A Preliminary Investigation of Bird Diversity in Nanjing

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Abstract**—** *To find out the classification information and distribution information of common birds in Nanjing, China, and provide reference for the government to formulate the protection policy of bird, this paper analyzes the bird observation data from 2007 to 2016 in the Bird Observation Center (Nanjing area), and analyzes the ecological changes of the observation points in combination with the Nanjing land using situation. the results show that Nanjing is an important bird habitat, with many species and national protected species, but in recent years, the acceleration of urbanization and human activities have seriously affected these originally good bird distribution areas, government departments should strengthen the response and management.*

Keywords**—** ***Nanjing, Bird diversity, Protected species.***

I. INTRODUCTION

From May 2012 to April 2013, Peng lifeng selected four habitats in Suzhou industrial park, set up 17 sample lines and 24 sample points, and studied the bird community monthly. A total of 130 species of birds were recorded, belonging to 41 families of 12 orders. Among them, the resident birds, summer birds, winter birds and passing migrant birds accounted for 26.15 %, 25.38 %, 27.69 % and 20.77 % of the total species, respectively. The cosmopolitan species and palaearctic realm species accounted main part of them, and has both oriental species and obvious characteristics of north-south transition. In terms of seasonal dynamics, the number of bird species in the park showed that, spring > winter > autumn > summer, and the density of the birds showed that, winter > autumn > spring > summer [1]. The wetland habitat has the largest number of birds and uniform distribution; Road habitat bird species are the least, uneven distribution, but the dominant species, mainly common companion birds. The clustering results show that environmental conditions are important factors affecting bird composition.

II. RESEARCH AREAS AND METHODS

2.1 Study of regional profiles

Nanjing is located in the eastern part of China, is the capital city of Jiangsu province, located in the southwest of Jiangsu province, geographical coordinates for 31 14 " to 32 37" north latitude, longitude 118 22" to 119 14", the terrain is given priority to with low hills, there are ZiJin mountain, Mufu mountain, Qixia mountain, Tang mountain, etc., accounting for about 60 % of the total area of the city, and the water system is developed, there are the Yangtze river, Qinhuai river, The city 's forest coverage rate is 26.4 %, 45 %, good environmental air quality, urban environment is beautiful. Nanjing is a subtropical monsoon climate, four distinct seasons, annual average temperature is 15.4^{o}C, and rainfall is abundant, annual average rainfall reached 1200 mm [2].

2.2 Research methods

2.2.1 Material

According to the records of the bird watching record center of the network, the bird watching records from 2007 to 2016 in Nanjing area were collected, and the data were sorted and dealt with.

2.2.2 Research methods

The records of bird watching center were sorted out by office 2007 suite, and the bird diversity was statistically analyzed in Nanjing from 2007 to 2016.Using the statistical function of Excel, the distribution characteristics of birds were analyzed and Shannon - Weiner index was calculated.

$$H' = -\sum_{i=1}^{S} P_i \log_2 P_i$$

III. RESEARCH RESULTS AND DATA ANALYSIS

3.1 Distribution and land use change of 15 bird species observation sites in Nanjing

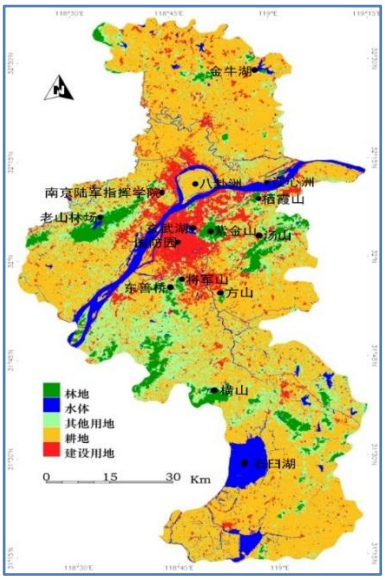

FIG.1: DISTRIBUTION AND LAND USE CHANGE OF 15BIRD SPECIES OBSERVATION SITES IN NANJING OF 2007

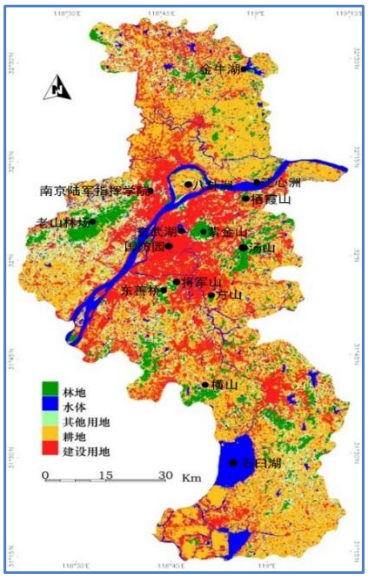

FIG.2: DISTRIBUTION AND LAND USE CHANGE OF 15 BIRD SPECIES OBSERVATION SITES IN NANJING OF 2012

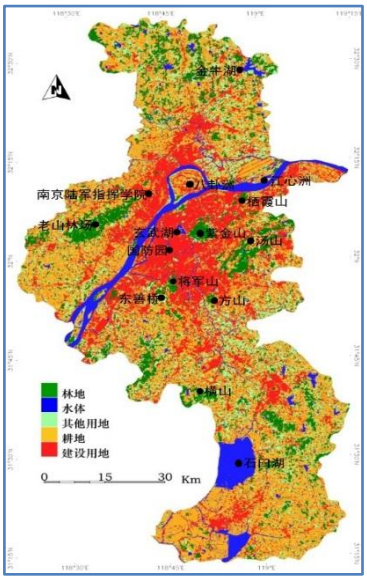

FIG.3: DISTRIBUTION AND LAND USE CHANGE OF 15 BIRD SPECIES OBSERVATION SITES IN NANJING OF 2016

Comparative analysis of the distribution and land use of 15 bird observation points in Nanjing from 2007 to 2016 shows that the construction land in Nanjing is increasing, while the forest land and cultivated land on which birds live are decreasing gradually. The land use of 15 bird observation points also conforms to this law. A total of 45 families and 269 species of birds have been recorded in Nanjing during the past decade, including 4 species of primary protected birds and 18 species of two protected birds. In 2007, 37 families and 129 species of birds were recorded; Thirty - nine families and 177 species of birds were recorded in 2008; In 2009, 42 families and 225 species of birds were recorded; In 2010, 43 families and 237 species of birds were recorded; In 2011, 38 families and 184 species of birds were recorded; Forty families and 179 species of birds were recorded in 2012; In 2013, 39 families and 149 species of birds were recorded; Thirty nine families and 160 species of birds were recorded in 2014; In 2015, 41 families and 201 species of birds were recorded; In 2016, 43 families and 198 species of birds were recorded.

3.2 Shannon - wil index of birds in Nanjing city from 2007 to 2016

Due to the differences in the ecological environment of each observation point, the number of birds is also different, and Shannon - wil index is generally used in the area with many species. Therefore, the bird data of each observation point is integrated, and the whole city of Nanjing is taken as a large observation point for calculation. The Shannon - wil index of birds in Nanjing from 2007 to 2016 was 3.968, 3.933, 4, 166, 4.248, 3.868, 3.290, 3.770, 3.635, 3.403 and 3.936, respectively. The data show that the diversity of birds in Nanjing fluctuates steadily in a relatively small atmosphere, with little change around ten years, and the diversity index of birds is high and species are abundant.

3.3 Correlation analysis between two observation points of Mount Zijin and Xuanwu Lake and the birds in Nanjing City

Mount Zijin and Xuanwu Lake, as two typical bird observation points in Nanjing, located in the city center of Nanjing, mainly in forest land and water area, surrounded by construction land, greatly influenced by human activities.

The number of birds in Nanjing city fluctuates within a stable range (figure 4), and Zijin mountain and Xuanwu Lake both the number of birds and the number of species compared with Nanjing city, especially in recent years, with the increase of construction land around the two places, the vigorous development of tourism, free open to tourists, resulting in the number of birds' fluctuations. Originally is an important habitat of birds in Nanjing Xuanwu lake has been greatly affected, it is difficult to reproduce the original birds chirping, competing to fly.

3.3.1 Correlation analysis between the number of birds and species

A linear correlation analysis was conducted between the number of families and species of birds in Nanjing for ten years and Mount Zijin and Xuanwu Lake. In terms of the number of families, the correlation coefficient r was 0.345 and 0.292, respectively. Therefore, there was only a very low linear correlation between the number of families of Mount Zijin birds and Nanjing, while there was no linear correlation between the number of families of Xuanwu Lake birds and Nanjing. In terms of species number, correlation coefficients were 0.669 and 0.511, respectively. The results showed that there was a significant linear correlation between the species numbers of birds in Mount Zijin and Xuanwu Lake, and Mount Zijin was higher than Xuanwu Lake. ($0< r < 1$ indicates that there is linear correlation in different degrees: $r \leq 0.3$ indicates that there is no linear correlation; $0.3 < r \leq 0.5$ is low linear correlation; $0.5 < r \leq 0.8$ was significant linear correlation; $R > 0.8$ is highly linear correlation).

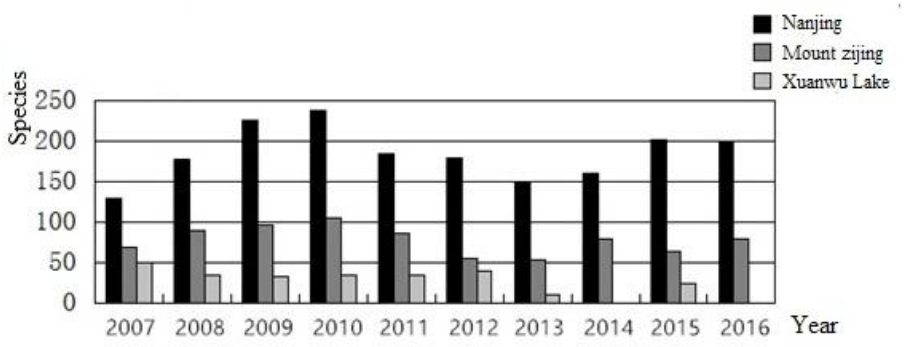

FIG. 4: TEN YEARS' BIRD SPECIES IN THE CITY OF NANJING AND MOUNT ZIJIN AND XUANWU LAKE

3.3.2 Correlation analysis of diversity index

Using the data of fig. 5, we analyzed the bird diversity index of Nanjing in the past ten years with the linear correlation coefficient r of 0.472 and 0.262, respectively. the results showed that the bird diversity of Mount Zijin had significant linear correlation with the bird diversity of Nanjing, while the bird diversity of Xuanwu lake had no linear correlation with the bird diversity of Nanjing.

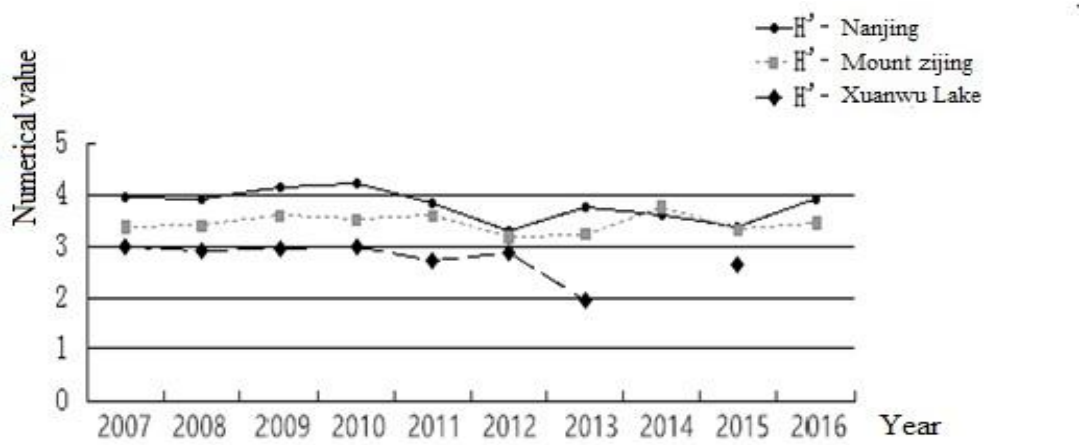

FIG. 5: NANJING CITY AND MOUNT ZIJIN, XUANWU LAKE TEN YEARS BIRD SHANNON - WILL INDEX LINE STATISTICAL CHART

On the whole, with high abundance and diversity of birds in Nanjing city as a reference, Zijin mountain because of the terrain as a mountainous area, there are large areas of undeveloped forest land, ecological environment preservation is good, moderate human disturbance and construction and development, so that the bird habitat is rich and diverse, eventually make the Zijin mountain bird richness and species diversity in ten years to remain stable, Zijin mountain is an important habitat of Nanjing birds Basaltic lake is different, the surrounding construction in a decade a large number of buildings, the interior has gradually been artificial, the number of tourists surge, resulting in the loss of bird original diversity habitats, bird richness and species diversity significantly reduced, the national protection of birds also slowly disappear (Table 1), Nanjing birds gradually lost basaltic lake, an important habitat.

TABLE 1
NANJING CITY AND MOUNT ZIJIN, XUANWU LAKE TEN YEARS' NATIONAL BIRD PROTECTION STATISTICS

Level	National first level protection			National second level protection		
Year	Nanjing	Mount Zijin	Xuanwu Lake	Nanjing	Mount Zijin	Xuanwu Lake
2007	4	0	0	7	2	3
2008	2	0	0	5	1	0
2009	2	0	0	11	3	0
2010	4	0	0	10	4	1
2011	1	0	0	10	4	0
2012	1	0	0	8	3	1
2013	1	0	0	5	3	1
2014	0	0		7	3	
2015	2	0	0	11	4	0
2016	2	0		9	2	

IV. DISCUSSION

Long - term investigation and study of species composition and dynamics in a certain area can provide reference for environmental monitoring, evaluation and protection, and birds as indicators of urban ecosystems, in the evaluation of urban ecological environment quality plays an indicator role [3]. With the aggravation of urbanization, not only the urban landscape changes its appearance, but also threatens the survival of urban birds. Different natural habitats, urban bird habitats have high heterogeneity, frequent human disturbance and other unique characteristics, and compared with natural habitat bird diversity research; urban and suburban bird diversity is obviously insufficient attention.

4.1 Impact of urbanization on urban birds

4.1.1 Urban birds and their characteristics

Urban birds are those living in the urban environment, they together with humans in the city without relying on human feeding, their own foraging [4]. Has the following characteristics: is the construction of urban bird community, living in a relatively dense population, productivity and economic development, has a certain degree of cultural development, artificial environment is given priority to with the comprehensive area (i.e., the city), is an important part of the natural factors of human survival, is one of the wild animals in the urban environment [5]. Mainly including the original area before the urbanization of the remaining birds; Birds migrating from outside into cities; Semi - domesticated birds escaping from domesticated places or markets; And birds that migrate and stay for a period.

Compared with non-urban birds, urban birds have their own unique characteristics, mainly in the following aspects: in the urban ecosystem, human activities are frequent, bird communities are under serious human activities, urban birds due to the lack of natural enemies and accustomed to the existence of human beings, smells and activities, they often lack of vigilance. Human production and living activities are often an important factor leading to the death of urban birds; Urban bird habitats range from almost natural ecological communities to completely artificial habitats, so the diversity of habitats is rich. Urbanization will further lead to the natural landscape gradually replaced by artificial landscape, especially the building and artificial trees gradually replace the trend of natural forest land is difficult to reverse in the short term, and urban environmental pollution is serious. Urban birds suitable for habitat is highly fragmented, is a typical isolated island habitat; The various habitat types, small relative area and enhanced manual management make the urban environment have mosaic characteristics, numerous boundaries and high heterogeneity. Urban bird habitats often undergo drastic changes, such as soil erosion, herbicide and pesticide use, drainage and the disappearance of shrub layers and other factors can cause habitat loss and isolation; Overall, urban bird species diversity is relatively low, but the number of species is sometimes quite large. Species that are sensitive to human disturbance and birds that have strict habitat requirements are generally difficult to adapt to urban ecosystems. The impact of urbanization on bird communities is twofold: higher heterogeneity provides abundant available resources for birds while human disturbance and habitat loss result in decreased diversity and density.

4.1.2 Impact of urbanization on bird communities

A. Effects of urbanization on bird community composition

Habitat landscape conditions, such as topography, presence or absence of water and vegetation community structure, directly affect the composition of animal communities. Urbanization leads to significant changes in urban landscape, which leads to the development of urban bird community in the direction of bad succession. Insect - eating birds, ground nesting or tree-hole nesting birds, etc., which are common in natural forest land, have a decreasing trend in species and quantity in cities [6], because these birds, especially some " area sensitive" birds, do not like to appear in smaller forest land.

Many non-urban habitats are often successfully adapted to urban habitats. For example, parakeet's native to Papua New Guinea rain forests appear in some highland towns in the country, while coastal birds, white kingfisher, extend to parks in Singapore and so on. There are some exotic species, the population increases with urbanization, and gradually become dominant species, such as sparrows, pigeons, floor Yan, etc. But the species that inhabit the artificial green space are generally far fewer than those that inhabit the native forest land. The smaller the area of the primary ecosystem remains, the greater the likelihood of species composition changes and extinction and the invasion of exotic birds [7].

B. Effects of urbanization on bird community structure

Studies have shown that the island of habitats has caused urban birds to suffer the same adverse effects as other fragmented landscapes. It is generally believed that with the increasing degree of urbanization and the resulting changes in urban landscape, the species of birds in the city will be reduced and species diversity will be reduced.

Some researchers argue that moderate urbanization helps to increase the richness and species diversity of bird communities, which validates the so-called moderate interference theory with urban bird communities [8]. Research shows that the diversity of birds in urban parks is significantly higher than other urban habitats. There is also a phenomenon that although there are few species of birds in cities, the number is much higher than that in neighboring rural areas, such as 21 species in Helsinki, Finland, and 54 species in neighboring virgin forest areas, but the number and weight of birds per km2 in cities are 3 and 10 times higher than those in forests, respectively.

Other studies have found that winter urban parks have more species and larger numbers of individuals than surrounding rural or forested areas, and this difference is particularly pronounced in northern Europe, which may be associated with winter feeding in urban parks. Winter feeding can help birds adapt to the urban environment, not only affect bird density and species richness, but also change their species composition. Birds in areas with higher levels of urbanization make greater use of food tables than in areas with lower levels of urbanization.

C. Effects of urbanization on bird reproduction

With the acceleration of urbanization and the change of urban landscape, many birds lose their habitat in the city. Ground nesting birds are reported to be rare in urban parks, and lack of hidden plants, lack of suitable nesting sites or competitive pressures in nesting areas may limit the number of ground nesting birds [9]. Studies conducted in Finland suggest that nest birds and deciduous forest birds prefer urban parks, which may be related to the characteristics of individual bird species, resource availability, high diversity of habitats in large parks, nest occupancy and intra-species competition. Some urban parks benefit from the large number of artificial nests in the park, and studies have shown that birds have a higher success rate in nesting than in natural caves. Another feature is that birds in isolated habitats tend to nest high.

Some studies have found that human activities may affect the success rate of urban birds breeding, among which the entertainment of urban parks is the main factor affecting the habitat and breeding of birds in urban forest land. However, some scholars found in the study, surrounded by high-density buildings in the park of human activities did not affect the breeding of birds, this may be because the park 's recreational use frequency is not big, or the impact of human activities compared with other variables is relatively small. For example, many species of crow birds around the world have spread from their original distribution area to urban environment nest breeding, and have become very accustomed to human activities. Perhaps less harm from humans is the main reason for these changes. In addition, waste and feeding in cities may also be one of the reasons for the high population density of crows.

V. CONCLUSION

Urbanization is the process of globalization's artificial environment change, and the effect of urbanization on birds is explored on a multi-scale basis. The results have a lot of enlightenment for us to study the relationship between human,

wildlife and environment. Because urbanization has a dual impact on urban bird diversity, we should take different measures to protect urban birds for different habitats. To strengthen the protection of Zijin mountain, Mufu mountain, Qixia mountain, Tang mountain, Fangmountain, Lao mountain, to minimize artificial interference and blind development and utilization; To adopt effective measures to restore these degraded ecosystems in the wetlands such as Xuanwu lake, Mochou lake and the wetlands along the river; For urban park green space and residential areas these birds indispensable important habitat, can increase plant species, the establishment of natural tree species of islands, make artificial landscape diversity. Through these measures to protect urban birds, promote the formation of a good bird - man - environment three-in-one symbiotic circle.

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