 4. Explanatory degree of overall characteristic factors (**a**) and environmental element characteristic factors (**b**) of different parks to common spontaneous plants composition.

4. Discussion

4.1. Composition and Distribution of Spontaneous Plants in Ecological Park

In this study, 138 species of spontaneous plants were recorded in Jiangyangfan Park. The results obtained were similar to the previous survey results in the same place [25–27]. It could be seen that the plant communities in the park had been in a relatively stable state through long-term succession. Compared with the results of the spring investigation, the number of species of spontaneous plants in the wetland in summer only increased by 17 [28]. This might be because the extremely high-temperature weather this summer affected the growth and development of plants. It might also be because most of the life forms were perennial plants, which meant the species number of wetland spontaneous plants in Jiangyangfan Park did not change greatly in spring and summer. Asteraceae and Poaceae belonging to dominant families in both wetlands and other green spaces. This was

consistent with the results of most plant surveys in parks [29,30]. There were 37 genera with one species in the park, accounting for 29.37% of the total genera. In comparison, the occasional genera in Hangzhou Xixi National Wetland Park accounted for 85.5% [31], which indirectly indicated that the diversity of spontaneous plants in Xixi National Wetland Park was higher than that in Jiangyangfan Park.

The native plants of spontaneous plants accounted for more than half of wetlands [32], chemical areas [33], coal mining subsidence areas [34], campuses [35], and idle land [36]. Among them, the proportion of native plants in Xiangruhu National Wetland Park (84.00%) [37], Xixi National Wetland Park (83.40%) [38], Jiangyangfan Park Wetland Part (78.63%), and River Corridor (78.48%) [39] all reached more than 75%. It could be seen that the wet environment is beneficial to the growth of spontaneous plants and could promote the improvement of local plant diversity and form a sustainable and low-maintenance natural garden landscape.

The habitat conditions of Jiangyangfan Park were clearly distinguished. The composition and distribution of spontaneous plants in wetlands and other green spaces were quite different. Within the scope of wetland, the sum of the important values of *Phragmites australis*, *Hydrocotyle verticillata* and *Alternanthera philoxeroides* accounted for 37.93%, exceeding one third of the total, becoming the three dominant species. As a clonal plant, *Phragmites australis* had strong adaptability [40]. At present, the reed pond has formed a large reed landscape. *Alternanthera philoxeroides*, as an alien invasive plant, was mainly distributed at the junction of waterways. However, it was hard to see them around the reeds. This was because *Phragmites australis* could inhibit the diffusion of *Alternanthera philoxeroides* in time and space [41], preventing it from spreading to a large area of water. *Phragmites australis* played an important role in maintaining the stability of the wetland ecological environment. Other green spaces included artificial and secondary forests and virgin forests. Many tall trees and shrubs grew in these places. *Koelreuteria bipinnata* 'integrifoliola' (Merr.) T.Chen and *Ulmus parvifolia* were native species in Hangzhou, which had the characteristics of tenacious vitality and strong adaptability. Their tree seedlings were more common in green spaces. Although *Boehmeria nivea* and *Sambucus javanica* were local species, they could easily form a single dominant community and occupy the living space of other plants. This kind of self-growing plant with strong propagation ability and threat should be controlled reasonably. In other greenbelts, the frequency of *Alternanthera philoxeroides* increased significantly without the inhibition of *Phragmites australis*. As shade-tolerant ground cover plants [42,43], *Oplismenus undulatifolius* and *Oxalis corniculata* presented as the top two high-frequency species in other green spaces. *Oxalis corniculata* propagated rapidly and could be used for greening quickly. According to the plant type, flower color, crown width, and flower amount, *Oxalis corniculata* with high ornamental value could be selected and applied to parks or suburban areas that were biased towards wild interest and nature.

4.2. Species Composition and Diversity of Spontaneous Plants in Different Parks

In order to avoid the interference of landscape patterns on plant diversity, four parks with similar geographical locations but different types were selected in the investigation [44]. They are Ecological Park (Jiangyangfan Ecological Park), Urban Cultural Park (White Pagoda Park), Ruins Park (Eight Diagrams Field Relic Park), and Community Park (Haiyue Waterscape Park). Although White Pagoda Park, Eight Diagrams Field Relic Park, and Haiyue Waterscape Park all belong to Yuhuang Shannan Fund Town Scenic Area, the park's positioning and management schemes were completely different. Eight Diagrams Field Relic Park is once the site of the royal home field in the Southern Song Dynasty. The yin-yang diagram of the gossip center is the core. The planning and construction mainly focus on preserving sites and replanting plants around it. Eight kinds of crops are planted in the eight central areas cut by the garden road, and seasonal rotation is implemented to ensure the landscape effect of the four seasons. The design goal of White Pagoda Park is to focus on the protection and utilization of industrial heritage and build it into a historical and cultural

landmark park. It includes five gardens: Baita Garden, Zhakou Garden, Hangjiang Garden, Daqiao Garden and Jiefang Garden. The White Pagoda Park referred to in this survey was subject to the scope of construction drawings provided by the government. It only referred to Baita Garden, Hangjiang Garden, and Daqiao Garden [45]. Haiyue Waterscape Park was originally a farm. After renovation and dredging, it forms an existing large-scale water landscape and becomes a good place for citizens to relax and entertain. Different historical backgrounds and planning concepts make the differences between parks more obvious. This is very beneficial to further explore the correlation between autotrophic plants and park characteristics.

Alternanthera philoxeroides and *Oxalis corniculata* were common species in parks. Among them, *Hydrocotyle sibthorpioides* was adapted to grow in a warm environment and widely distributed in southern China. It could be seen everywhere in Hangzhou. Its relative importance ranks first in Eight Diagrams Field Relic Park, White Pagoda Park, and Haiyue Waterscape Park. However, in Jiangyangfan Park, the important value of *Hydrocotyle sibthorpioides* was not in the top 10. Part of the reason for this phenomenon was that the requirements for soil were not strict. However, it was very sensitive to saline-alkali soil. The suitable soil pH range was 4.0–7.5 [46]. At the beginning of the construction of Jiangyangfan Park, the soil conditions were slightly alkaline [25]. Therefore, *Hydrocotyle sibthorpioides* only appeared frequently in roadside vegetation areas, and it grew less in other areas, such as swamps. In areas, such as swamps and wetlands, the occurrence frequency and growth range of *Hydrocotyle verticillata* were relatively extensive. This was related to its growth habit of liking humidity and not choosing soil.

As an ecological park, the species composition, species source and diversity index of Jiangyangfan Park were obviously higher than other parks. However, the plant data between White Pagoda Park and Eight Diagrams Field Relic Park were very similar, probably because their habitat conditions were similar. If the diversity indices of herbs and woody plants were calculated separately, the diversity indices of herbaceous plants in Jiangyangfan Park, Eight Diagrams Field Relic Park, and White Pagoda Park were higher than those of woody plants, while the evenness indices were lower than those of woody plants. The analysis result of Haiyue Waterscape Park was contrary to other parks. The diversity index of woody plants was higher than that of herbaceous plants. The habitat type of Haiyue Waterscape Park was relatively simple. Plant cultivation was mainly carried out around a large area of water. Occasionally created a landscape effect of small bridges and flowing water. The plant configuration was similar to the conventional park's, and the community structure was basically three layers of arbors, shrubs and herbs. Because of the daily pruning and management of plants, it was difficult for herbaceous plants to survive and reproduce. With extremely tenacious vitality, *Hydrocotyle sibthorpioides*, *Oxalis corniculata*, and *Digitaria sanguinalis* were the primary ground cover herbs.

4.3. Park Characteristic Factors Affecting the Composition and Diversity of Spontaneous Plants

Eight Diagrams Field Relic Park was built the earliest (2007) and White Pagoda Park was built the latest (2014). However, the diversity of spontaneous plants between them was similar. Combined with the analysis results of variance decomposition and hierarchical segmentation, the years of construction were not the key characteristic factors to determine the diversity of spontaneous plants. This was different from the survey results of parks in Latin America [47]. This result might be due to the fact that the investigation of parks in Latin America involved the gradient between urban and rural areas, which increases the research scale. This paper mainly focuses on Jiangyangfan Park and surrounding parks. A comparative study of plant diversity in 15 parks in Shanghai and six parks in Salzburg showed that the park area was the main factor affecting the number of plant species [48]. This was consistent with the findings of this study. It could be seen that in the remaining urban green space, the park's size seemed to be an important factor affecting species richness. In the characteristics of environmental factors, the total area of green space and the total area of the water body were also key factors that had a great influence

on the composition and distribution of spontaneous plants. The plant community structure was also more complicated in the larger green space. This was the result of the interaction between plants and other organisms.

Eight Diagrams Field Relic Park and Jiangyangfan Park had similar water bodies. However, in the water body of Eight Diagrams Field Relic Park, there were only cultivated aquatic plants such as *Nelumbo nucifera*, *Alisma plantago-aquatica* L. and *Thalia dealbata* Fraser. Occasionally, *Lemna minor* would appear. The constructed hard revetment and regular manual cleaning made the water landscape around the Eight Diagrams Field not change much, and the spontaneous plants could not last forever. However, in Jiangyangfan Park, once there was a large area of water or green space, invasive plants such as *Phragmites australis*, *Hydrocotyle verticillata* and *Humulus scandens* would easily form a large area of the single plant community. Therefore, in redundancy analysis, these plants were positively correlated with green space and water area. Negative correlation with management intensity. It had been proved that the diversity of habitats and the heterogeneity of microhabitats had the most decisive influence on plant richness [49]. The diversity of spontaneous plants in Haiyue Waterscape Park was obviously lower than that in other parks. In addition to factors, such as park area and management intensity, it had a certain relationship with its single habitat type. Spontaneous plants were not carefully managed by people and were often more sensitive to the surrounding environment than cultivated plants. Even the diversity of cultivated plants would greatly affect the associated spontaneous plants.

According to a survey, the plant diversity in the arbor layer was the highest and the herb layer was the least in the urban area of Hangzhou (a new first-tier city) [50]. From the perspective of spontaneous plants, Jiangyangfan Park was dominated by herbaceous plants. In particular, the wetland habitat had the richest plant resources and was full of vitality. Some scholars had recorded 424 species of spontaneous plants in Xixi National Wetland Park, with the largest number of species in the herb layer [51]. Some scholars had investigated the spontaneous plants of the Beijing-Hangzhou Grand Canal (the main city section of Hangzhou), and the herb layer was still the dominant layer [52]. Residents in urban suburbs preferred herbs with rich species and structures [53]. Therefore, it could be reasonably speculated that if we wanted to increase the diversity of herbaceous layer in green space, we could provide living conditions for spontaneous plants in addition to artificial planting. In the greening construction of urban suburbs, increasing the area of green space and water bodies, reducing the fragmentation of green space and water bodies, and reducing human disturbance could promote the growth of spontaneous plants and improve the ecological environment.

5. Conclusions

This study carried out a detailed investigation of the spontaneous plants in the ecological park. On this basis, the comparison with other park plants was elaborated. The study proved that different park characteristic factors influence the composition and diversity of spontaneous plants. The degree of influence varies. The proportion of spontaneous plants belonging to the native species was higher than 80% in all four parks. Because our original intention was to apply the results of the study to the ecological restoration of suburban areas, the high proportion of native species in the spontaneous plants was therefore good news for practical application. We propose that in order to promote the naturalization of parks and enhance biodiversity, the environmental characteristics of parks can be taken into consideration when constructing and managing parks and suburban areas. Rational utilization of the growth characteristics and ecological value of spontaneous plants will help to build a beautiful and harmonious suburban landscape with low maintenance.

Author Contributions: All the authors of this manuscript have contributed substantially to the work here reported. Conceptualization, Y.Y., Q.Y., F.S. and Y.Z.; data curation, Y.Y., Q.Y., D.F. and Y.H.; writing—original draft, Y.Y., Y.C. and Q.Y.; investigation, Y.Y., Q.Y., D.F., Y.C., T.G., H.C. and H.Y.; visualization, Y.Y., Q.Y. and D.F.; resources, F.S. and Y.Z.; funding acquisition, F.S.; supervision, F.S. and Y.Z.; project administration, F.S. and Y.Z.; validation, Y.Z. All authors have read and agreed to the published version of the manuscript.

Funding: This research was supported by the Project of National Natural Science Foundation of China (NO: 51978627) and the Scientific Research and Training Program of Undergraduates at the Zhejiang Agriculture and Forestry University in China (NO: S202210341012).

Data Availability Statement: Not applicable.

Acknowledgments: We thank Xiaopeng Li for her valuable suggestions and comments on the manuscript. We also express our gratitude to all the students who participated in the survey, for their assistance with this paper.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Zhou, L. Assessment of ecological environment quality for urban sustainable development based on AHP. *Comput. Intel. Neurosc.* **2022**, *2022*, 4056713. [CrossRef] [PubMed]
2. Guo, L.; Di, L.; Tian, Q. Detecting spatio-temporal changes of arable land and construction land in the Beijing-Tianjin corridor during 2000–2015. *J. Geogr. Sci.* **2019**, *29*, 702–718. [CrossRef]
3. Yao, T. Urban landscape pattern and ecological environment characteristics based on the concept of green city development. *J. Environ. Prot. Ecol.* **2020**, *21*, 1961–1971.
4. Park, S. Spatial assessment of landscape ecological connectivity in different urban gradient. *Environ. Monit. Assess.* **2015**, *187*, 425. [CrossRef] [PubMed]
5. Li, H.; Peng, J.; Liu, Y.; Hu, Y. Urbanization impact on landscape patterns in Beijing City, China: A spatial heterogeneity perspective. *Ecol. Indic.* **2017**, *82*, 50–60. [CrossRef]
6. Tian, Y.; Wang, L. The effect of urban-suburban interaction on urbanization and suburban ecological security: A case study of suburban Wuhan, central China. *Sustainability* **2020**, *12*, 1600. [CrossRef]
7. Gao, Y.; Kim, S. Critical factors in the sustainable development of plant furnishing in urban park ecological environment. *J. Environ. Prot. Ecol.* **2022**, *23*, 1425–1431.
8. Jeong, K.; Byun, B. A study of ecological design strategies around national parks: A case of Moodeungsan National Park in Kores. *J. Wetlands Res.* **2016**, *18*, 1–9. [CrossRef]
9. Jeong, S.; Bae, K. Urban ecological park design: A case of namsan rehabilitation project. *Seoul Studies* **2006**, *7*, 101–122.
10. Deng, H.; Jim, C.Y. Spontaneous plant colonization and bird visits of tropical extensive green roof. *Urban Ecosyst.* **2017**, *20*, 337–352. [CrossRef]
11. Chen, C.; Mao, L.; Qiu, Y.; Cui, J.; Wang, Y. Walls offer potential to improve urban biodiversity. *Sci. Rep.* **2020**, *10*, 9905. [CrossRef] [PubMed]
12. Atha, D.; Alvarez, R.V.; Chaya, K.; Catusco, J.-P.; Whitaker, E. The spontaneous vascular plant flora of New York's Central Park. *J. Torrey Bot. Soc.* **2020**, *147*, 94–116. [CrossRef]
13. Laffont-Schwob, I.; Triboit, F.; Prudent, P.; Soulié-Märsche, I.; Rabier, J.; Despréaux, M.; Thiéry, A. Trace metal extraction and biomass production by spontaneous vegetation in temporary Mediterranean stormwater highway retention ponds: Freshwater macroalgae (*Chara* spp.) vs. cattails (*Typha* spp.). *Ecol. Eng.* **2015**, *81*, 173–181. [CrossRef]
14. Priede, A.; Mežaka, A.; Dobkeviča, L.; Grīnberga, L. Spontaneous revegetation of cutaway fens: Can it result in valuable habitats? *Mires and Peat* **2016**, *18*, 1–14. [CrossRef]
15. Gagnon, F.; Rochefort, L.; Lavoie, C. Spontaneous revegetation of a peatland in Manitoba after peat extraction: Diversity of plant assemblages and restoration perspectives. *Botany* **2018**, *96*, 779–791. [CrossRef]
16. Zhang, Y. Study on the Effects of Different Environmental Factors on Morphology and Physiology of *Acer catalpifolium*, an Endangered Species in the Rainy Zone of West China. Doctor Thesis, Beijing Forestry University, Beijing, China, 2020. [CrossRef]
17. Qian, S.; Qin, D.; Wu, X.; Hu, S.; Hu, L.; Lin, D.; Zhao, L.; Shang, K.; Song, K.; Yang, Y. Urban growth and topographical factors shape patterns of spontaneous plant community diversity in a mountainous city in southwest China. *Urban For. Urban Green.* **2020**, *55*, 126814. [CrossRef]
18. Shen, S. Less and elegant review of Hangzhou Jiangyangfan Ecological Park. *Landsc. Archit.* **2011**, *1*, 32–35. Available online: http://www.youthla.org/lajournal/201101-2/032-wuwei/ (accessed on 18 February 2023).
19. Yan, X.; Liu, Q.; Shou, H.; Zeng, X.; Zhang, Y.; Chen, L.; Liu, Y.; Ma, H.; Qi, S.; Ma, J. The categorization and analysis on the geographic distribution patterns of Chinese alien invasive plants. *Biodivers. Sci.* **2014**, *22*, 667–676. Available online: https://kns-cnki-net-443.webvpn.zafu.edu.cn/kns8/Detail?sfield=fn&QueryID=0&CurRec=1&recid=&FileName=SWDY201405015&DbName=CJFDLAST2022&DbCode=CJFD&yx=&pr=&URLID= (accessed on 18 February 2023).

20. Zhang, S.; Xiao, Y. Life-form and diversity of sexual system of invasive alien plants in China. *Bull. Bot. Res.* **2013**, *33*, 351–359. Available online: http://bbr.nefu.edu.cn/EN/Y2013/V33/I3/351 (accessed on 18 February 2023).
21. Wu, A.; Deng, X.; Ren, X.; Xiang, W.; Zhang, L.; Ge, R.; Niu, Z.; He, H.; He, L. Biogeographic patterns and influencing factors of the species diversity of tree layer community in typical forest ecosystems in China. *Acta. Ecol. Sinica.* **2018**, *38*, 7727–7738. [CrossRef]
22. Li, X. Diversity and Public Perception of Spontaneous Plants in Public Parks in Urban Environment. Doctor Thesis, Beijing Forestry University, Beijing, China, 2020. [CrossRef]
23. Oksanen, J.; Simpson, G.L.; Blanchet, F.G.; Kindt, R.; Legendre, P.; Minchin, P.R.; O'Hara, R.B.; Solymos, P.; Stevens, M.H.H.; Szoecs, E.; et al. Vegan: Community Ecology Package, R Package Version 2.6–4; R Foundation for Statistical Computing: Vienna, Austria. 2022. Available online: https://CRAN.R-project.org/package=vegan (accessed on 13 February 2023).
24. Lai, J.; Zou, Y.; Zhang, J.; Peres-Neto, P.R. Generalizing hierarchical and variation partitioning in multiple regression and canonical analyses using the rdacca.hp R package. *Methods Ecol. Evol.* **2022**, *13*, 782–788. [CrossRef]
25. Wang, X.; Lin, Q. The story of the design of Hangzhou Jiangyangfan Ecological Park. *Landsc. Archit.* **2011**, *1*, 18–31. [CrossRef]
26. Quan, C.; Huang, F.; Fan, L. Study on the resources of plants and dynamic monitoring of landscape in Jiangyangfan Ecological Park. *Chin. Landsc. Archit.* **2016**, *32*, 99–102. Available online: https://www.cnki.com.cn/Article/CJFDTotal-ZGYL201603022.htm (accessed on 18 February 2023).
27. Quan, C.; Zhang, H.; Gao, S. Study on the secondary vegetation community classification and success in Jiangyangfan Ecological Park. *Anhui Agric. Sci.* **2022**, *50*, 110–114. Available online: https://www.cnki.com.cn/Article/CJFDTOTAL-AHNY202204029.htm (accessed on 18 February 2023).
28. Yang, Y.; Xu, B.; Yu, Q.; Fan, L.; Guo, T.; Fu, D.; Chen, H.; Yan, H.; Shao, F.; Li, X. Distribution pattern and factors influencing spontaneous plant diversity in different wetland habitats. *Forests* **2022**, *13*, 1678. [CrossRef]
29. Li, X.; Dong, L.; Guan, J.; Zhao, F.; Wu, S. Temporal and spatial characteristics of spontaneous plant composition and diversity in a Beijing Urban Park. *Acta Ecol. Sinica.* **2018**, *38*, 581–594. Available online: https://www.cnki.com.cn/Article/CJFDTOTAL-STXB201802023.htm (accessed on 18 February 2023).
30. Liu, X.; Li, G.; Pan, M.; Qi, S.; Zhang, Z. Analysis on species composition of terrestrial plants in Hefei city parks. *J. Anhui Agric. Univ.* **2021**, *48*, 923–933. [CrossRef]
31. Yao, X.; Li, H.; Jin, Y.; Shi, Y.; Bao, Z. Study on the diversity and community composition of spontaneous vegetation in herb layer in Hangzhou Xixi National Wetland Park. *Chin. Landsc. Archit.* **2021**, *37*, 123–128. [CrossRef]
32. Xu, Y.; Zhang, X.; Liu, X.; Zhang, Z. Biodiversity and spatiotemporal distribution of spontaneous vegetation in Tangdao Bay National Wetland Park, Qingdao City, China. *Int. J. Environ. Res. Public Health* **2022**, *19*, 11665. [CrossRef]
33. Chen, Y.; Dai, X.; Zhang, Q.; Zhou, K.; Hu, F. Characteristics and utilization potential of spontaneous vegetation in Shanghai Chemical Industry Park. *J. Chin. Urban For.* **2021**, *19*, 9–15. Available online: https://www.cnki.com.cn/Article/CJFDTOTAL-TJNY202201020.htm (accessed on 18 February 2023).
34. Meng, Y.; Yang, X.; Luo, Z.; Hu, Y.; Yang, R. Investigation and analysis on biodiversity of the spontaneous plant in coal mining subsidence area: A case study of Jiulihu coal mining subsidence area in Xuzhou City. *Tianjin Agric. Sci.* **2022**, *28*, 87–90. Available online: https://kns-cnki-net-443.webvpn.zafu.edu.cn/kns8/Detail?sfield=fn&QueryID=8&CurRec=1&recid=&FileName=TJNY202201020&DbName=CJFDLAST2022&DbCode=CJFD&yx=&pr=&URLID= (accessed on 18 February 2023).
35. Chen, C.; Li, L.; He, T. Investigation and analysis of spontaneous vegetation resources in Guangxi University. *Chin. J. Tropical Agric.* **2023**, *43*, 83–89. Available online: https://kns-cnki-net.webvpn.zafu.edu.cn/kcms/detail/46.1038.S.20221014.1111.004.html (accessed on 18 February 2023).
36. Chu, C. Spatial Distribution and Plant Diversity of Idle Land in the Main City of Nanjing. Master Thesis, Nanjing Agricultural University, Nanjing, China, 2020. [CrossRef]
37. Zhu, J. Investigation on Diversity and Influencing Factors of Spontaneous Plant in Xiangru National Wetland Park. Master Thesis, China West Normal University, Nanchong, China, 2020. [CrossRef]
38. LI, X.; Zhang, S.; Feng, L.; Wu, R. Habitat and species diversity of spontaneous plants on both sides of river corridor in Chengdu urban area. *Landsc. Archit.* **2022**, *29*, 64–70. [CrossRef]
39. Li, F. Spatial Pattern and Influencing Factors of Clonal Plant *Phragmites australis* Population in Yangguan Wetland of Dunhuang. Master Thesis, Northwest Normal University, Lanzhou, China, 2021. [CrossRef]
40. Wu, J. Effects by *Phragmites australis* and *Iris pseudacorus* on thecharacters of the riparian invasive plant: *Alternanthera philoxeroides*. Master Thesis, East China Normal University, Shanghai, China, 2014. Available online: https://cdmd.cnki.com.cn/Article/CDMD-10269-1014317762.htm (accessed on 18 February 2023).
41. He, C.; Li, D. Studies on shade-endurance capacity of *Oplismenus undulatifolius*. *Pratacultural Sci.* **2013**, *30*, 1531–1534. Available online: https://www.cnki.com.cn/Article/CJFDTOTAL-CYKX201310008.htm (accessed on 18 February 2023).
42. Dong, Q.; Li, L.; Liu, Y.; Liu, D. Photosynthetic characteristics of ten species of wild ground cover plants. *Northern horticulture* **2016**, *9*, 93–97. [CrossRef]
43. Ramírez, N.; Briceño, H. Ecology of morphological fruit types, and fruit and seed colors in 27 Venezuelan plant communities. *Acta Oecol.* **2022**, *116*, 103838. [CrossRef]
44. Li, M. Characteristics and Influencing Factors of Plant Community and Diversity in Shenzhen Urban Parks. Master Thesis, Southwest University, Chongqing, China, 2021. [CrossRef]

45. Chen, P.; Zhao, P.; Chen, M. Planning and design of Hangzhou Zhakou White Pagoda park. *Chin. Landsc. Archit.* **2020**, *36*, 99–103. Available online: https://www.cnki.com.cn/Article/CJFDTotal-ZGYL2020S2023.htm (accessed on 18 February 2023).
46. Ling, J.; Liu, B.; Zhao, D. Preliminary report on chemical control of *Hydrocotyle sibthorpioides*. *Anhui Agri. Sci. Bull.* **2000**, *6*, 46–47. Available online: https://www.cnki.com.cn/Article/CJFDTOTAL-AHNB200003020.htm (accessed on 18 February 2023).
47. Figueroa, J.A.; Castro, S.A.; Reyes, M.; Teillier, S. Urban park area and age determine the richness of native and exotic plants in parks of a Latin American City: Santiago as a case study. *Urban Ecosyst.* **2018**, *21*, 645–655. [CrossRef]
48. Xiang, G. Comparative Study on Plant Diversity in Urban Parks between Shanghai, China and Salzburg, Austria. Master Thesis, East China Normal University, Shanghai, China, 2017. Available online: https://cdmd.cnki.com.cn/Article/CDMD-10269-1017075910.htm (accessed on 18 February 2023).
49. Nielsen, A.B.; van den Bosch, M.; Maruthaveeran, S.; van den Bosch, C.K. Species richness in urban parks and its drivers: A review of empirical evidence. *Urban Ecosyst.* **2014**, *17*, 305–327. Available online: http://www.researchgate.net/profile/Anders_Nielsen5/publication/257671090_Species_richness_in_urban_parks_and_its_drivers_A_review_of_empirical_evidence/links/0c96053b4105630f4a000000 (accessed on 18 February 2023). [CrossRef]
50. Zhang, Y.; Li, Z.; Yang, J.; Hu, Y.; Zhang, Z.; Ye, B. Community structure and species diversity of urban green space in Hangzhou China. *J. Northeast For. Univ.* **2013**, *41*, 25–30. [CrossRef]
51. Zhang, Y.; Zhang, F.; Zhang, X.; Zhou, X. Vascular plant diversity and flora analysis of Xixi National Wetland Park. *J. Zhejiang For. Sci. Technol.* **2020**, *40*, 57–64. [CrossRef]
52. Jin, Y.; Lou, J.; Yao, X.; Shi, Y.; Bao, Z. Species composition and diversity characteristics of spontaneous vegetation in different habitats in the riparian zone of urban channelized rivers: A case study of the Beijing-Hangzhou grand canal in the main section of Hangzhou. *Chin. Landsc. Archit.* **2022**, *38*, 110–115. [CrossRef]
53. Ta, N.; Li, H.; Zhu, Q.; Wu, J. Contributions of the quantity and quality of neighborhood green space to residential satisfaction in suburban Shanghai. *Urban For. Urban Green.* **2021**, *64*, 127293. [CrossRef]