Chapter

Assessment of Urban Biodiversity: A Case Study of Beijing City, China

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Abstract

Habitat loss is the most important factor affecting biodiversity. Beijing is an international metropolis with rich biodiversity. With the development of urbanization, biodiversity has been affected to a certain extent in Beijing City. We investigated plant communities in three green land types, parks, residential areas, and roads along an urbanization gradient in the Beijing urban area (inner 6th ring road). Species composition, similarity index, and diversity of plants in urban areas were calculated. The results showed 536 species, belonging to 103 families, and 319 genera in the Beijing urban area. Among them, there were 361 native species and 175 imported species. Eighty species were imported from abroad and 95 species from inland, namely 14.9% and 17.7% of the total species, respectively. The species richness and diversity of trees and shrubs first increased and then decreased along the urbanization gradients, with the decreasing trend from the inner 2nd ring road and the increasing trend from the 3rd–4th ring road. No significant difference was found along the urbanization gradient for herbaceous plants. There were no significant differences in species evenness along the urbanization gradient.

Keywords: urbanization, green land types, plant, community, homogenization, species richness

1. Introduction

City is a complex ecosystem including nature and society [1]. Different functional areas in the city are embedded with each other to form a complex system, which supports the city's demand for huge logistics, energy flow, information flow, and other flows. It also determines that the city has special habitat characteristics, such as obvious gradient change of environmental factors, apparent reduction of natural habitat areas, habitat fragmentation, and fragile ecosystem [2]. Urban biodiversity is not only the fundamental condition of urban survival but also the basis of human survival. At the same time, it has ecological, cultural, and esthetic values [3]. The protection and maintenance of urban biodiversity is the foundation of urban healthy development, the premise of improving the function of urban ecosystem and meeting the needs of human survival. Urban green space is an artificially constructed plant community, which affects the living environment of citizens, but it is disturbed by human activities to a great extent. Therefore, the protection of biodiversity in the city is extremely important and difficult simultaneously.

Urbanization is considered to be one of the main drivers of environmental change, which has a significant impact on the attributes of biological and abiotic ecosystems all over the world [4–7]. Driven by the tide of economic globalization and the requirements of improving people's living standards, the level of urbanization will be further improved. At the global scale, a widely used dataset for projecting the global urbanization level by 2050 is the national-scale 5-year-interval World Urbanization Prospects (WUP) data released by the Population Division of the Department of Economic and Social Affairs of the United Nations (UNPD) [8]. According to WUP, the world urbanization rate will reach 68.4% by 2050 [9]. Well-managed urbanization processes can help maximize the benefits of economic agglomeration while reducing environmental degradation and other potential adverse impacts [10, 11]. However, rapid urbanization will also bring many negative effects. For example, the urban expanded, which often grows faster than parks or reservations [12–14]. Among them, the impact of urbanization on biodiversity is the focus of attention and one of the hotspots in current ecological research [15]. Urban expansion leads to habitat fragmentation and invasion of alien species, thus reducing professional species and increasing common generalist species. This process is defined as biological homogenization [13, 16, 17]. Urbanization leads to the decrease of biodiversity. The invasion of alien species and the reduction of local species caused by urbanization lead to the homogenization of urban organisms [13, 17–19], and the homogenization of urban plants is also prominent [20]. Plants are the basis of all life and development, providing habitats for animals and microorganisms.

Plant diversity is the foundation of urban ecosystem stability and the guarantee of urban sustainable development. It plays an indispensable role in the stability and function of urban ecosystem. Plant diversity under the influence of urbanization is the basis and hotspot of current urban biological ecosystem research [21]. The research on urban plant diversity began in the 1840s in Germany, Britain, and other European countries, and in the 1980s and 1990s there were extensive studies in various developed countries [22–26]. In developing countries, urbanization often has two characteristics: First, the natural ecosystem is replaced by artificial buildings; second, the natural soil is replaced by the green space dominated by exotic ornamental plants, which has a great impact on biodiversity [27]. China has a relatively late cognition of urban plant diversity, and there are few studies. Since 2000, there have been studies on plant diversity in Zunhua, Shanghai, and other cities in China [28–31]. Beijing, which has developed rapidly urbanization, also has a certain research foundation [32, 33], including research on plant diversity in parks [34–36], research on plant diversity in residential green spaces [37], and research on exotic plants in residential green spaces [38]. However, there are relatively few studies on the impact of urbanization on plant diversity under different urban green space types [39, 40], and there is a lack of research on the impact of urbanization gradient on plant distribution.

2. Research area and survey method

Beijing is the capital of China and the ancient capital of many dynasties in history. It is located in the north of North China Plain (39°28′–41°05'N, 115°25′–117°30′E), with a width of 160 km from east to west, a length of 176 km from north to south, and a total area of 16410.54km^2, under the jurisdiction of 16 municipal districts. It is adjacent to Tianjin and surrounded by Hebei Province together with Tianjin, bordering

Yanshan Mountain and Inner Mongolia Plateau in the north, Huang-Huai-Hai Plain in the south, Taihang Mountain and Shanxi Plateau in the west, and Songliao Plain in the northeast. It is generally divided into three geomorphic units: western mountain, northern mountain, and southeast plain. Beijing has a typical warm temperate semi-humid continental monsoon climate, with an annual average temperature of 12.77°C (1978–2013) and an average annual precipitation of 548.86 mm (1978–2013). Though affected by the terrain, climate, soil, and other conditions, Beijing is rich in natural vegetation types, showing regular vertical distribution and transitional alternation. The main zonal vegetation is the warm temperate deciduous broad-leaved forest and the distribution of temperate coniferous forest. However, as an international metropolis, there are few natural communities in the urban area, and there are relatively many kinds of artificially planted plants.

The plant communities of three main types of green space in the parks, streets, and residential areas in each ring of the built-up area in Beijing are selected. Mechanical point method is used to conduct sample point survey within the 6th ring of the built-up area in Beijing. The lines are drawn from the center to the east, west, south, and north (i.e., "two axes"—along the east-west axis of Chang'an Street and the north-south axis perpendicular to it), and select appropriate parks, streets, and residential areas in four directions to conduct plant diversity surveys (three sample points were selected for different green space types within the 2nd ring). A total of 19 parks, 19 residential areas, and 19 streets were selected. A total of 57 transects were investigated in the street, and 114 arbor quadrats, 456 shrub quadrats, and 456 herb quadrats were surveyed in parks and residential areas.

The overall situation of the park green space, residential green space, and street green space in the selected sample points is inspected, and the types of plants, life forms, and whether they are introduced species appearing in the green space were recorded. Among them, all plant species in the park green space and residential green space were recorded, and 100 m transect was selected for each street to record all plant species. According to the method recommended by Fang et al. [41], three tree quadrats of 10 m × 10 m were selected in each park green space and residential green space, and four 5 m × 5 m shrub quadrats and four 1 m × 1 m herb quadrats were selected from each tree quadrat (shrub and herb quadrats were selected from tree quadrats, respectively).

3. Species composition of Beijing City

A total of 536 species of plants belonging to 319 genera and 103 families were investigated in the built-up area of Beijing.

From the perspective of family composition, among the 103 families, Compositae is the family with the largest number of species, including 56 species, followed by Rosaceae with 46 species, Gramineae and Leguminosae with 39 and 37 species, respectively. More than 89% of the families contain less than 10 species, and families with less than 5 species account for 69.9%, including 40 families with 1 species. There are 32 families including 2~4 species, and only 11 families including more than 10 species.

In terms of genus composition, among the 319 genera surveyed, *Prunus* and *Artemisia* contain more than 10 species, *Populus, Polygonum*, and *Chenopodium* contain more than 5 species, while 314 genera such as *Rosa*, *Salix*, *Dendranthema* contained less than 5 species, accounting for 98% of the total, of which 217 genera contain only 1 species, accounting for 68% of the total genera, 91 genera with 2~4 species, accounting for 28.5% of the total genera, and 11 genera with more than 5 species, accounting for only 3.5% of the total genera.

In terms of frequency, *Sophora japonica* has the highest frequency of arbors in all quadrats of urban green space plants in Beijing, up to 0.59, followed by *Sabina chinensis*, which is 0.32. *Buxus megistophylla* had the highest frequency of shrub occurrence, which is 0.46, and *Punica granatum* was 0.06. *Setaria viridis*, the most common herb, is 0.2, followed by *Viola philippica*, which was 0.19.

4. Species richness within each loop of Beijing City

The number of plant species distributed within the 2nd ring is the least, with 218 species (**Table 1**). Among them, there are 66 species of plants in the streets in the 2nd ring, 189 species in the park, and 159 species in the residential area. There are 371 species in the 5th to 6th ring, which is significantly higher than other rings. Among them, the number of plant species in the park is the largest, reaching 299 species. There is little difference in the distribution of plant species in other rings, namely 243 species in the 2nd to 3rd ring, 259 species in the 3rd to 4th ring, and 261 species

Ring road	Green type	Richness of species	The proportion
Inside the 2nd ring	Street	66	40.7%
	Park	189	
	Residential	159	
	Total	218	
2nd to 3rd ring	Street	80	45.3%
	Park	192	
	Residential	146	
	Total	243	
3rd to 4th ring	Street	87	48.3%
	Park	208	
	Residential	173	
	Total	259	
4th to 5th ring	Street	76	48.7%
	Park	199	
	Residential	193	
	Total	261	
5th to 6th ring	Street	72	69.2%
	Park	299	
	Residential	171	
	Total	371	

Table 1.
The number of species and the proportion of the total number of species in each ring under different types of green space.

in 4th to 5th ring. Among the 536 species distributed in the urban area of Beijing, 114 species are only distributed in one ring, accounting for 21.3% of the total number of species surveyed, belonging to rare distribution; 266 species are distributed in 2rd to 4th rings, account for 49.6% of the total surveyed species and belong to dispersive species; and 156 species of plants are distributed in the 5 loops, accounting for 29.1% of the surveyed total species, belonging to widely distributed species.

5. Introduced species

Among the 536 plant species surveyed in the urban area of Beijing, 175 species are introduced species, accounting for 32.6% of the total, including 95 domestically introduced species and 80 foreign introduced species. Trees and shrubs account for a large proportion of the introduced species. Among them, 41 species of arbors are introduced domestically, accounting for 37.6% of the total arbor species, 16 species of arbors are introduced abroad, accounting for 14.7% of the total arbor species. The proportion of shrubs introduced from China is 33.6%, and that from abroad is 14.1%. In the survey, there are 253 native herbaceous species, accounting for 79.1% of the total herbaceous species, and the total number of introduced herbaceous plants is only 20.9%.

The number of introduced species in different rings in Beijing urban area is unevenly distributed, of which 99 species are introduced in the 2nd ring, accounting for 45.4% of the total number of species in the 2nd ring. Outside the 2nd ring, with the increase of urbanization gradient, the number of introduced species showed a gradual increase trend. There are 90 introduced species from the 2nd ring to the 3rd ring, accounting for 37% of the total species. There are 100 introduced species from the 3rd ring to the 4th ring, accounting for 38.6% of the total species. There are 108 introduced species from the 4th ring to the 5th ring, accounting for 41.4% of the total species. There are 129 species introduced from the 5th ring to the 6th ring, accounting for 34.8% of the total species.

6. Similarity index and diversity index

The similarity indices of street green space and park green space between the 3rd to 4th ring and the 4th to 5th ring are the highest, which are 0.50 and 0.52, respectively, indicating that the species composition of the streets and parks in the two loops is the most similar (**Table 2**). The similarity index between the 2nd to 3rd ring and the 4th to 5th ring in the green space in the residential area is the highest, which is 0.48. The three types of green space with the lowest similarity index among the rings are different. On the whole, the similarity indexes between the street green space and the park green space from the 3rd to 4th ring and other rings are relatively high, reaching an average of 0.47 and 0.45, respectively, indicating that the species composition similarity between the street green space and the park green space from the 3rd to 4th ring and the corresponding green space types of other rings is high. The similarity index between park green space and residential green space from the 5th to 6th ring and other rings is relatively low, with an average of 0.35 and 0.39, respectively, indicating that some species of park green space and residential green space from the 5th to 6th ring are less distributed in the corresponding green space types in other rings.

The plant richness indexes of different life forms change differently with the outward expansion of the city. The richness indexes of trees and shrubs show a trend

	Jaccard indexes	2nd to 3rd ring	3rd to 4th ring	4th to 5th ring	5th to 6th ring
Street	Inside the 2nd ring	0.36	0.45	0.38	0.39
	2nd to 3rd ring		0.47	0.40	0.43
	3rd to 4th ring			0.50	0.45
	4th to 5th ring				0.44
Park	Inside the 2nd ring	0.40	0.38	0.41	0.27
	2nd to 3rd ring		0.51	0.45	0.34
	3rd to 4th ring			0.52	0.39
	4th to 5th ring				0.40
Residential	Inside the 2nd ring	0.47	0.42	0.46	0.40
	2nd to 3rd ring		0.44	0.48	0.42
	3rd to 4th ring			0.44	0.38
	4th to 5th ring				0.35

Table 2.
The similarity index between the various rings under different types of green space.

of decreasing first and then increasing, while the richness indexes of herbs gradually increase with the increase of urbanization gradients. Among the plants of different life forms, herbs are the most abundant. The herb richness index of the 3rd to 4th ring is the highest, reaching 0.89, and that of the 2nd ring is the lowest, which is 0.83. The shrub richness was the lowest, and the shrub richness index was only 0.18 in the 2nd ring, which was relatively high. Trees are slightly higher than shrubs, and the tree richness index in the 3rd to 4th ring is the lowest, which is 0.40, and the highest in the 2nd ring is 0.71.

With the increase of urbanization gradient, the diversity index of trees and shrubs shows a trend of decreasing first and then increasing, while the diversity index of herbs has no obvious change law with the change of urbanization gradient. Among them, the species diversity of herb is the largest, the 5th to 6th ring with the highest herb index reach 0.98, and the lowest 4th to 5th ring also reach 0.86. The second is arbor, the highest diversity index is 0.60 in the 5th to 6th ring, and the lowest diversity index is 0.29 in the 3rd to 4th ring. The diversity of shrubs is the lowest. The lowest shrub index in the 4th to 5th ring is only 0.04, and the highest shrub index in the 2nd ring is only 0.16.

With the increase of urbanization gradient, the species evenness of trees, shrubs, and herbs has no obvious change. Among them, the species evenness of shrub is the lowest, with an average of 0.12, the highest within the 2nd ring is 0.19, and the lowest in the 4th to 5th ring is only 0.05. The evenness of arbor and herb is relatively high, with average values of 0.50 and 0.58, respectively. The highest evenness of arbor is 0.57 in the 2nd ring, and the highest evenness of herb is 0.64 in the 2nd to 3rd ring.

Due to the change of green space types, the species diversity index (richness, diversity, and evenness) of shrubs shows significant difference ($P < 0.05$), and the other species diversity indexes do not show significant difference. With the changes of

Species diversity indices	*T*-test	Impact factor	
		Green type	Ring road
Margalef's indexes of tree	*F*	0.000**	2.154
	P	0.984	0.376
Shannon's indexes of tree	*F*	0.093	2.970
	P	0.762	0.610
Pielou's indexes of tree	*F*	1.030	1.101
	P	0.317	0.243
Margalef's indexes of shrub	*F*	4.939	25.407
	P	0.032*	0.054
Shannon's indexes of shrub	*F*	7.635	38.461
	P	0.009**	0.324
Pielou's indexes of shrub	*F*	8.475	51.018
	P	0.006**	0.519
Margalef's indexes of the herb	*F*	0.001**	0.968
	P	0.971	0.578
Shannon's indexes of the herb	*F*	0.034 *	0.333
	P	0.855	0.571
Pielou's indexes of the herb	*F*	0.133	0.728
	P	0.718	0.335

Table 3.
The ANOVA analysis between species diversity indices and impact factor.

different loops, there was no significant difference in species diversity index (richness and diversity) ($P > 0.05$). Pearson's correlation analysis between species diversity index and various influencing factors is listed in **Table 3**. Shrub richness is significantly correlated with green space types at the level of 0.05. Shrub diversity index and evenness index were significantly correlated with green space types at the level of 0.01. There was no significant correlation between the species diversity indexes in each loop.

7. Species and environmental factors

The species distribution of different green space types is greatly affected by human factors, so this study only ranks the species distribution in different loops. Because there are many species, only the species with relatively high frequency are shown in the ranking chart. The canonical correspondence analysis (CCA) results of species-environment clearly show the distribution of species in different loops and the average value of relative occurrence frequency. In the tree species environment CCA ranking diagram, the characteristic value of axis1 is 0.411 and the characteristic value of axis2 is 0.255. The two axes show a high correlation between species and environmental factors, which are 0.795 and 0.777, respectively. The interpretation rates of the two axes can reach 42.0% and 68.1%, respectively. The distribution and occurrence frequencies of different tree species in the 2nd ring and the 5th to 6th ring are not different, but the occurrence frequencies in other rings are significantly different. For example, the average value of occurrence frequency of ash tree in each ring is in the order of: 3rd to 4th ring >2nd to 3rd ring > inside the 2nd ring >5th to 6th ring >4th to 5th ring, while the average value of occurrence frequency of juniper tree in each ring is in the order of: inside the 2nd ring >5th to 6th ring >4th to 5th ring >3rd to 4th ring >2nd to 3rd ring. The characteristic values of axis1 and axis2 in the shrub species-environment CCA ordination diagram are 0.328 and 0.255, respectively. The correlation between species and environmental factors shown in the two axes is relatively high, 0.769 and 0.670, respectively. The interpretation rates of the two axes are 33.6% and 59.7%, respectively. The frequency of occurrence of most shrub species in the 4th to 5th ring is relatively low. Among them, *Buxus megistophylla*, *Buxus sinica*, *Prunus cerasifera*, and *Lonicera maackii* have the lowest distribution frequency in the 4th to 5th ring, while the highest frequency is in the 5th to 6th ring. The average frequency of occurrence in the 2nd ring, the 2nd to 3rd ring, and the 3rd to 4th ring is not much different. The characteristic values of axis1 and axis2 in the herbaceous species environment CCA ordination diagram are 0.206 and 0.156, respectively. The correlation between the species and environmental factors shown in the two axes is also relatively high, which are 0.750 and 0.753, respectively. The interpretation rates of the two axes are 36.3% and 63.8%, respectively. The species of herbaceous plants are significantly more than trees and shrubs, and they are highly concentrated in each ring. Most herbaceous plants have the highest occurrence frequency inside the 2nd ring and in the 5th to 6th ring. Among them, plants such as *Eleusine indica*, *Digitaria sanguinalis*, *Ophiopogon japonicus,* and *Viola philippica* have a higher frequency inside the 2nd ring and in the 5th to 6th ring, and they are distributed in all other rings with little difference in their frequency.

Relevant studies [17–19] show that the high-intensity human interference, invasion of alien species, and reduction of native species caused by urbanization have led to the homogenization of species distribution. This study found that the similarity index of urban green space plants in Beijing is high, indicating that the cultivation and allocation of urban green space plants in Beijing are greatly affected by human activities, especially the species of trees and shrubs on the streets are relatively single, which makes the urban plants tend to be homogeneous. On the issue of protecting urban plant diversity, the first principle to be followed is to respect nature and maintain and protect urban plant diversity guided by respect for nature. According to international excellent experience, the goal of urban biodiversity protection is to introduce nature and forests into cities. The area of green space in the city is small, and the core of protecting urban plant diversity is to use limited green space, scientifically and reasonably carry out ecological allocation, and maintain and restore urban biodiversity. In the early stage of urban development planning, precious plants and areas with high biodiversity value should be protected in a key way, and in garden design, both ornamental value and ecological benefits should be used, native species should be encouraged, exotic species should be introduced reasonably, corresponding plants should be selected and configured under different environmental conditions according to local conditions, species with different ornamental values (fruits, leaves, branches, flowers, etc.) should be configured reasonably, and shade-tolerant ground cover plants should be used scientifically to increase urban plant diversity. Grass germplasm resources are an important part of biodiversity [42] and have the characteristics of strong adaptability, low maintenance and management costs, and unique ornamental value [43, 44], especially ornamental grasses, which play an extremely important role in urban landscape design. In the urban area of Beijing, most native species have extremely high ornamental value and are natural ground cover plants. The application and rational allocation of native species in urban green space plants can reflect the regional characteristics and urban personality of the city and can also reflect the local characteristics of urban landscaping in the region. It will also promote the harmonious coexistence between man and nature and achieve a symbiotic and co-prosperous relationship.

The richness and diversity index of urban plants also change with the degree of urbanization. At present, due to different research sites or methods, there are two main trends of the impact of urbanization on urban plant diversity: one is that plant diversity increases with the strengthening of urbanization [45] and the other is that the plant richness increases along the change from urban area to urban-rural fringe to suburb [26, 46]. McKinney [47] found in the summary of the research on the impact of urbanization on species richness that 65% of the plant research results show that with the slow improvement of urbanization level, the plant species richness continues to increase. However, in this study, within a certain range, the plant richness and diversity index decreased with the increase of urbanization gradient and then showed a gradually increasing trend with the development of the city. Different from previous studies [36], in this study, the richness index of shrubs is lower than that of trees, which may be due to the fact that trees are the main body of artificial green space, shrubs are used in combination, and less species are selected. It is found that the plant diversity index inside the 2nd ring is slightly higher than that in the 2nd to 3rd ring, which may because the landscaping construction inside the 2nd ring pays attention to the introduction and allocation of shrubs and herbs, which makes the diversity of trees, shrubs, and grasses inside the 2nd ring relatively high. Previous studies have shown that woody plant richness in residential areas and parks is higher than that of other land use types [48]. This survey found that the species diversity index of shrubs is more significantly affected by green space types.

The difference of quadrat species diversity index with the change of environmental factors is not significant, but the distribution of species is greatly affected by environmental factors. CCA ranking analysis shows that the average value of distribution and occurrence frequency of plant species in each loop is different, which may be because the microclimate formed in different environments is more suitable for the survival of some species, or because different soil environments affect the distribution of species [49]. It may also because different urban construction areas have different urban landscape design schemes.

Research has shown that urbanization leads to the increase of alien species, while the diversity of native species decreases [29, 45, 50, 51]. The number of introduced species of urban plants in Beijing shows a gradually increasing trend outside the 2nd ring. The main reason may be that in the later urban construction, the introduction and cultivation of exotic garden plants have been gradually increased. At the same time, it shows that more and more attention is paid to the introduction of alien species in urban construction to achieve better plant configuration and ornamental effect, but the introduction of alien species will ignore the phenomenon of native species.

At the beginning of urban development and after it develops to a certain extent, the richness and diversity index of urban plants increase. In urban construction, not only must foreign species be introduced for the design and configuration of garden plants, but more attention must be paid to the selection of local species, that appropriately increase the types and quantity of shrubs and the types of turfgrass. If not necessary, avoid using a large area of single turfgrass, which can not only make the tree, shrub, and grass form a close-to-natural multilayer green space community structure but also give full play to its ecological benefits to the greatest extent and make the urban biodiversity play its value [52].

Beijing has a wide geographical scope and a huge number of green areas. Because the survey objects are some sample points in the urban artificial green space, the number and area of the selected sample points are limited, so the results of plant species, family and genus distribution, biological diversity characteristics, and other aspects of research are not comprehensive enough. If you want to have a more accurate and in-depth study on the plant diversity of Beijing's urban green space, it is necessary to comprehensively investigate all plant communities in the city and establish a complete Beijing urban green space biodiversity monitoring system to monitor the dynamic changes of urban biodiversity for a long time, so as to provide services for the protection of biodiversity in Beijing.

8. Conclusion

1. A total of 536 species of plants belonging to 319 genera and 103 families were investigated within the 6th ring in Beijing. Among them, Compositae, Rosaceae, Gramineae, and Leguminosae are many families, while Plum and Artemisia are many genera. Among the 536 plant species investigated, 175 are introduced species, of which 95 are domestic introduced species, accounting for 17.7% of the total, and 80 are foreign introduced species, accounting for 14.9% of the total.

2. There is high similarity of green space plants in Beijing urban area. The similarity index of street green space and park green space is the highest between the 3rd to 4th ring and the 4th to 5th ring, reaching 0.50 and 0.52, respectively. The highest similarity index of residential green space is between the 3rd to 4th ring and the 4th to 5th ring, with an index of 0.48.

3. With the increase of urbanization gradient, the species richness and species diversity index of trees and shrubs in urban green space plants shows a trend of first decreasing and then increasing, while the change rule of herbs is not obvious. The evenness of plant species has no obvious change with the increase of urbanization gradient.

4. The distribution and occurrence frequency of different plants in each ring are different. Some arbor species appear in the 2nd ring and the 5th to the 6th ring at the same time, and the average value of the occurrence frequency in the two rings is not different. The frequency of most shrub species in the 4th to 5th ring is relatively low, and the species of herbs are significantly higher than those of trees and shrubs and have a high concentration distribution in each ring.

9. Prospect

Practice has proved that there are many factors affecting urban development and biodiversity change. The city itself is a huge complex ecosystem, and the social, economic, and natural environment of different cities are quite different. In addition, the terrain, climate, hydrology, and soil conditions of cities are diverse, so the impact of urban development on biodiversity is completely different [2]. In the future, the impact of urbanization on biodiversity can be considered from the following aspects:

1. Using a geo-detector model to determine the impact strength of certain urbanization factors that affect urban biodiversity. For example, Li et al. [53] used the geographic detector model to determine the influence intensity of urbanization factors on tree diversity in Beijing. The results showed that the influence intensity of the influence factors was in the following order: land use type > forest canopy patch size > population density > impervious surface scale > distance from city center. The interactions among the factors are nonlinearly enhanced, indicating that urban tree diversity depends not only on the properties of a single factor but also on the spatial interactions among multiple factors.

2. Studying the impact of urban heat island effect on ecological interaction under climate change [54]. In urban heat islands, warmer temperatures may negatively affect the abundance, phenology, physiology, and behavior of species, including pollinators, herbivores, natural enemies, and urban pioneers, affect the evolution of pathogen virulence, and affecting reciprocal and antagonistic ecological interactions in cities [55–58].

3. Studying the quantitative relationship between urbanization intensity and biodiversity diversity. For example, Zhao et al. [59] used the percentage of total impervious surface area (PTIA) as an indicator of urbanization intensity, showing that PTIA is the main predictor of plant diversity variability in Wuhan urban areas and establishing a threshold for plant diversity.

4. Research on urban biodiversity conservation. Liu et al. [60] proposed that university campuses are valuable resources for urban biodiversity research and protection. Therefore, university campuses with high biodiversity can be protected and used as valuable resources for biodiversity education, research, and protection; Huang Chunwei and other researchers [61] found that the habitat loss caused by cities to biodiversity mostly occurs in countries with low political stability and regulatory quality, which can link land governance with the threat of urbanization to biodiversity.

The research of Fuller and others [62] shows that there is a clear link between biodiversity and the social benefits of urban nature. Therefore, the theoretical knowledge of urban biodiversity conservation is actively applied to buffer the damage to biodiversity caused by urbanization. It will also be the main content of future research.

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