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Composition and Diversity of Over-Wintering Aquatic Bird Community on Poyang Lake, China

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Abstract: The present study aimed to investigate the structure, composition and diversity of the over-wintering aquatic bird community of Poyang Lake, including Poyang Lake National Nature Reserve (PNNR), Nanji National Nature Reserve (NNNR) and Duchang Provincial Nature Reserve (DPNR), China. After the preliminary survey, birds surveyed from vantage points at each study site between the years 2016 and 2020 in the winter season. A total of 58 bird species belonging to nine orders and 13 families were observed. The study showed variation in effective species numbers (Species richness, Shannon's diversity and Simpson's diversity) among the three study sites and the survey years. Nanji National Nature Reserve had the highest avian diversity, whereas Duchang Provincial Nature Reserve had the lowest. Globally threatened bird species, Siberian Crane (critically endangered), Oriental Stork (endangered), found in our study sites. However, the current management practices of the nature reserve and conservation of this globally threatened bird species are inadequate, especially of Duchang Provincial Nature Reserve. Therefore, for long term conservation of birds in these areas, it needs continuing intentional improvement of the sites and awareness creation to the local community.

Keywords: avian diversity; over-wintering; aquatic bird community; Poyang Lake

1. Introduction

Poyang Lake is the largest freshwater lake in East Asia [1] and is of global importance for conserving migratory aquatic bird of the East Asian–Australasian Flyway [2,3]. It is connected to the Yangtze River and lies on the Northern border of Jiangxi Province. The main rivers that drain to Poyang lake (Ganjiang, Fuhe, Xinjiang, Raohe and Xiushui) are discharged into the Yangtze River from a narrow outlet in the North [4,5]. Among the five major rivers, Ganjiang is the largest in the region, extending 750 km and contributes almost 55% of the total discharge into the Poyang Lake [1]. In addition to the main tributaries that drain into the lake, a seasonal reverse-flow system has also significantly contributed to the complexity of its yearly hydrological variation [6,7]. This variation, both within and among years, directly contributes to the large biomass of plant life [5,8], which provides a wide range of foraging options for many aquatic bird species [2,9–11].

Aquatic birds are species that entirely depend on wetlands for a variety of activities such as foraging, loafing and molting [7,12]. Poyang Lake is a significant global biodiversity area that harbors more than 400,000 aquatic birds belonging to about 87 species [3,13,14] in the winter season. For instance, geese and swans were the most abundant aquatic birds found in Poyang lake followed by shorebirds. During summer, Poyang lake was covered by water and flood, while in winter, the water reduces exposing rivers, channels and smaller sub lakes. Sub lakes, which play an essential role in aquatic bird conservation, are mainly located in the western and southern parts of the Poyang

lake [10]. Therefore, to conserve the wetland ecosystem of Poyang Lake and endangered migratory birds, the Chinese government has established two National nature reserves and four Provincial Nature Reserves. These are Poyang Lake National Nature Reserve (denoted hereafter as PNNR in this study), Nanji National Nature Reserve (denoted hereafter as NNNR), Duchang Provincial Nature Reserve (denoted hereafter as DPNR in this study), Baishazhou Provincial Nature Reserve, Kangshan Provincial Nature Reserve and Qingfeng Provincial Nature Reserve) [14,15].

Among the National Nature Reserve and Provincial Nature Reserves located in the western, southwestern and northeastern part of Poyang lake, PNNR, NNNR and DPNR had high aquatic bird richness, abundance and a high proportion of IUCN endangered species [16]. Thus, they are important areas for aquatic bird protection [16,17]. Mainly, during the winter season, these areas serve as stopping over for many migratory birds. Hence understanding species composition and abundance patterns among sub lakes of Poyang lake is very crucial in the conservation of the aquatic birds.

Biodiversity measurement and assessment is an active research focus of ecology [18,19]. Richness and abundance estimates are two of the simplest ways to describe biodiversity and are essential to consider when assessing any ecosystem [20]. They are also used to generate more complex ecological indices [21], including Hill numbers. Species richness features significantly in foundational models of community ecology [22,23] and is a crucial metric in conservation biology [24,25]. Despite its intuitive and universal application, conversely, species richness is a problematic index of biodiversity (i.e., sampling intensity and species abundance problem). Hill numbers overcome many of the traditional diversity measure shortcomings [18].

Previously, some scholars studied aquatic birds of Poyang Lake, but most of their studies focused on long-term trends of aquatic birds and limited species, especially cranes [26,27]. Similarly, they used the traditional methods to measure and assess biological diversity (biodiversity). Therefore, there is a need to understand more about the composition and diversity of aquatic bird community over a longer time scale [15,28] and using different biologic diversity measures different from traditional methods. Thus, this study intended to provide the current composition and diversity of wintering aquatic bird species in three representative areas of Poyang Lake (i.e., PNNR, NNNR and DPNR). Additionally, Hill numbers biodiversity measure was used instead of the traditional diversity measures (species richness, Shannon index, Simpson index) [18,29]. Hill numbers are a mathematically unified family of biologic diversity indices that integrate relative abundance and species richness, which facilitate the precise comparison of diversity [30].

2. Materials and Methods

2.1. Study Area Description

Poyang Lake, the largest freshwater lake in China, is located at the south bank of Yangtze River in Jiangxi province between 28°24′–29°46′ N and 115°49′–116°46′ E (Figure 1), covering an area of approximately 4000 km^2 [1]. This study conducted in three nature reserves of Poyang lake, namely PNNR, NNNR and DPNR (Table 1), located in the western, southwestern and northeastern parts of Poyang Lake, respectively. They support a high proportion of the globally threatened species, such as critically endangered Siberian Crane (*Grus leucogeranus*), endangered Oriental Stork (*Ciconia boyciana*), vulnerable Swan Goose (*Anser cygnoides*) and White-naped Crane (*Grus vipio*) [6,31,32]. The topography of the Poyang Lake catchment varies from high mountainous regions (maximum elevation of about 2200 m above sea level) to alluvial plains in the lower reaches of the primary watercourses. Poyang Lake has a humid subtropical climate with an annual average temperature of 16.7–17.7 °C, with average annual precipitation of 1400–1900 mm [2]. *Carex* spp., *Phragmites australis*, *Potamogeton* spp. and *Polygonum* spp. that are essential food sources of various birds dominate the wetland vegetation of Poyang Lake [9].

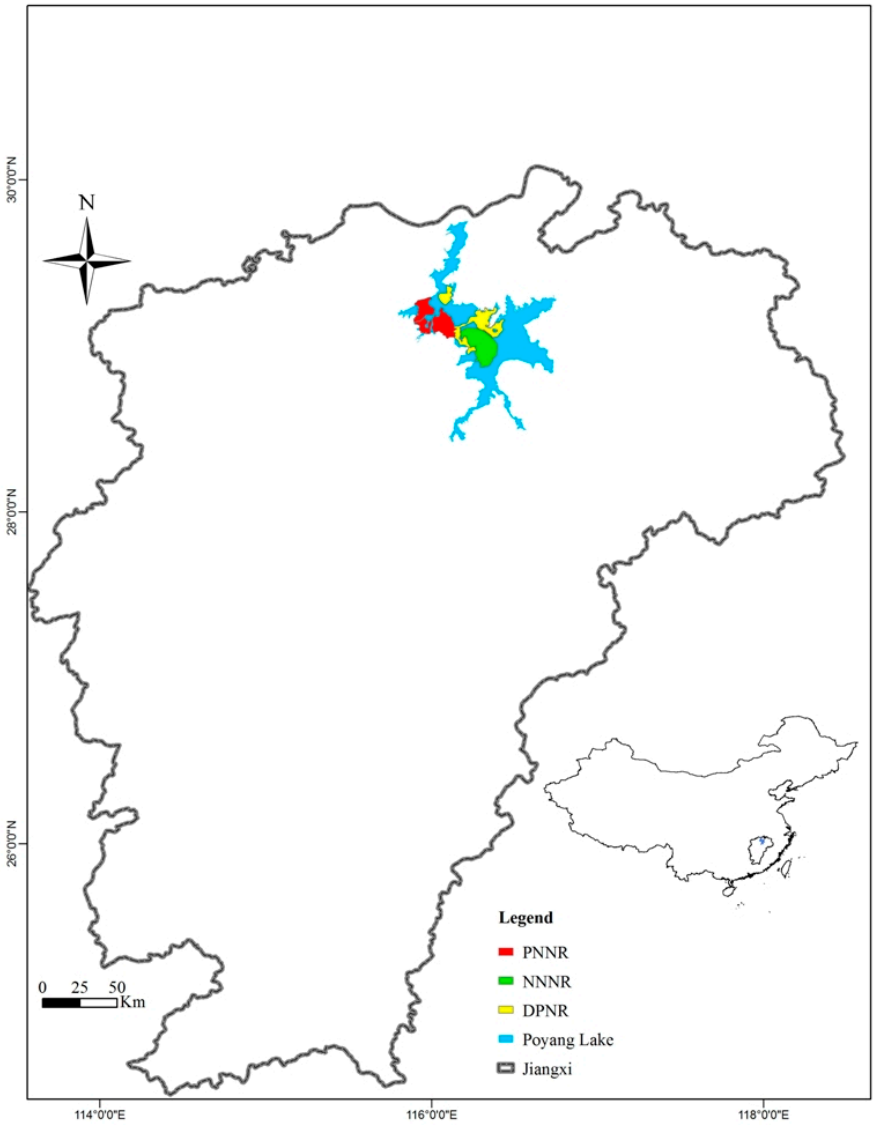


Figure 1. Location of the study area. Sub-section of Poyang Lake, Jiangxi Province, China.

Table 1. List of sub-lakes surveyed.

Nature Reserve (Study Area)	Area (Km^2)	Sub-Lakes of Nature Reserve Surveyed
Poyang lake National Nature Reserve (PNNR)	224	Da Hu Chi 1 and 2, Sha, Bai Sha Xiong Cun Nan, Chang Hu Chi, Zhu Shi, Zeng Mi Zhou, Da cha, Dong Tan, Yuan Xia Dong Bei Ba, Yuan Xia Dong Bei Xiao, Mei Xi, Ba Zi Qiang, Bang, San Shan, Zhonghu Chi, Xiang
Nanji National Nature Reserve (NNNR)	333	Bai Sha, Dong, Nan Shen, San Ni Wan 1 and 2, Bei Shen, Xia Bei Jia, Shang Bei Jia, Feng Wei, Ji Shan, Zhan Bei, San, Chang, Zhu, Shan Nan, Zeng Bei
Duchang Provincial Nature Reserve (DPNR)	411	Xin Miao, Ma Ying, Ji Shan, Poyang, Da Mian, Shi Pai, Zhu Tong, Hua Miao, Zhu De Ye, Nanxi, Xiao yang xu ti

2.2. Methods

The total area of Poyang lake (4000 km^2) was covered by water and flood during summer (July–August), while in winter, it reduces to less than 1000 km^2, exposing mudflats and smaller independent sub lakes. We conducted this study in two National nature reserve and one Provincial

nature reserve of Poyang lake (i.e., 16 sub lakes from each PNNR and NNNR, 10 sub lakes from DPNR) (Table 1). Each winter surveys (20–27 Jan 2016; 09–26 Jan 2017; 25–28 Jan 2018; 09–26 Jan 2019 and 07–15 Jan 2020) were carried out in each of the 42 sub lakes when the population of birds was relatively stable [2,3,31].

Birds surveyed from one to five vantage points in each sub lakes with binoculars and a spotting scope for five consecutive winter seasons. However, some sub lakes of DPNR were not surveyed during the Survey 3 (2018) due to weather conditions and transportation problem. The distance between any two observation points was at least 2–3 km to avoid double counting and at least 20% to 25% of the study area was covered. Large flocks counted by dividing them into groups of 10, 20 or 50 individuals to improve the accuracy of counting [33]. The time spent at the survey site varied depending on the size of the sub lakes, bird population size and visibility. For identification and categorization of birds to respective taxonomic groups, digital camera photographs, bird identification guide books and published literature [34–36] were used. Similarly, the conservation status was determined using the latest IUCN assessment [32], published literature and field guide books [37].

After the collection of data, we computed effective species numbers, known as Hill numbers or actual diversities [18,30,38] (of order 0, 1 and 2) in the iNEXT package of R software version 3.61 [39]. The three Hill numbers are species richness (q = 0), the exponential of Shannon's diversity index (q = 1) and the inverse of Simpson's diversity (q = 2). Confidence intervals around Hill numbers were developed to facilitate the comparison of both rarefied and extrapolated samples by bootstrap methods [30,38].

3. Results

In total, 58 bird species grouped into 9 orders and 13 families were observed in the study sites (Appendix A). The order Charadriiformes consisted of a high number of families (4 families and 13 species). The number of species in the order Anseriformes recorded was exceptionally high (15 spp.) followed by Charadriiformes (13 spp.). The number of species in the order Anseriformes was higher in NNNR than PNNR and DPNR (Figure 2). Two globally threatened bird species, Siberian Crane (critically endangered) and Oriental Stork (endangered), Eurasian Curlew, Black-tailed Godwit and Northern Lapwing were near-threatened bird species recorded in our study sites. Hence this study sites were not only harbored the highest waterbird richness and abundance, but also provided a home for the highest proportion of most endangered species (Table A1).

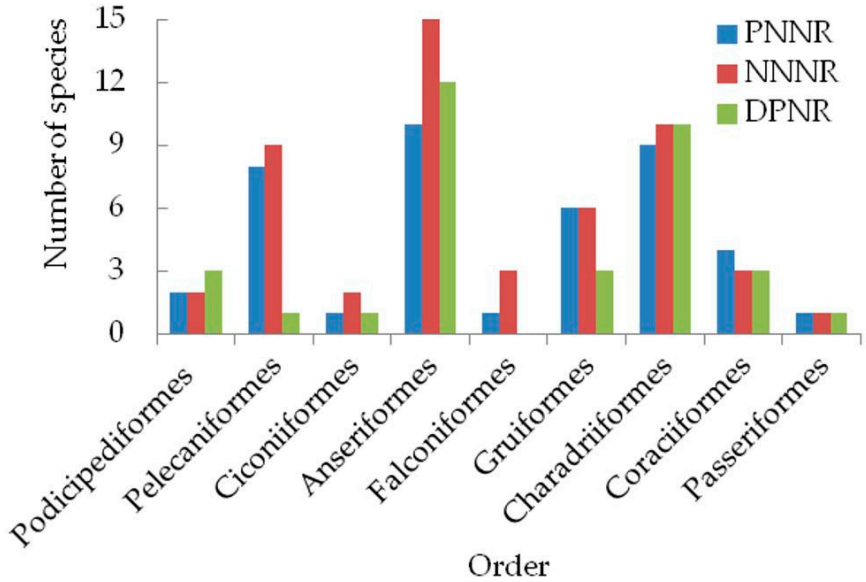


Figure 2. Composition of bird orders in the study site of Poyang Lake.

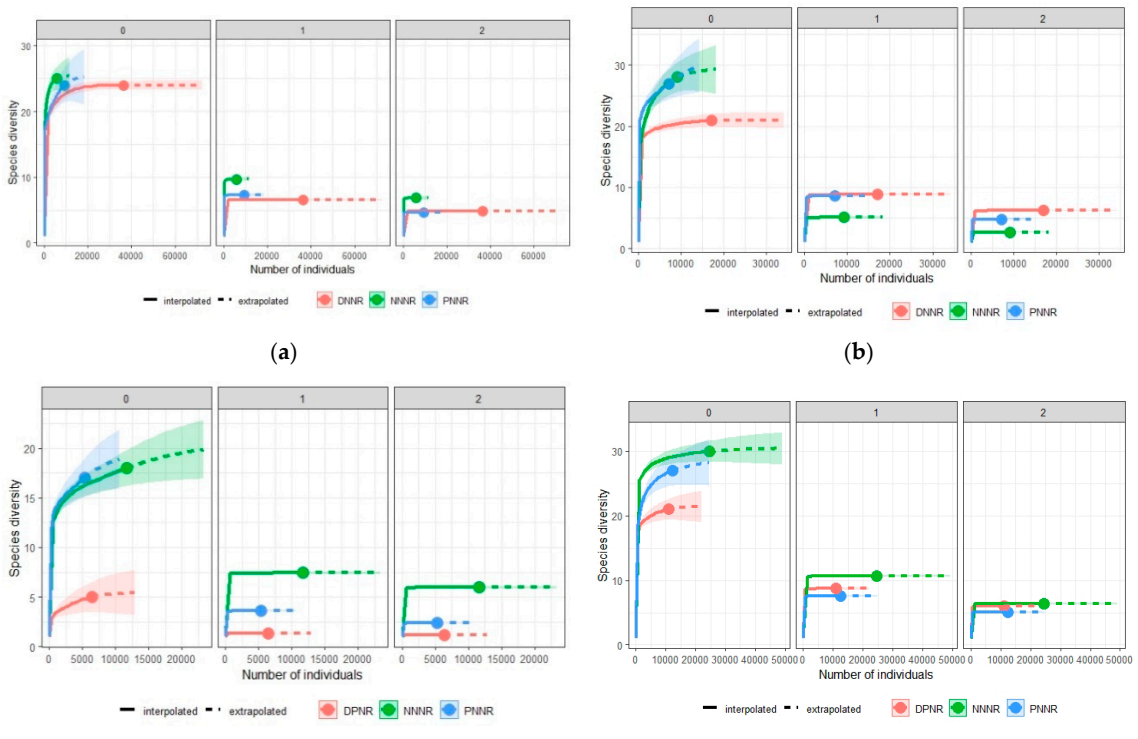
Our survey data showed that the Siberian Crane and White-naped Crane were wintering at all sites on Poyang Lake (PNNR, NNNR and DPNR) (Table A1). Similarly, our results suggest that the highest number of Oriental Stork and Siberian Crane mainly distributed in PNNR. Oriental Stork were recorded in all the five consecutive years in each study sites (Tables 2 and A1). DPNR had the highest proportion of Ruddy Shelduck and the lowest Lesser White-fronted Goose and Swan Goose (Tables 2 and A1).

Table 2. Vulnerable and Endangered over-wintering aquatic bird species counts at each section of Poyang Lake between the years 2016 and 2020 in the winter season at the three study sites.

Common Name	Scientific Name	Survey Year				
		2016	2017	2018	2019	2020
Swan Goose	*Anser cygnoides* ^{VU}	3477	2281	0	5356	798
Siberian Crane	*Grus leucogeranus* ^{CR}	159	338	0	2483	810
White-naped Crane	*Grus vipio* ^{VU}	838	800	0	259	83
Hooded Crane	*Grus monacha* ^{VU}	324	139	0	35	64
Oriental Stork	*Ciconia boyciana* ^{EN}	1340	3489	1248	525	2059

VU, CR and EN stand for vulnerable, critically endangered and endangered.

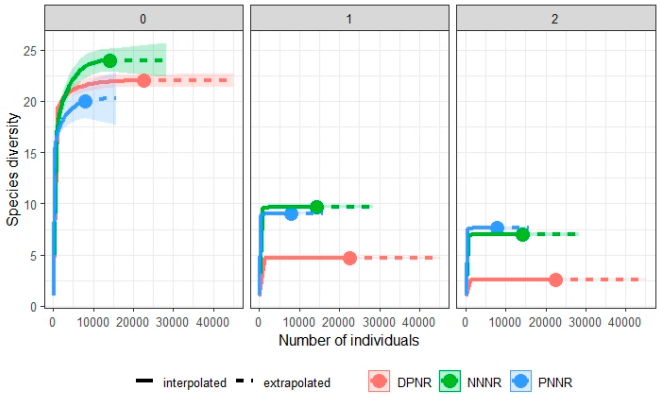
This study showed variation in effective species numbers among each three study sites and each survey year (Figure 3). For example, in Survey 1, 2016, the highest observed effective species number, 25 bird species, 9.70 Shannon index and 6.84 Simpson index were observed in NNNR with the corresponding asymptotic estimator of 26, 2.27 and 0.85, respectively, followed by DPNR (24, 6.57 and 4.85) (Figure 3a). The plot of the confidence interval of species richness of all surveys is overlapping except DPNR, which shows no significant species difference in all surveys of the two nature reserves. However, the Shannon diversity and Simpson diversity plot of Survey 3 (Figure 3c) were not overlapped. Hence significant differences in Shannon diversity and Simpson diversity were observed between the survey sites in Survey 3.



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

(**c**) (**d**)

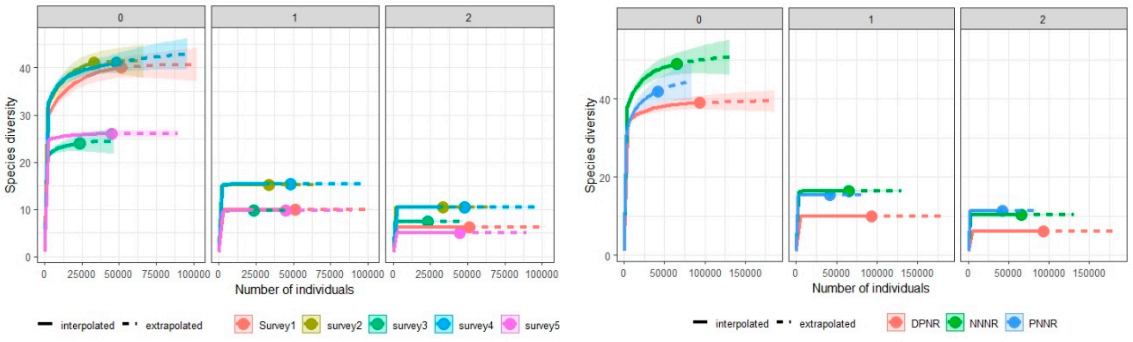
Figure 3. *Cont.*



(**e**)

Figure 3. Rarefaction and extrapolation based on Hill numbers (for order q = 0, 1, 2), species richness (q = 0), Shannon's diversity (q = 1) and inverse Simpson's diversity (q = 2) of reference sample collected from the study sites in the five consecutive survey years ((**a**). Survey 1; (**b**). Survey 2; (**c**). Survey 3; (**d**). Survey 4; (**e**). Survey 5) 2016–2020. The solid line is the rarefaction curve and the dotted line is the extrapolation curve, which goes up to double the size of the reference sample. The shaded area represents 95% confidence intervals obtained using the bootstrap method based on 200 replication.

This study showed that there is an essential temporal variation in biodiversity indices among the five consecutive surveys (Figure 4a) during the whole study time. Hence, the highest values of diversity in the reference sample (nonstandardized data) were found in Survey 4 (2019) where 41 species richness, 15.34 Shannon index and 10.46 Simpson diversity index (solid points in Figure 4a) with the corresponding asymptotic hill numbers for q = 0, 1, 2 are 44, 2.73, 0.91. In contrast, the lowest values of the three metrics were noted in Survey 3 (2018): 24, 9.74 and 7.44 (solid points in Figure 4a) with the corresponding asymptotic estimator for species richness, Shannon diversity and Simpson diversity 25, 2.28 and 0.87, respectively. However, in Survey 1, Survey 2 and Survey 4, there was no significant difference in species richness (q = 0) because the plot of the confidence interval did not overlap.



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

Figure 4. Abundance data-based rarefaction and extrapolation of Hill numbers for order q = 0,1,2 (species richness (q = 0), Shannon's diversity (q = 1) and inverse Simpson's diversity (q = 2)). For the entire five consecutive survey years (**a**) and for the three study site during the whole study periods (**b**). The solid line is the rarefaction curve and the dotted line is the extrapolation curve, which goes up to double the size of the reference sample. The shaded area represents 95% confidence intervals obtained using the bootstrap method based on the 200 replication.

Similarly, temporal variation in biodiversity indices among the study sites (PNNR, NNNR and DNNR) was observed. For instance, the highest values of diversity in the reference sample (nonstandardized data) were found in NNNR, where 49 species richness, 16.37 Shannon index and 10.35 Simpson diversity

index (solid points in Figure 4b) were observed. The asymptotic estimator for species richness, Shannon diversity and Simpson diversity (i.e., Hill numbers for q = 0, 1, 2) were 51, 2.80 and 0.90, respectively. In contrast, the lowest values of the three metrics were noted in DPNR: 39, 9.92 and 6.11 (Solid points in Figure 4b) and their corresponding respective asymptotic hill numbers are 40, 2.30 and 0.84.

The number of species observed in each entire survey year of each study site ranged from 29 (NNNR) to 4 (DPNR) (Figure 5). For example, in PNNR Survey 2, 2017 (Figure 5a), the highest effective number, 27 bird species, 8.62 Shannon index and 4.77 Simpson index were observed, with the corresponding asymptotic estimator for species richness, Shannon diversity and Simpson diversity 27, 1.99 and 0.78, respectively. Similarly, the lowest species richness 17, Shannon index 3.61 and 2.36 Simpson diversity index were noted in Survey 3, 2018 (solid point in Figure 5a) with the corresponding asymptotic estimator 20, 0.58 and 1.29, respectively.

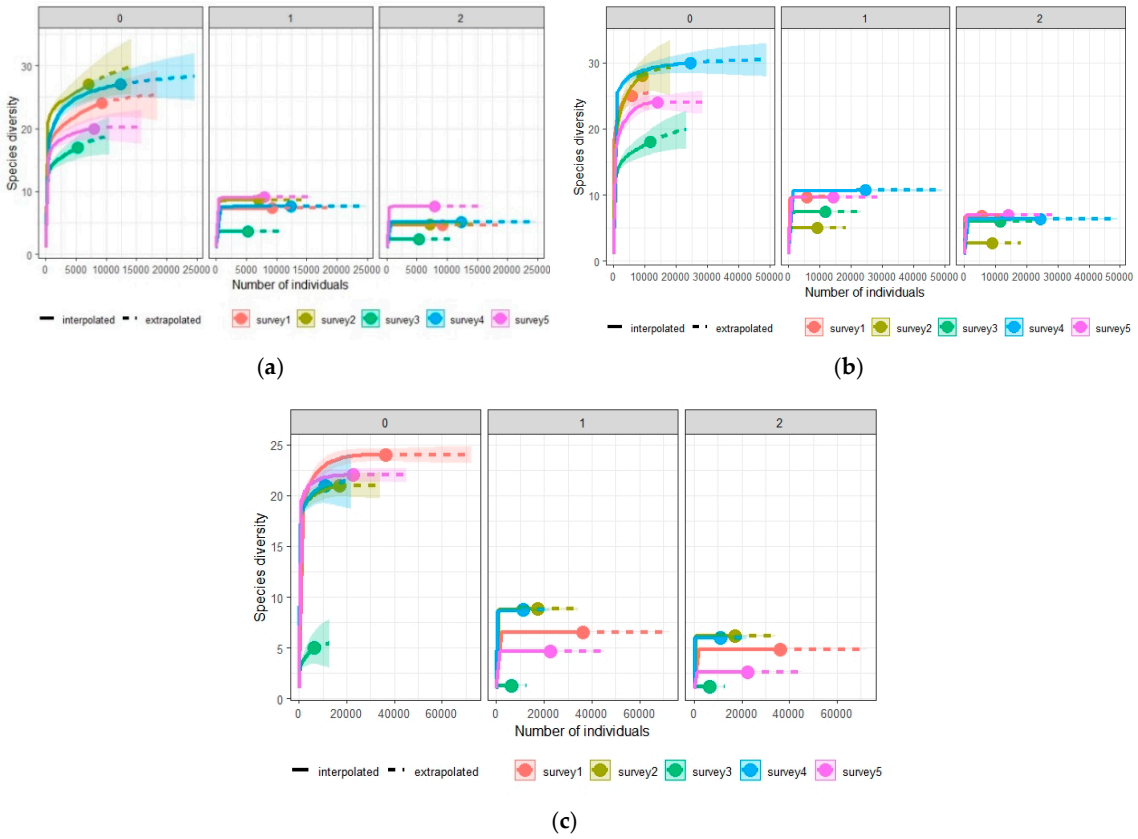


Figure 5. Abundance data-based rarefaction and extrapolation of Hill numbers for order q = 0–2 (species richness (q = 0), Shannon's diversity (q = 1) and inverse Simpson's diversity (q = 2)). For the five consecutive survey years (2016–2020) of PNNR (**a**), NNNR (**b**), and DNNR (**c**). The solid line is the rarefaction curve and the dotted line is the extrapolation curve, which goes up to double the size of the reference sample. The shaded area represents 95% confidence intervals obtained using the bootstrap method.

4. Discussion

The western and southwestern parts of Poyang Lake are playing essential roles in the conservation of wintering aquatic bird species. It contains high species richness and abundant waterbird species during the winter season. This may be due to the existence of large intra-wetland variation [2,40–42] and more abundant food sources [15,43–45] during the winter season. Additionally, fewer disturbances exist in the western and southwestern areas.

PNNR, NNNR and DPNR are a vital wetland ecosystem that provides habitat to various aquatic birds. Every sub lakes with continuous water surface and distinct boundaries within Poyang

Lake accommodate various waterbird species during the winter. However, the distributions of waterbirds were not the same. Some areas were populated by some species, whereas some of them were only observed to have a few birds. For example, Ruddy Shelduck was only recorded in DPNR. Moreover, inside the sub lakes, aquatic birds showed slight changes in their distribution. The distributional changes of the aquatic birds may be due to food availability [7,9,46,47], habitat area and water depth [28,41,48–52], protection status [53,54] and vegetation availability [5,6,12,15].

Temporal variation in biodiversity indices was observed among the three study sites and the survey years. The highest value of diversity observed in NNNR and Survey 4 (2019), whereas the lowest noted in DPNR and Survey 3. During Survey 3 (2018), because of the weather condition and transportation (Ferry) problem, some sub lakes of the study areas were not surveyed. Consequently, the lowest number of species recorded. Additionally, the difference in species diversity among the different study sites and survey year could also be associated with differences in habitat characteristics and feeding habits of birds [41,43,55]. For example, DPNR covered the main water body of Poyang lake and had a large area of deep water, which lowers its suitability for some bird species. Consistent with previous studies [3,56,57], all the study areas provide essential habitats and supporting a considerable number of bird species, including the essential wintering endangered migratory aquatic birds.

Similarly, in agreement with the investigation of other studies in the same area [3,58,59], Anseriformes was the most dominant order, followed by Charadriiformes. The composition of the aquatic birds in the study areas took considerable changes during the study time. For instance, Black-tailed Godwit, which was recorded in the earlier study [17,26] only observed in our first survey. White-naped Crane and Hooded Crane were mainly observed in PNNR (i.e., Zhu Shi Hu, Bang Hu, Da Hu Chi and Sha Hu).

A significant population of Greater and Lesser White-fronted Geese (*Anser albifrons* and *Anser erythropus*), Swan Geese (*Anser cygnoides*) and Tundra Swans (*Cygnus columbianus*), inhabited Poyang Lake during winter seasons, which may be a reflection of the equal availability of their preferred habitats [28,59,60]. However, their abundance has greatly fluctuated in agreement with a previous study [58,59] and their global population was declining due to habitat destruction [54,61,62]. Globally threatened species, such as Siberian Crane, White-naped Crane and Oriental Stork, were also had a relatively high abundance. The estimated total population of Siberian Cranes were 3800–4000 [32]. In the entire Poyang Lake, an earlier study recorded 3750 Siberian Cranes [32]. However, in this study 159–2483 (minimum and maximum, hereafter min and max) Siberian Cranes were recorded. The estimated total population of White-naped Cranes was 6250–6750 [63] and in the entire Poyang Lake, an earlier study recorded 500–1000 [63]. Whereas in this study 525–3489 (min and max) White-naped Cranes were recorded. Similarly, the estimated total population of Oriental Storks was 1000–2499 [64] and an earlier study recorded 4052 [64] in the entire Poyang Lake. However, in this study, we recorded 83–838. This study showed that 20.21% (Siberian Crane), 52.8% (White-naped Crane) and 43% (Oriental Stork) were found in PNNR, NNNR and DPNR.

From this, we conclude that the study areas' (24.2% of the entire Poyang lake) waterbird population number showed variation in each year. This may be because of the population decrease or overestimation of population size in the earlier study. According to this study, the average yearly abundances in three study sites of Poyang Lake (24.2% of Poyang Lake) and the proportion of IUCN of this globally threatened species were 10.11%, 6.09% and 99.04%, respectively. The Storks were also commonly found in only a few sub lakes (i.e., Chang Hu, Zhan Bei Hu and San Ni Wan in NNNR and Mei Xi Hu in DPNR). Whereas the Siberian Crane and White-naped Crane commonly found in PNNR (i.e., Bang Hu and Da Cha Hu) consistent with other studies on Crane [6,26].

All the three nature reserves had some infrastructure and competent staff and have been doing well in aquatic bird monitoring [6,41]. However, some local people lack awareness about conservation laws [58] and DPNR had a lack of funds. Additionally, an essential constraint to aquatic bird protection is a lack of administration of most sub lakes [16,29,65]. Therefore, continuous monitoring and awareness creation [66–68] among local communities regarding long term conservation of birds around sub lakes

is required. Similarly, continuous quantitative survey and ecological study of wintering waterbird in the entire sub lakes of Poyang Lake also need more attention.

5. Conclusions

The study demonstrated that a large number of bird species were over-wintering in Poyang Lake. Interestingly some of the globally endangered bird species inhabited in the sub lakes of Poyang Lake, thus making this site an important conservation area. Therefore, an intense conservation action with harmonized and protected promising wintering stop sites should be performed to increase bird diversity in such a large fresh wetlands area. Similarly, for long term conservation of birds around the wetland, continuous monitoring of bird species, intentional improvement of the sites and awareness creation to the local community are recommended. In particular, DPNR needs more attention. Future studies should also focus on the flyway of the migratory bird species and organizing online taxonomic database of Poyang Lake waterbird.

Author Contributions: Conceptualization, Q.W. and M.T.D.; methodology, M.T.D. and Q.W.; software, M.T.D.; validation, Q.W. and M.T.D.; formal analysis, M.T.D.; investigation, Q.W., M.T.D., L.C., Z.X. and Z.L.; resources, M.T.D. and Q.W.; data curation, Q.W. and M.T.D.; writing—original draft, M.T.D.; writing—review and editing, Q.W. and X.S.; visualization, M.T.D.; supervision, Q.W.; project administration, Q.W.; funding acquisition, Q.W. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest: No conflict of interest.

Appendix A

Table A1. List of wintering waterbird species and the total individual numbers recorded in five consecutive winter season surveys at each study site of Poyang Lake, China.

Order/Family Common Name	Scientific Name/Conservation Status	Study Site			RS
		PNNR	NNNR	DPNR	
PODICIPEDIFORMES					
Podicipedidae					
Little Grebe	*Tachybaptus ruficollis*	167	1048	818	R
Black-necked Grebe	*Podiceps nigricollis*	0	0	338	W
Great Crested Grebe	*Podiceps cristatus*	110	177	817	W
PELECANIFORMES					
Phalacrocoracidae					
Great Cormorant	*Phalacrocorax carbo*	609	355	122	W
Ardeidae					
Black-crowned Night Heron	*Nycticorax nycticorax*	0	957	0	R
Chinese Pond-heron	*Ardeola bacchus*	1	0	0	S
Grey Heron	*Ardea cinerea*	1159	1739	710	R
Great White Egret	*Ardea alba*	54	0	22	W
Intermediate Egret	*Ardea intermedia*	3	2	5	S
Little Egret	*Egretta garzetta*	173	42	0	S
Threskiornithidae					
Eurasian Spoonbill	*Platalea leucorodia*	2162	3952	2494	W
Eurasian Bittern	*Botaurus stellaris*	3	2	66	S
CICONIIFORMES					
Ciconiidae					
Black Stork	*Ciconia nigra*	0	4	0	W
Oriental Stork	*Ciconia boyciana* [EN]	5982	1766	913	W

Table A1. *Cont.*

Order/Family Common Name	Scientific Name/Conservation Status	Study Site			RS
		PNNR	NNNR	DPNR	
Podicipediformes					
ANSERIFORMES					
Anatidae					
Tundra Swan	*Cygnus columbianus* ^{NT}	1108	11,415	6898	W
Swan Goose	*Anser cygnoides* ^{VU}	6444	2752	2716	W
Bean Goose	*Anser fabalis*	5495	13,125	27,032	W
Greater White-fronted Goose	*Anser albifrons*	4426	1601	285	W
Lesser White-fronted Goose	*Anser erythropus* ^{VU}	732	421	311	W
Greylag Goose	*Anser anser*	1578	5881	461	W
Ruddy Shelduck	*Tadorna ferruginea*	0	228	21,222	W
Eurasian Wigeon	*Mareca penelope*	46	212	0	W
Gadwall	*Mareca strepera*	0	41	0	W
Common Teal	*Anas crecca*	0	1251	2487	W
Mallard	*Anas platyrhynchos*	1204	2657	44	W
Chinese Spot-billed Duck	*Anas zonorhyncha*	1313	601	2822	R
Northern Pintail	*Anas acuta*	0	406	0	W
Northern Shoveler	*Spatula clypeata*	0	200	0	W
Red-breasted Merganser	*Mergus serrator*	0	45	0	W
Common Pochard	*Aythya ferina*	0	0	172	W
Tufted Duck	*Aythya fuligula*	2	0	664	W
FALCONIFORMES					
Accipitridae					
Hen Harrier	*Circus cyaneus*	6	6	0	W
Eastern Marsh Harrier	*Circus spilonotus*	0	3	0	W
Pied Harrier	*Circus melanoleucos*	0	1	0	W
GRUIFORMES					
Gruidae					
Common Crane	*Grus grus*	427	462	675	W
Siberian Crane	*Grus leucogeranus* ^{CR}	2641	730	419	W
White-naped Crane	*Grus vipio* ^{VU}	1586	176	218	W
Hooded Crane	*Grus monacha* ^{VU}	524	38	0	W
Rallidae					
Common Coot	*Fulica atra*	39	1416	0	W
Common Moorhen	*Gallinula chloropus*	1	1	0	R
CHARADRIIFORMES					
Recurvirostridae					
Pied Avocet	*Recurvirostra avosetta*	60	3911	11,431	W
Charadriidae					
Northern Lapwing	*Vanellus vanellus* ^{NT}	580	843	523	W
Gray-headed Lapwing	*Vanellus cinereus*	4	0	0	S
Scolopacidae					
Eurasian Curlew	*Numenius arquata* ^{NT}	0	4	0	W
Common Greenshank	*Tringa nebularia*	101	3	200	W
Spotted Redshank	*Tringa erythropus*	499	340	1330	W
Common Redshank	*Tringa totanus*	1319	2267	4	W
Common Sandpiper	*Actitis hypoleucos*	1302	0	41	W
Black-tailed Godwit	*Limosa limosa* ^{NT}	0	300	418	W
Laridae					
Herring Gull	*Larus argentatus*	2	1	445	W
Black-headed Gull	*Larus ridibundus*	13	1453	5683	W
Black-tailed Gull	*Larus crassirostris*	0	0	499	W
Whiskered Tern	*Chlidonias hybrida*	0	2272	0	W
CORACIIFORMES					
Alcedinidae					
Common Kingfisher	*Alcedo atthis*	1	5	1	W
White-breasted Kingfisher	*Halcyon smyrnensis*	4	0	0	W
Pied Kingfisher	*Ceryle rudis*	8	198	25	W
Crested Kingfisher	*Megaceryle lugubris*	1	8	3	W
PASSERIFORMES					
Motacillidae					
White Wagtail	*Motacilla alba*	19	3	2	R
Total number of species		42	49	39	

PNNR—Poyang National Nature Reserve; NNNR—Nanji National Nature Reserve; DPNR—Duchang Provincial Nature Reserve; CR—critically endangered; EN—endangered; VU—vulnerable; NT—near threatened; RS—residence type; R—residence; S—summer; W—winter.

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