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The Distributive Characteristic on Bird Communities in Poyang Lake Wetlands in January 2021 to May 2022, Jiangxi, China

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ABSTRACT

Background: The birds depending on the aquatic creatures in the wetland, as an indicator species, their individual species represent the responses of other species within the habitat or group. To pro tect the wetland and the creatures in Poyang Lake, Jiangxi Province of China, it is essential for local officials to get more reference data and evidence to make a more scientific and sustainable development of them.

Methods: A comprehensive survey was made on the time patterns of waterfowl communities using a UAV drone. And statistical analyses of the data included the Shannon-Wiener index and the Pielou index were computed.

Result: The results of the study show that 211 species of birds were recorded, representing 13 orders and four families, accounting for 45.4% of the total 465 species of birds in Jiangxi Province. The bird community diversity index for the year was 3.19 and the uniformity index was 0.61, which was the highest in spring, followed by autumn, winter and summer. This evaluation led us to the conclusion that the rich bird resources of Poyang Lake are numerous and precious.

Key words: Bird communities, Group statistics, Pielou index, Shannon-wiener index, Temporal patterns.

INTRODUCTION

Habitat information critical for conservation is necessary for birds that require wetlands for survival. Seasonal changes are distinct in temperate zones, where wild birds migrate northward and southward, driven by daylight cycles (Pabian *et al*., 2015), while birds in the northern hemisphere migrate in spring and autumn (Richardson, 1990). Knowledge of the distinctions between migratory periods is important because they determine the composition and abundance of species. This information is an important factor in determining the quality of particular wetlands (Wetland International, 2010). In addition to fulfilling the essential function of improving the biodiversity of wetlands, wetland birds are sensitive to habitat disturbances and thus can be utilized as biological assessment and environmental indicators (Nsor and Obodai, 2014; Buckland, 2006; Winter, *et al*., 2005). Wetland bird fluctuations in composition as well as abundance represent a response not only to internal environmental factors but also external factors (Svensson, 1978) which, in turn, can be used to determine appropriate periodic surveys for monitoring the quality and health of wetland environments (Bird Life International, 2018). Although wetlands share many similar characteristics, they are highly variable in terms of size, location and hydrology (Bregnballe *et al*., 1997). And, the ecosystem is being rapidly destroyed due to habitat loss, animal hunting, road construction, raising of transmission lines, general pollution and agricultural activities, in addition to many other factors, all of which directly and indirectly affect wildbirds (Logman Aslan *et al*., 2018; Noor Aminullah *et al*., 2018). Therefore, yearly surveys to identify seasonal fluctuations and species composition are presented in the current study and waterfowl-as indicator species-are focused on.

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MATERIALS AND METHODS

Bird spatial features in Poyang Lake wetland in Jiangxi Province of China and its ornithological tourism resources were chosen, which is one of the most important wintering and resting places for migratory birds in the world. A calculated population and evaluation system can reflect the comprehensive value of ornithological tourism resources objectively. Poyang Lake, well-known as the “White crane world” and “Kingdom of rare birds”, is the largest freshwater lake in China and the largest ecological wetland in Asia, with an area of 3914 km^2 and a volume of 30 billion m^3 at normal water levels. Approved as a national nature reserve in 1983, one of its most vital functions is to protect the rare migratory birds and wetland ecological environment. An example is the white crane, because Poyang Lake provides

for winter crossings of migratory birds in Asia and in this context is one of the largest and most important habitats (about 637,000 birds annually), with more than 98% of the *White cranes* of the world population, including 95% of *Oriental white storks*, 70% of *White cranes* and 60% of *Ansercygnoides*.

Because the wetland is too large to count all the regions, an observation post in Duchang county was used in this study, which is located in the south of the main lake area, at the front edge of the delta formed by the northern, middle and southern branches of the GanJiang River confluence into the open waters of Poyang Lake, with a geographical range of 116°2′24″-116°36′30″ east longitude and 28°50′28″-29°10′20″north latitude (Fig 1). Rivers, lakes and shores are interlaced in the reserve, most of which are lakeshores and water, creating over 100 wetlands along the lake and beach, accounting for about 1/3 of the wetland area and the water area and depth vary greatly within and between years.

An advanced and efficient aerial tool was used to comprehensively investigate habitat distributions and populations of rare birds, with a minimum need for professional personnel, overcoming the deficiencies of conventional methods that do not involve access to vehicles and boats.

Instruments

A UAV drone with a digital video camera was used, which could hover with good stability and flexibility, beneficial for bird counting and species identification. To improve the accuracy and avoid count omissions and double counting and human interference, the flight speed of the UAV was maintained at about 80 km/h, with a minimum flight speed of 60 km/h and altitude was kept between about 80-200 m.

The layout of the transects ensured that all habitat types in the survey area were covered in terms of topography, vegetation and human disturbance. The survey in Duchang region was conducted for more than one year, from January

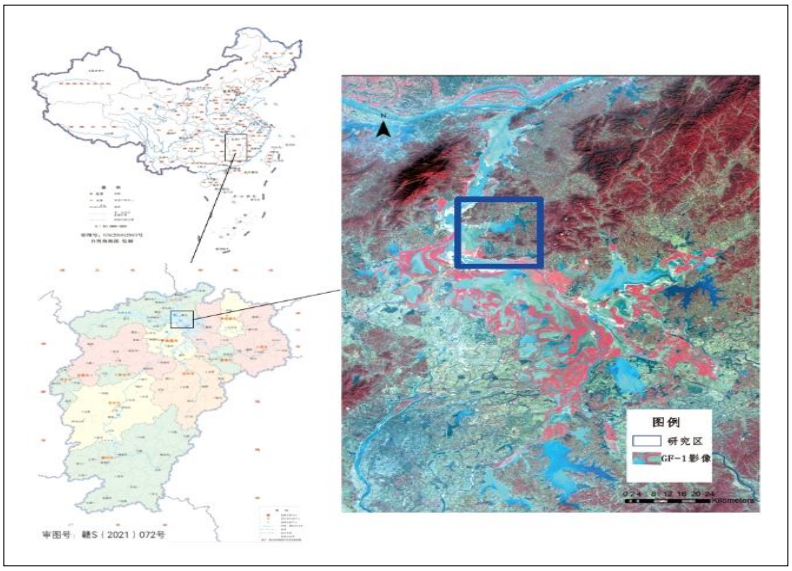


Fig 1: Boundary of natural wetland in Poyang Lake.

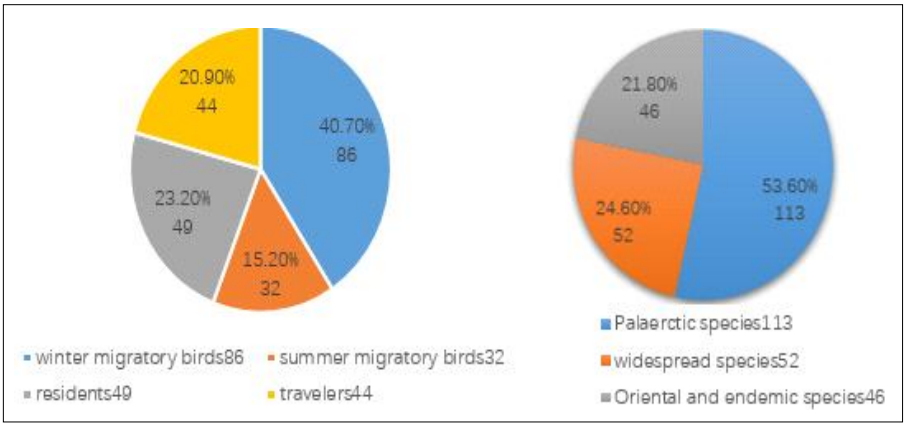


Fig 2: Statistics of the bird species in Duchang.

2021 to May 2022, 1-2 times a month for 2-3 h each time, mainly in the morning (7:00-10:00) or afternoon (15:30-18:30), when waterfowls are active.

Accurate counts were combined with estimations whereby the "direct counting method" was adopted for small groups and the "group statistics method" for large groups.

Diversity index statistics

The Shannon-Wiener index was used to calculate the diversity index. The formula is:

$$H' = -\Sigma P_i \log_2 P_i$$

Where,

P_i = Ratio of the number of individual species to that of all species.

Uniformity index statistics

The Pielou index was used to calculate the uniformity index. The formula is:

$$E = \frac{H'}{H_{max}}$$

Where,

H' = Calculated as above.

H_{max}= $\log_2 s$ (Boulinier *et al*., 2001).

RESULTS AND DISCUSSION

Statistics on bird species

In total, 211 species of birds representing 11 orders and 40 families were recorded in our field investigation at the Reserve. These account for 45.4% of the total 465 species of birds in Jiangxi Province, among which 118 species of migratory birds account for 55.9% of bird species in the reserve, 86 species of winter migratory birds account for 40.7%, 32 species of summer migratory birds account for 15.2%, 49 travelers account for 23.2% and 44 residents account for 20.9%. A total of 113 Palaearctic species occupy 53.6% of the 211 species, 52 widespread species occupy 24.6% and 46 Oriental and endemic species occupy 21.8% (Fig 2).

The bird distribution in the reserve reflects the species composition of wetland bird communities, represented by 102 species of *Passeriformes* and 18 families, accounting for 48.4% of the total bird species in the nature reserve and 109 species of *non-Passeriformes* from 22 families accounting for 51.6% of the total. Among the *non-Passeriformes*, the most diverse order was *Charadriformes* with 34 species, accounting for 16.1% of bird species in the reserve, followed by *Anseriformes* (33 species) accounting

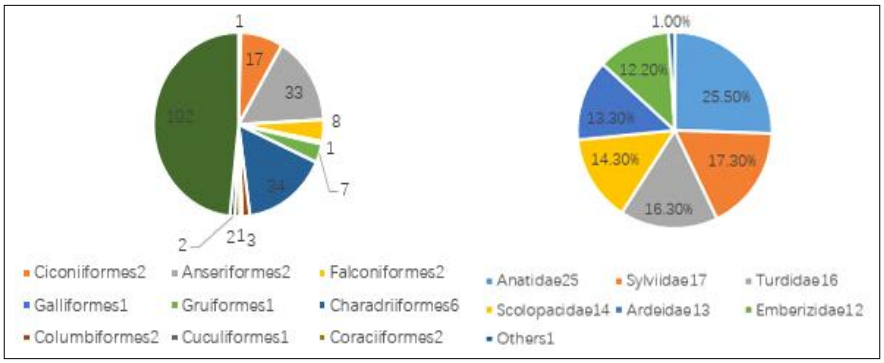


Fig 3: Bird distributions in Duchang.

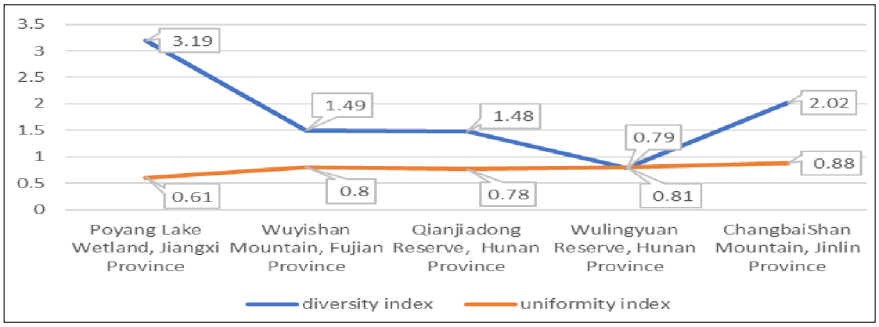


Fig 4: The diversity and evenness index of birds in some major reserves.

Table 1: The diversity and evenness in each habitat during different seasons in Duchang.

	Spring		Summer		Autumn		Winter	
	Diversity	Evenness	Diversity	Evenness	Diversity	Evenness	Diversity	Evenness
Thickets	3.52	0.83	2.77	0.92	2.96	0.86	2.61	0.86
Marsh	0.76	0.51	1.38	0.51	1.81	0.62	0.63	0.71
Grass	2.76	0.53	1.82	0.63	2.79	0.75	3.08	0.89
Farmland	3.45	0.82	2.71	0.91	2.77	0.82	2.54	0.84

for 15.6% and another 17 species of stork-shaped *Ciconiiformes*, accounting for 8.1%. Waterfowl dominate the reserve, with 98 species accounting for 46.5% of all bird species and more than ten species in six families accounting for 46.1%, in the following taxonomic orders: 25 species of *Anatidae*, 17 species of *Sylviidae*, 16 species of *Turdidae*, 14 species of *Scolopacidae*, 13 species of *Ardeidae* and 12 species of *Emberizidae* (Fig 3).

Relationships between bird diversity and environmental factors

The species diversity of bird communities is directly and indirectly affected by their ecological surroundings. As shown in Fig 4, the Shannon-Wiener diversity index of birds in the Poyang Lake Wetland Nature Reserve is much higher than that in the National Forest Reserve in terrestrial environments, while the Pielou uniformity coefficient is a little lower, as it is shown that wetlands are an important habitat and closely related to the birds.

The diversity and evenness of bird community and habitats across four seasons

There have been a regular, dynamic changes in the spatial ranges of species and in turn the richness and diversity of bird communities; richness and diversity of course varies across seasons. Based on seasonal residence and migration, species were grouped into seasonal types: resident birds, migratory birds and passing birds. The natural landscape of the reserve can be divided into four ecological types: shrubs, mudflats, grasslands and farmlands. Table 1 shows the diversity and evenness of distribution of birds in each wetland habitat and the number of bird species in each habitat in the four seasons.

Spring bird community

The diversity and evenness of distribution of waterfowl species in the spring was high. A total of 67 species were recorded in February, accounting for 68.4% of the total bird species observed that year. Spring bird migration peaks in March, with a majority in transit. The species richness of farmlands was highest: 48 species accounting for 58.7% of all species in spring and the two indexes were also highest during this season. In recent years, few cropland less than 1% of the total area of the reserve was abandoned,and because it was spring, some birds still lived there, such as *Passer montanus*, *Turdus merula, Strepelia chinensis, Lonchura striata, Lonchura punctlata, Pycnon Sinensis, Motacilla alba, Laniusschach, Acridotheres cristatellus* and *Sturnus nigricollis*. There were 38 species in the shrub habitat, accounting for 43.5% of all species in spring, mainly represented by migratory finches such as *Phyllosco pusinornatus, Muscicapamuttui, Phylloscopusboeralis, Muscicapasibirica* and *Muscicapalatirostris*. In spring, the grasslands were not flooded and many Passeriformes, such as *Alauda arvansis, Cisticolejuncidis and Anthusspinoletta*, as well as Ardeidae for*Bubulcus ibis, Ardeolabacchus, Egrettaalba*, *etc*. were present. The abundances of species on mudflats was relatively low with only 18 species, accounting for 16.4% of all species and the two indexes were also lowest for this habitat.

Summer bird community

Habitat area and food resources are the key factors that determine the number and distribution of birds, which are directly affected by hydrological changes and then will take great changes on the number and spatial distribution pattern of wintering migratory birds. With some active protection measures taken by various departments of Poyang Lake, a certain number of rice paddies and lotus ponds around the lake area have been reserved to supply water birds for food and publicity on waterbirds protection has been strengthened, so that the residents around the lake area have less influence on water birds feeding in the constructed wetlands and provide a good habitat environment for water birds, attracting many water birds to forage. The waterfowl in Poyang Lake are mainly winter migratory birds and passing birds. Consequently, the number of species in each habitat in summer was considerably reduced, with only 61 species recorded, accounting for 28.9% of the annual species. This was especially the case in May, where they accounted for 24.4%, with only a small number of ducks breeding in the area. The species richness of farmlands was highest, with 31 species, accounting for 50.8% of all summer species. The habitat with the second highest species richness was shrubs, represented by 27 species accounting for 44.3%, including *Fulicaatra, Gallinula chloropus, Anas poecilorhyncha, Vanellus cinereus, Podiceps ruficollis, Hydrophasianuschirurgus, Podiceps cristatus, Rallus aquaticus, Chlidoniashybrida, Chlidoniaslevcopterus* and *Bubulcusibis*. There were the least birds recorded on the mudflats, justfive species accounting for 9.1%: *Ciconia boyciana, Ciconia nigra, Grus monacha, Grus vipiothe andGrus*. Illustrated in Fig 4, however, the highest diversity index was 2.77 in the shrubs habitat, the second highest was 2.71 on farmlands and the lowest was 1.38 on the mudflats, which was slightly inconsistent with species number.

Autumn bird community

Migratory birds migrate from March to April in spring and migrate more widely in the fall, so the species range more widely during the spring those in the fall. There was the highest abundance of birds in the grassland habitat, where 41 of 102 autumn bird species were seen, accounting for 40.2% of the total bird species during the autumn season. Farmland and shrub habitats both had 30 species accounting for 29.4%. The species richness of the mudflats was the lowest with only 14, accounting for 13.7% of all autumn species. Most species present in autumn were represented by resident individuals, accounting for 82% of species recorded, the dominant species being *Ansercygnoldes* and *Fulicaatra*. Fig 4 shows that the highest diversity index was in the shrub habitat (2.96), followed by grassland (2.79), farmland (2.77) and mudflat (1.81). The

two indexes showed consistent, but were inconsistent with the number of species.

Winter bird community

As the temperature gradually drops, a large number of rare migratory birds always arrive in Poyang Lake from Inner Mongolia grassland, northeast marsh and Siberian wilderness and their wintering life here will last nearly half a year. It is understood that tens of thousands of rare birds will gather in Poyang Lake from all directions. The species and number of overwintering migratory birds here will continue to increase. In winter there were the most species of birds: 151 species were observed, accounting for 71.6% of all species observed during the year. Grasslands provided the most abundant food for 63 species, accounting for 41.7% of all species observed in winter, represented by geese and overwintering *Passeriformes* such as *Ansercygnoides, Anser, Anserfabalis, Anseralbifrons*, *Certbiafamiliaris, Coturnix japoics, Turdus merula, Lucustellapryeri, Prinissubflaus, Anthuscervinus* and *Anthsspinoletta*. On the mudflats there were 38 species, accounting for 32.5%, represented by many *Larus ridibundus, Cerylerudis, Motacilla cinerea, Motacillaalbs, Halcyon smyrnensis, Alcedoatthis, Cisticola juncidis* and *Anthsspinoletta*. There were a few species observed in the shrubs habitat, such as *Emberizasulphurata, Emberizarustica, Emberizapusilla, Emberizatristrami, Emberizachrysophys* and *Emberiza elegans*. The highest diversity index was for grassland, followed by the mudflats. As illustrated in Fig 4, the two indexes showed greater consistency, however species number was inconsistent.

CONCLUSION

It is concluded from the above results that birds can be found in abundance on Poyang lake and the present diversity distribution characteristics reflect periodic changes and the interactions between biomes, where the wetland can provide for winter-crossing migratory birds in Asia-in this respect Poyang Lake is one of the largest and most important habitats. We confirm that wetlands are an important habitat for birds and these bird communities are directly and indirectly influenced by their ecological surroundings in terms of how the number of families and species of birds relates to the diversity of habitat vegetation. The above results are similar to the previous investigation, monitoring and research literature about Poyang Lake area, especially in the past 30 years, the survey of terrestrial wildlife resources and the results of the first and second scientific expedition in Poyang Lake in the past year took Zheng Guangmei's Catalogue of the Taxonomy and Distribution of Birds in China (2nd Edition) as the classification system to systematically organize the bird list in Poyang Lake. Besides adding new recorded species, some controversial bird species were also discussed and revised. These values observed are also similar to those recorded by others (Zheng *et al*., 2016) for the same two indexes for many nature reserves in China, where the governments pay more attention and service awareness to the wetland and birds. However, the infrastructure conditions and service work for ornithological tourism still needs to be improved, especially the professional service facilities such as bird-watching guidance and bird-watching equipment rental and sales and bird-watching tour guide staff are lacking.

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Conflict of interest

All authors declared that they have no conflict of interest.

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