Effects of Tourism Disturbance on Plant Species Diversity and Soil Physicochemical Properties in Wulingyuan World Heritage Reserve

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Abstract: Based on the investigation and analysis of plant species diversity and soil physical and chemical properties in Wulingyuan World Natural Heritage site by distance sampling method, the results show that with the increase of vertical distance, the plant species diversity increases, the biological dominance decreases, the species richness increases, and the distribution uniformity increases; with the rise of the travel grade, the plant species diversity and the soil physical and chemical properties decrease.Also,Besides, the plant species diversity increased and then decreased, the ecological evenness decreased and then increased, the species richness first increased and then reduced, and the distribution evenness first increased and then dropped, which conforms to the hypothesis of moderate interference; the plant species diversity also has a correlation with the physical and chemical properties of soil, and has mutual influence.

1. Introduction

According to data from the World Tourism Organization (UNWTO), tourism will account for 9% of global gross domestic product (GDP) in 2019. Tourism from pollution-free industries to a negative impact on the ecological environment is significant. The conflict between the development of tourism and the diversity of plant species is the most direct. Waldén et al., by comparing the 2001 field inventory of vascular plant species diversity and the follow-up inventory survey in 2012, the restoration of semi-natural grasslands can promote semi-natural habitats and their Related biodiversity protection [1]. Iliadou used micro experiments to reveal the underlying mechanism of ecosystem function and how the role of ecosystem flow is affected by the loss of biodiversity [2]. Damschen reveals the response mechanism of plant diversity in plant communities, plant landscapes and ecosystems in tourism activities. At the same time, during the disturbance of tourism to plant species, the relationship between soil and plants is particularly close. Ford et al. believe that plants play a decisive role in soil stability. The combination of ground vegetation and root systems protects the soil from erosion. Soil stability and biomass are positively correlated with plant diversity [4]. Relevant scholars in the Wulingyuan World Natural Heritage Reserve have also conducted precise studies on plant communities and plant diversity [5]-[6].Still ,due to the complexity of tourism disturbances, as well as plant diversity, multiple habitats and other factors, tourism disturbances and plants The relationship between species diversity and soil physical and chemical properties is less involved. Taking the Wulingyuan World Natural Heritage Reserve as an object to study the direct and indirect interference of tourism on plant species diversity, multi-dimensional and systematic description of the impact of tourism interference on the diversity of plant species has important practical significance for the ecological construction of Wulingyuan Natural Heritage Site , Has a precise reference to the sustainable development of tourism in other similar scenic spots.

2. Materials and Methods

2.1 Overview of the Study Area

The Wulingyuan World Natural Heritage Site is located in the middle part of the Wuling Mountains in the northwest of Hunan Province, with a total area of about 391 square kilometres and

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a core scenic area of more than 250 square kilometres The forest coverage rate of Wulingyuan World Natural Heritage is 97.7%. There are 93 families and 517 species of woody plants alone. The precious tree species are Davidia involucrata, which is protected by the first-class state, and Bell, Ginkgo, and Fragrant. Fruit trees and Liriodendron tulipifera, Fragrant Phoebe, Eucommia ulmoides, Money willow, Cat feces, Silver magpie, Taxus chinensis and so on. The number of tourists received increased from 83,700 in 1982 to 30,288,900 in 2018, with total tourism revenue of 26.552 billion yuan.

2.2 Parcels Setting and Investigation

The sampling site is set up by distance sampling method and gradient pattern method. The length of Jinbianxi River is 5710m. They are in Guimenyan (A), Jinbianyan (B), Jinbianya (C), Changshouquan (D), and Jumping. Six parcelss are set up at Yutan (E) and Shuimensimen (F), among which A and F are first-level sidewalks (P1), B and C are second-level sidewalks (P2), D and E (P3) It is a three-level sidewalk, and three different distances and depths of vegetation zone with distances of 0m (Short Distance, SD), 5m (Middle Distance, MD), and 10m (Long Distance, LD) are set on the side of each different level of the sidewalk. The three sets of parcelss are synchronously set with 3 repeating parcelss in the direction of the vertical sidewalk, a total of 9 parcelss, as shown in Figure 2.1 below, but due to the influence of terrain, cliffs and streams, a total of 42 parcelss are set. Record the plant species, species, height and cover in the sample parcels. At the same time, 5 sample points are randomly placed in each parcels to collect soil samples. The soil samples collected were air-dried, cleaned, crushed and sieved for physical and chemical properties analysis. The soil bulk density was measured by the ring knife method, the soil water content was measured by an aluminium box drying method, and the organic matter content of soil C and N were measured by an EA3000 element analyzer.

2.3 Determination of Plant Diversity Indicators

According to Wang Dianbei [7] and others in the study of plant species diversity, four indicators that have been proved to be more stable and useful by a large number of applications are selected: species richness index (Ma), Shannon-Wiener diversity index (H'), Pielon uniformity Degree index (J) and ecological dominance index (D) to measure the species diversity in the community.

Species richness index Margalef (Ma): $M_a = (S-1)/\ln N$ (Formula 1)

Shannon-Wiener diversity index (H): $H = -\sum P_i(\ln P_i)$ (Formula 2)

Pielon uniformity index (J): $J = H/\ln S$ (Formula 3)

Ecological dominance (D): $D = 1-\sum P_i^2$ (Formula 4)

In the formula, i=1,2,3...; S is the total number of species in the parcels where the species i is situated; N is the total number of individuals in the parcels where the species is located; Pi is the proportion of the i-th species, ie Pi =ni/N0, ni is the number of individuals of the i-th species, and N0 is the total number of species in a specific parcels.

2.4 Determination Method of Soil Physical and Chemical Properties

Soil water content: W = (wet weight-dry weight) / dry weight (Equation 5)

Soil bulk density: ring knife method

Bulk density (G) = S/V (g/cm3) (Equation 6)

Among them, S-the weight of the dry soil in the ring knife (g) V-the volume of the ring knife (cm3)

Soil pH: measured by a pH meter, water is 1/25 of soil (Equation 7)

Soil organic matter C, N content: EA3000 organic element analyzer determination

3. Results and Analysis

3.1 Changes in Plant Species Diversity

From the perspective of the composition of species diversity, a total of 54 plants, 85 genera, and

102 species (see Table 1) were found in 6 locations, and the SD plant species were mainly Urticaceaeu (*Oreocnide frutescens*(Thunb.)Miq., *Pilea pumila*(L.)A.Gray, and *Pellionia radicans*(Sieb.et Zucc.)Wedd.),Gramineae(*Oplismenus undulatifolius*(Arduino)Beauv,*Lophatherum gracile* Brongn), MD plant species are mainly Apiaceae Lindl (*Pternopetalum davidii* Franch, *Cryptotaenia japonica* Hassk.), Polygonaceae (*Antenoron neofiliforme*(Nakai)Hara, *Fagopyrum dibotrys*(D.Don)Hara),Acanthaceae(*Asystasiella neesiana*(Wall.)Lindau), Balsaminaceae(*Impatiens balsamin*a L.), LD plant species are mainly ,Liliaceae (*Asparagus cochinchinensis*(Lour.)Merr, *Paris polyphylla* Smith),Caryophyllaceae *(Stellaria media*(L.)Cyr),Cruciferae (*Cardamine hirsuta* L) Saxifragaceae (*Chrysosplenium serreanum* Hand.-Mazz, *Tiarella polyphylla* D.Don, *Dichroa febrifuga* Lour.*Hydrangea villosa* Rehd). The distribution of species is shown in Table 1. At the same tour level, the disturbance decreases and the biomass increases with the distance from the vertical tour path. At the same distance, the biomass increases first and then decreases as the tour-level increases.

3.2 Changes in Plant Diversity Index

At the same tour level, with the increase of the vertical tour distance, the Ma index, Shannon-Wiener index, and Pielon index all growth, and the ecological dominance index decreases. The four indices indicate that the farther away from the tour, the less interference and the fertile species The degree, diversity, and evenness all increase, and the ecologically dominant species decrease. At the same time, the richness index Ma of different tour levels at the same distance increases and then falls, and the Shannon-Wiener index also increases and then decreases. It shows that diversity increases first and then decreases with the increase of interference intensity, and moderate interference increases species diversity to a precise extent.

Table 1 Plant species composition table

Distance from Path	Species Composition	P1	P2	P3
SD	Family	7	10	9
	Genera	9	14	13
	Species	14	27	24
MD	Family	13	19	15
	Genera	23	28	25
	Species	31	34	32
LD	Family	11	12	11
	Genera	20	28	25
	Species	24	32	30

3.3 Relationship between Plant Species Diversity and Soil Physical and Chemical Properties under Tourism Disturbance

The five indicators of soil water content (W), bulk density (G), pH value, C, and N content in each parcels were studied. The results showed that with the increase of the distance of the vertical sidewalk, the soil water content increased, and the bulk density decreased, C, N The organic matter content increased; Still, at the same vertical path distance, with the decrease of the path level, the soil bulk density and pH value first decreased and then increased, and the soil water content and CN organic matter content increased first and then decreased (Table 2).

The correlation between the diversity index and soil physical and chemical properties is shown in the following table. The results show that: Ma diversity index is positively correlated with water content and C content, negatively correlated with pH, but not significantly related to bulk density and N content; Bulk density and pH are positively correlated with water content (W), C content and N content; H diversity index is negatively correlated with bulk density and pH, and with water content (W), C content and N content; uniform Degree index (J) is positively correlated with water content (W), C content, and N content, negatively associated with bulk density, and not significantly correlated with pH (Table 3).

Table 2 Physical and Chemical Properties of Soil

Soil physical and chemical properties	Tour class	P1	P2	P3
G(g/cm3)	SD	0.988	0.912	0.938
	MD	0.858	0.834	0.882
	LD	0.893	0.793	0.828
W(%)	SD	0.155	0.218	0.167
	MD	0.328	0.428	0.408
	LD	0.449	0.503	0.452
N(%)	SD	0.546	0.679	0.603
	MD	0.676	0.745	0.714
	LD 0.807	0.848	0.759	
C(%)	SD	4.835	6.258	4.755
	MD	7.291	8.479	7.879
	LD	10.962	11.341	11.238
pH	SD	6.96	6.71	6.91
	MD	6.61	6.18	6.28
	LD	6.31	5.99	6.04

Table 3 Correlation Coefficient Between the Diversity Index and Soil Physical and Chemical Properties

	Ma	D	H	J	G	W	N	C	pH
Ma	1	-0.981**	0.943**	0.547*	-0.424	0.634**	0.442	0.503*	-.0657**
D	-0.981**	1	-0.975**	-0.647**	0.499*	-0.707**	-0.539*	-0.607*	0.592*
H	0.943**	-0.975**	1	0.714**	0.578*	0.664**	0.486*	0.587*	-0.503*
J	0.547*	-0.647**	0.714**	1	-0.602*	0.579*	0.538*	0.534*	-0.314

4. Discussion and Conclusion

In the species diversity index, the Margalef index (Ma) reflects the species richness, the Shannon-Wiener index (H) indicates the total number of species, the Pielon index (J) reflects the species uniformity, the ecological dominance (D) reflects the species dominance In physical and chemical properties of soil, bulk density reflects soil compactness, water content reflects soil moisture, N and C content reflect soil organic matter content, and pH reflects soil acidity and alkalinity. Studies have shown that in the Wulingyuan World Natural Heritage Site, tourism activities have affected the distribution characteristics of species diversity. With the increase in distances, families, genera, and species have increased significantly. From the main species of kenaf, stalk *Pilea pumila*, and *Pellionia radicans* , Seeking rice grass, light bamboo leaf grass, to saccharine, duck celery, golden thread, white elderberry, impatiens, and then to Asparagus, Chonglou, chickweed, ginseng, top ten credits, broken rice Shepherd's purse, golden waist, Changshan, hydrangea, plant species diversity index also changed significantly, with the increase of the vertical distance of the sidewalk, plant species diversity increased, the dominant degree of dominant species decreased, biomass also increased, at the same time It also has the same effect on soil factors. With the increase of the vertical path distance, the soil physical and chemical properties indicators show that soil moisture, porosity, and organic matter content all increase with the decrease of interference, but at the same distance, they are different The level of the path has a different effect on plant species diversity. With the increase of the rank of the path, the degree of interference decreases. The diversity index indicator shows that the plant diversity a trend of increasing and then reducing. The degree does not cause a tremendous negative impact on plant, but also reduces the dominance of the dominant species, thereby enriching the plant's biological diversity. This phenomenon is consistent with the “moderate interference hypothesis” in landscape ecology, which proposes that moderate interference is beneficial to increase the heterogeneity of the landscape, In contrast high-intensity interventione may increase or decrease the heterogeneity of the scene.

There is a precise correlation between the index of plant species diversity index and the index of

soil physical and chemical properties. The analysis shows that soil bulk density is significantly positively correlated with dominance and negatively correlated with diversity and evenness. It shows that the density of soil near the vertical path is considerably higher than that of the distance, the density of the soil around the first-level path is higher than that of the second-level path, and it is also higher than the third-level path. It also affects the plant through the impact on the soil due to disturbances such as trampling by tourists The dominance of species reduces the diversity, richness and evenness of species. There is a markedly positive correlation between water content and plant species diversity index, which indicates that the loss of soil moisture due to tourism disturbances also affect the growth of plants, which reduces the diversity of plant species. The contents of organic matter C, N and pH were also significantly related to plant species diversity, indicating that the impact of tourism on soil physical and chemical properties also affected the changes in plant species diversity. However, there are many factors which affect the physical and chemical properties of the soil, such as soil parent material and vegetation, which are also essential factors that affect the physical and chemical properties of the soil. The influence of the physical and chemical properties of the soil also needs to take into account factors such as soil elevation, slope, and geology. Therefore, when selecting the sampling area, The Jinbianxi Trail area with low altitude and basically consistent topography is chosen to minimize the impact of natural factors on the physical and chemical properties of the soil.

Under tourism disturbances (travellers trampling, engineering construction, tourist waste), plant species diversity and soil physical and chemical properties increase with the increase of the distance of the vertical sidewalk; at the same distance, with the rise of the level of the sidewalk, the plant species are diverse The properties and soil physical and chemical properties increase first and then decrease, which is consistent with the moderate interference hypothesis. Moreover, there is a precise significant relationship between plant species diversity and soil physical and chemical properties, indicating that tourists' trampling on the sidewalk at close distances affects the physical and chemical properties of the soil to a precise extent, reducing biodiversity. In the investigation, it found that tourists trampled the Bare railing land, sandy land, etc. Tourists in the Wulingyuan World Natural Heritage Site have increased a lot over the years.Still as a natural resource scenic spot, the protection and management of plant species diversity in the scenic spot is lacking. Since the fixed tourism development facilities have been completed, the scientific literacy of tourists should be strengthened To strengthen the ecological protection awareness of the staff and tourists in the scenic area, and promote the sustainable use of resources in the Wulingyuan Natural Heritage Site.

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