

A Profile on Avian Fauna in Mapamyumco, Tibetan Plateau, China

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ABSTRACT

Mapamyumco is one of the important lakes on the Tibetan Plateau, where the knowledge of avian fauna is poorly known due to its remote location and harsh environmental conditions. Here, we conducted a preliminary study on the diversity of bird species in the region to provide basic information about the avian fauna in Mapamyumco. We compiled the field survey data, occasional records by the local rangers, and literature as well as the public birding databases (e.g. China Birdwatching Record Center and eBird). A total of 102 species belong to 15 orders, and 28 families were recorded; among them, 45 species from 11 families are passerines (45.19%), and 57 species from 14 non-passeriform orders. A large portion (67.31%) of birds are Palearctic, and the majority of birds are residents (50.00%) and summer breeders (32.69%). Six species (5.77%) are listed as Class I national key-protected animals and 12 species (11.54%) of Class II key-protected animals. Two species were listed in the IUCN endangered level (EN), 1 species listed as vulnerable (VU), and 6 species listed as near-threatened (NT). The species list of the current study indicates that the avian fauna in Mapamyumco is in line with the climatic and zoogeographical characteristics of the area. Our study provides an essential database for the sake of bird diversity conservation in the far west part of the Qinghai-Tibet Plateau.

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Authors' Contribution

The study program was conceived by SG and YL. SG led the fieldwork with TS and LH. HC and YD provided the field observation data. DZ conducted data analysis and drafted the early version of the manuscript. AT and SG modified the figures and edited the language. All the authors have read and approved the final version of the manuscript.

Key words

Highland wetlands, Tibet, Birds, Species diversity, Conservation, Key-protected species

INTRODUCTION

Highland lakes and wetlands have multiple functions, including climate regulation and pollutant degradation. They serve as essential channels for energy and material exchange between the surrounding environment and water bodies (Liu, 2022). Additionally, they are crucial habitats, particularly for wetland waterbirds. Waterbirds are a significant biological group in wetland ecosystems and are often regarded as important indicator species that reflect the health status of wetlands, due to their rich diversity and higher level in the ecological food chain (Zhang *et al.*, 2022). The Tibetan Qinghai-Tibet Plateau is home to over 1,500 lakes, making it the largest and highest plateau inland lake cluster on Earth (Zeng *et al.*, 2022). Among

these lakes, Mapamyumco is located in Pulan County, Ali Prefecture, Xizang Autonomous Region, with an average elevation of 4,588 meters, making it the world's highest freshwater lake (Yao *et al.*, 2009). Mapamyumco possesses distinct plateau climate characteristics and is a significant lake wetland on the Qinghai-Tibet Plateau. It was listed as one of first national key protected wetlands of China since 1994 and was subsequently protected as an internationally important wetland under the Ramsar Convention in 2005. In 2018, it was approved as a national-level nature reserve by the State Council.

Species diversity is an important component and significant dimension of the biodiversity. Relevant studies on bird species diversity have been conducted for multiple important wetlands across such as Nam Co, Yamzhog Yumco and Selin Co (Zong *et al.*, 2004; Tang *et al.*, 2021; Zhang *et al.*, 2016). Such kind of studies have significantly contributed to our knowledge on the avian fauna in Qinghai-Tibet Plateau, especially the waterbirds in highland waterbodies, as well as the protection and management of the ecological environment. However, to date, there is a lack of specific reports on the characteristics of bird species composition and faunal constitution in the wetlands of Mapamyumco. Therefore, this study focused on the preliminary data compiling on the bird species

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diversity in the wetlands of Mapamyumco. By combining datasets from field surveys, public databases, and relevant literature, the research systematically summarized the character of bird species diversity in the region, aiming to provide a reference for the conservation of bird diversity and ecosystem protection in the area.

MATERIALS AND METHODS

Mapamyumco is located in Pulan county, Ali region, Tibet (Fig. 1), in the Mapamyumco basin between the Himalayas and the Gangdise mountains. With an average elevation of 4,588 metres, it is a freshwater lake with the largest water storage in Tibet and the highest freshwater lake in the world. The lake is located in a plateau semi-arid climate zone and has distinct characteristics of a plateau climate. The total area of the lake is 412 Km², with a water storage of about 20 billion m³. It is an inland freshwater lake with no outflow (Yao *et al.*, 2009). Pulan County, where Mapamyumco is located, has an average annual temperature of 3.6°C, with significant temperature variations throughout the year. Winters are characterized by low temperatures and low rainfall, with rivers generally frozen. In contrast, summers have higher temperatures and runoff from rivers into lakes becomes abundant. Precipitation in the region generally tends to decrease from east to west and from south to north. Precipitation varies unevenly over the seasons, with the raining season lasting from June to August, with an average annual rainfall

around 120 mm (Yao *et al.*, 2009). The area is rich in flora and fauna and serves as a breeding and roosting ground for a variety of wildlife (He *et al.*, 2019), including rare and endangered species such as the black-necked crane and Kiang (Xu *et al.*, 2010).

Methods

From 10 to 11 August 2021, two survey sites were selected in the wetlands at the coast of the Mapamyumco, Jiwu Temple and Gujiacuo along National Highway 219 and Provincial Highway 207. A total of 21 bird species belonging to 6 orders and 11 families were observed in the field. Additional bird species data collected by the national reserve staff during patrols and surveys across the area were incorporated. We also downloaded birding data related to the Mapamyumco wetlands from the Birdwatching Records of China Center (<https://www.birdreport.cn/>) and the eBird website (<https://ebird.org>). We excluded records before 2000 in consideration the uncertainty of data from earlier starting years to the current birds' distribution situation. A total of 50 bird species from 21 families in 9 orders were amended, resulting in a final set of bird species records comprising 104 species from 28 families in 15 orders.

Field identification, classification, and identification of bird species were based on the “A Field Guide to the Birds of China (New Edition by John MacKinnon)” (MacKinnon, 2022). The CNG field guide to the birds of China (Liu and Chen, 2021) and the birds in the Tibetan

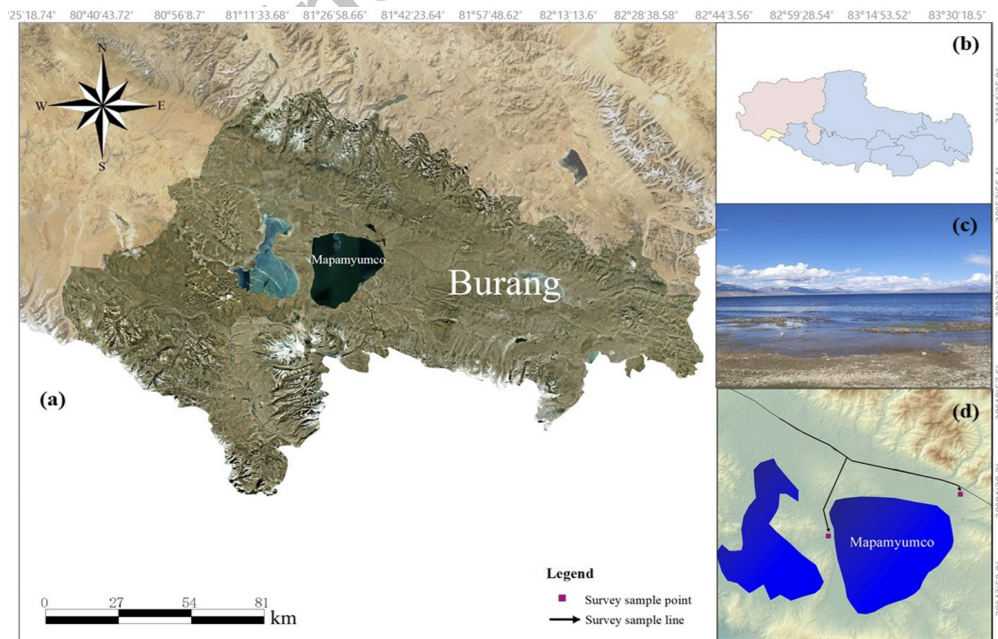


Fig. 1. Relative geographic positions of Mabunyangmo, Pulan County, Ali Prefecture, and the Xizang Autonomous Region (a, b), a site scenery of the Mabunyangmo (c), the survey sample line and sample point distribution (d).

Plateau of China (Lu, 2018). The classification and distribution of bird species were confirmed using the checklist of classification and distribution of the birds of China (4th Edition) (Zheng, 2023). The bird fauna and distribution types were referred to the zoogeography of China (Zhang, 2011). The conservation status of bird species was determined based on the list of national key protected wild animals (<https://www.forestry.gov.cn/c/www/dzbhtml>) and the IUCN red list (International Union for Conservation of Nature Red List).

The maps in the article were created using SuperMap iDesktop 11i (2022) SP1 and ArcGIS 10.8.1 versions, while data compilation and graph creation were done in R Studio and Origin Pro 2024.

RESULTS

Bird community and faunal composition

We recorded 21 bird species belonging to 6 orders and 11 families during the 2021 field survey. After supplement by the reserve staff as well as from the birdwatching

records of China Center and eBird, the final count reached 104 species from 28 families in 15 orders (Table I). Among them, Passeriformes dominate the highest proportion with 45.19% (47 species in 11 families). Non-Passeriformes birds, belonging to 14 orders and 17 families, comprised 57 species, with Charadriiformes, Anseriformes, and Falconiformes being the dominant orders with 11.54%, 10.58% and 9.62% of the total, respectively. Bucerotiformes, Suliformes, and Pteroclidiformes had the fewest species (see Fig. 2).

In terms of faunal composition, there were 70 bird species classified as Palearctic, representing 67.3% of all bird species recorded. Widespread species accounted for 24% (25 species), while 9 species belong to account for 8.7% of the total. In terms of the residence type, the constitution was as follows: 52 species were residents, 34 species are summer visitors birds, 16 species were passage migrants or vagrants, and only 2 species were winter visitors. These types represented 50.00%, 32.7%, 15.4%, and 1.9% of the total species, respectively.

Table I. List of bird species diversity in the Mapamyumco wetlands.

S. No.	Order/ Families/ Species	PROT	IUCN	Residence type	Regional fauna	Data source
I. Anseriformes						
1. Anatidae						
(1)	Gadwall (<i>Mareca strepera</i>)			P	P	A
(2)	Ruddy shelduck (<i>Tadorna ferruginea</i>)			S	P	A
(3)	Ferruginous duck (<i>Aythya nyroca</i>)		NT	P	P	A
(4)	Common pochard (<i>A. ferina</i>)		VU	P	P	A
(5)	Common merganser (<i>Mergus merganser</i>)			S	C	C
(6)	Northern shoveler (<i>Spatula clypeata</i>)			P	P	A
(7)	Red-crested pochard (<i>Netta rufina</i>)			S	P	A
(8)	Mallard (<i>Anas platyrhynchos</i>)			S	P	B
(9)	Indian spot-billed duck (<i>A. poecilorhyncha</i>)			R	O	C
(10)	Eurasian teal (<i>A. crecca</i>)			P	P	A
(11)	Bar-headed goose (<i>Anser indicus</i>)			S	P	A
II. Galliformes						
2. Phasianidae						
(12)	Tibetan snowcock (<i>Tetraogallus tibetanus</i>)	Class II		R	P	A
(13)	Himalayan snowcock (<i>T. himalayensis</i>)	Class II		R	P	A
(14)	Tibetan partridge (<i>Perdix hodgsoniae</i>)			R	P	A
III. Podicipediformes						
3. Podicipedidae						
(15)	Great crested grebe (<i>Podiceps cristatus</i>)			S	P	A
(16)	Black-necked grebe (<i>P. nigricollis</i>)	Class II		P	P	A
(17)	Little grebe (<i>Tachybaptus ruficollis</i>)			R	C	A

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S. No.	Order/ Families/ Species	PROT	IUCN	Residence type	Regional fauna	Data source
IV. Ciconiiformes						
4. Ardeidae						
(18)	Grey heron (<i>Ardea cinerea</i>)			S	P	A
(19)	Chinese pond heron (<i>Ardeola bacchus</i>)			S	O	A
V. Suliformes						
5. Phalacrocoracidae						
(20)	Great cormorant (<i>Phalacrocorax carbo</i>)			S	C	A
VI. Accipitriformes						
6. Accipitridae						
(21)	Black kite (<i>Milvus migrans</i>)	Class II		S	C	A
(22)	Cinereous vulture (<i>Aegypius monachus</i>)	Class I	NT	S	P	A
(23)	Bearded vulture (<i>Gypaetus barbatus</i>)	Class I	NT	R	P	B
(24)	Upland buzzard (<i>Buteo hemilasius</i>)	Class II		S	P	B
(25)	Himalayan buzzard (<i>B. refectus</i>)	Class II		R	O	C
(26)	Himalayan griffon (<i>Gyps himalayensis</i>)	Class II	NT	R	P	C
(27)	Oriental honey-buzzard (<i>Pernis ptilorhynchus</i>)	Class II		P	O	A
(28)	Golden eagle (<i>Aquila chrysaetos</i>)	Class I		R	P	A
(29)	Steppe eagle (<i>A. nipalensis</i>)	Class I	EN	P	P	A
(30)	Mountain hawk eagle (<i>Nisaetus nipalensis</i>)	Class II	NT	R	O	A
VII. Gruiformes						
7. Gruidae						
(31)	Black-necked crane (<i>Grus nigricollis</i>)	Class I	NT	P	P	A
8. Rallidae						
(32)	Common coot (<i>Fulica atra</i>)			S	C	A
(33)	Common moorhen (<i>Gallinula chloropus</i>)			R	C	B
VIII. Charadriiformes						
9. Charadriidae						
(34)	Lesser sand plover (<i>Charadrius mongolus</i>)			S	P	C
(35)	Long-billed plover (<i>C. placidus</i>)			P	P	C
(36)	Little ringed plover (<i>C. dubius</i>)			S	C	A
10. Laridae						
(37)	Black-headed gull (<i>Chroicocephalus ridibundus</i>)			W	P	B
(38)	Brown-headed gull (<i>C. brunnicephalus</i>)			S	P	A
(39)	Common tern (<i>Sterna hirundo</i>)			S	P	A
(40)	Pallas's gull (<i>Ichthyaeetus ichthyaeetus</i>)			P	P	A
11. Scolopacidae						
(41)	Ruff (<i>Calidris pugnax</i>)			P	P	C
(42)	Temminck's stint (<i>C. temminckii</i>)			P	P	A
(43)	Common sandpiper (<i>Actitis hypoleucos</i>)			P	P	A
(44)	Common redshank (<i>Tringa totanus</i>)			S	P	A
(45)	Green sandpiper (<i>T. ochropus</i>)			W	P	A

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S. No.	Order/ Families/ Species	PROT	IUCN	Residence type	Regional fauna	Data source
IX. Pterocliiformes						
12. Pteroclididae						
(46)	Tibetan sandgrouse (<i>Syrrhaptes tibetanus</i>)			R	P	A
X. Columbiformes						
13. Columbidae						
(47)	Hill pigeon (<i>Columba rupestris</i>)			R	P	B
(48)	Rock dove (<i>C. livia</i>)			R	C	C
(49)	Oriental turtle dove (<i>Streptopelia orientalis</i>)			R	C	A
(50)	Eurasian collared dove (<i>S. decaocto</i>)			R	C	A
XI. Cuculiformes						
14. Cuculidae						
(51)	Common cuckoo (<i>Cuculus canorus</i>)			S	C	C
(52)	Large hawk-cuckoo (<i>Hierococcyx sparveroides</i>)			S	O	C
XII. Strigiformes						
15. Strigidae						
(53)	Little owl (<i>Athene noctua</i>)	Class II		R	P	C
(54)	Northern eagle owl (<i>Bubo bubo</i>)	Class II		R	C	A
XIII. Bucerotiformes						
16. Upupidae						
(55)	Eurasian hoopoe (<i>Upupa epops</i>)			S	C	A
XIV. Falconiformes						
17. Falconidae						
(56)	Common kestrel (<i>Falco tinnunculus</i>)	Class I		R	C	B
(57)	Saker falcon (<i>F. cherrug</i>)	Class II	EN	S	P	A
XV. Passeriformes						
18. Alaudidae						
(58)	Tibetan lark (<i>Melanocorypha maxima</i>)			R	P	C
(59)	Crested lark (<i>Galerida cristata</i>)			R	P	A
(60)	Hume's short-toed lark (<i>Calandrella acutirostris</i>)			S	P	A
(61)	Asian short-toed lark (<i>Alaudala cheleensis</i>)			R	P	A
(62)	Horned lark (<i>Eremophila alpestris</i>)			R	P	A
(63)	Oriental skylark (<i>Alauda gulgula</i>)			S	C	A
19. Motacillidae						
(64)	Citrine wagtail (<i>Motacilla citreola</i>)			S	P	C
(65)	White wagtail (<i>M. alba</i>)			S	C	C
20. Phylloscopidae						
(66)	Tickell's leaf warbler (<i>Phylloscopus affinis</i>)			S	O	B
21. Passeridae						
(67)	White-rumped snowfinch (<i>Onychostruthus taczanowskii</i>)			R	P	A
(68)	Rufous-necked snowfinch (<i>Pyrgilauda ruficollis</i>)			R	P	B
(69)	Plain-backed snowfinch (<i>P. blanfordi</i>)			R	P	B
(70)	House sparrow (<i>Passer domesticus</i>)			R	C	B
(71)	Eurasian tree sparrow (<i>P. montanus</i>)			R	C	A
(72)	Black-winged snowfinch (<i>Montifringilla adamsi</i>)			R	P	B

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S. No.	Order/ Families/ Species	PROT	IUCN	Residence type	Regional fauna	Data source
(73)	White-winged snowfinch (<i>M. nivalis</i>)			R	P	A
(74)	Tibetan snowfinch (<i>M. henrici</i>)			R	P	C
22. Paridae						
(75)	Ground tit (<i>Pseudopodoces humilis</i>)			R	P	B
23. Muscicapidae						
(76)	Black redstart (<i>Phoenicurus ochruros</i>)			R	P	B
(77)	White-winged redstart (<i>P. erythrogastrus</i>)			S	P	A
(78)	Hodgson's redstart (<i>P. hodgsoni</i>)			P	P	B
(79)	Blue-fronted redstart (<i>P. frontalis</i>)			R	P	B
(80)	Blue rock thrush (<i>Monticola solitarius</i>)			R	O	B
(81)	Desert wheatear (<i>Oenanthe deserti</i>)			R	P	B
24. Emberizidae						
(82)	Godlewski's bunting (<i>Emberiza godlewskii</i>)			R	C	C
25. Corvidae						
(83)	Daurian jackdaw (<i>Coloeus dauuricus</i>)			P	C	C
(84)	Black-rumped magpie (<i>Pica bottanensis</i>)			R	C	C
(85)	Red-billed chough (<i>Pyrrhocorax pyrrhocorax</i>)			R	P	A
(86)	Alpine chough (<i>P. graculus</i>)			R	P	B
(87)	Northern raven (<i>Corvus corax</i>)			R	P	B
(88)	Large-billed crow (<i>C. macrorhynchos</i>)			R	C	C
26. Prunellidae						
(89)	Robin accentor (<i>Prunella rubeculoides</i>)			R	P	B
(90)	Brown accentor (<i>P. fulvescens</i>)			R	P	B
(91)	Alpine accentor (<i>P. collaris</i>)			R	P	C
(92)	Altai accentor (<i>P. himalayana</i>)			S	P	C
27. Hirundinidae						
(93)	Sand martin (<i>Riparia riparia</i>)			S	P	A
(94)	Barn swallow (<i>Hirundo rustica</i>)			S	C	C
(95)	Eurasian crag martin (<i>Ptyonoprogne rupestris</i>)			S	C	A
28. Fringillidae						
(96)	Red-fronted serin (<i>Serinus pusillus</i>)			R	P	C
(97)	Twite (<i>Linaria flavirostris</i>)			R	P	C
(98)	Great rosefinch (<i>Carpodacus rubicilla</i>)			R	P	B
(99)	Common rosefinch (<i>C. erythrurus</i>)			S	C	C
(100)	Himalayan beautiful rosefinch (<i>C. pulcherrimus</i>)			R	P	C
(101)	Pink-browed rosefinch (<i>C. rodochroa</i>)			R	O	C
(102)	Streaked rosefinch (<i>C. rubicilloides</i>)			R	P	C
(103)	Brandt's mountain finch (<i>Leucosticte brandti</i>)			R	P	B
(104)	Plain mountain finch (<i>L. nemoricola</i>)			S	P	A

1, Endangered and Protected List: (1) PROT, the National List of Wildlife under Key Conservation, is categorized into Class I and Class II. (2) IUCN: International Union for Conservation of Nature. Among them, Endangered (EN), Vulnerable (VU), Near Threatened (NT). 2, Residence types: Winter Visitor Birds (W), Summer Visitor Birds (S), Resident Birds (R), and Passage Migrant or Vagrant Birds (P). 3, Zonation: Palaearctic Species (P), Eastern Oceanic Species (O), and Widespread Species (C). 4, Data Sources: Field Observations (A), Birdwatching Records of China Center (B), eBird (C).

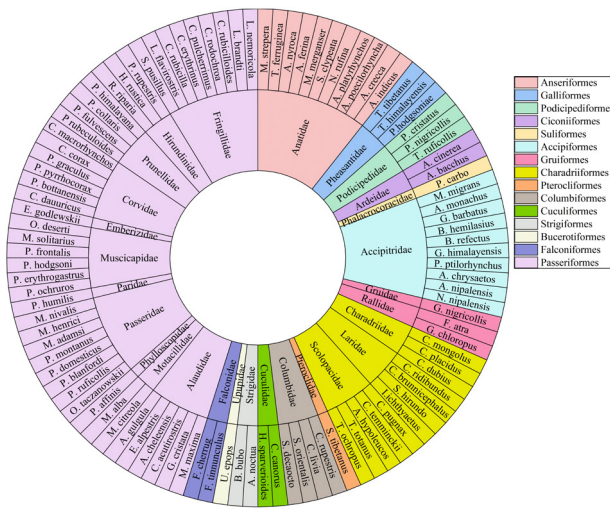


Fig. 3. Taxonomic distribution of bird species in the Mapamyumco region. The circular diagram is organized hierarchically, with the inner ring representing bird families within each order and the outer ring representing the species within each family. Each segment of the figure corresponds to a specific order, which is color-coded for clarity. This figure highlights the diversity of bird species and their taxonomic classification, showcasing the proportional representation of each family and species within the broader avian orders present in the high-altitude ecosystem of Mapamyumco.

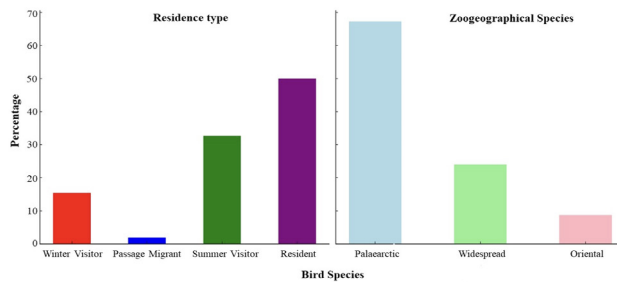


Fig. 3. The percentage distribution of bird species in the Mapamyumco region, categorized by residence type (Winter Visitor, Passage Migrant, Summer Visitor, and Resident) and zoogeographical origin (Palearctic, Widespread, and Oriental). The categorization by residence type reflects the seasonal patterns and migratory behaviors of the species, while the zoogeographical classification highlights the influence of broad biogeographical regions on the composition of the avian community. The figure illustrates the dominance of Resident and Palearctic species, reflecting the biogeographical and ecological characteristics of Mapamyumco as a habitat for both local and migratory birds within this high-altitude ecosystem.

Endangerment and protection status of birds

Of the bird species recorded, 6 are classified as National Category I, including cinereous vulture (*Aegypius monachus*), bearded vulture (*Gypaetus barbatus*), golden eagle (*Aquila chrysaetos*), steppe eagle (*Aquila nipalensis*), black-necked crane (*Grus nigricollis*) and saker falcon (*Falco cherrug*). There are 12 species listed in the National category II, including Tibetan snowcock (*Tetraogallus tibetanus*), Himalayan snowcock (*Tetraogallus himalayensis*), black-necked grebe (*Podiceps nigricollis*), black kite (*Milvus migrans*), and upland buzzard (*Buteo hemilasius*), Himalayan buzzard (*Buteo refectus*), Himalayan griffon (*Gyps himalayensis*), Oriental honey-buzzard (*Pernis ptilorhynchus*), mountain hawk eagle (*Nisaetus nipalensis*), little owl (*Athene noctua*), northern eagle owl (*Bubo bubo*) and common kestrel (*Falco tinnunculus*). On the IUCN red list, two species, steppe eagle and saker falcon, are listed as endangered (EN). One species, common pochard (*Aythya ferina*), is listed as vulnerable (VU), and the other six species, ferruginous duck (*Aythya nyroca*), cinereous vulture, bearded vulture, Himalayan griffon, mountain hawk eagle and black-necked crane, are listed as near threatened (NT) (Table I).

DISCUSSION

Bird species diversity in the Mapamyumco Wetland.

The findings of the current study indicated that the wetlands of Mapamyumco recorded a total of 104 bird species belonging to 15 orders and 28 families. Passeriformes have the highest diversity, followed by Charadriiformes, Anseriformes, and Accipitriformes. Within Passeriformes, species of Fringillidae, Passeridae, Corvidae, and Alaudidae were predominant. Regarding residency types, resident birds and summer migrants were more abundant, while winter migrants were less common. In terms of faunal composition, according to the animal geographic division (Zhang, 2011), Mapamyumco wetlands fall within the Qinghai-Tibetan region of the Palearctic Realm, specifically the Chang Tang sub-region. The study results suggest that the avian fauna in this wetland is primarily composed of Palearctic Realm birds, in line with the zoogeographic division. Simultaneously, the wetland has a relatively low proportion of Oriental Realm birds. This might be due to its geological proximity to the Sino-Himalays (Oriental realm), causing a mixture of avifauna or subspecies endemism in response to local adaptation. In terms of conservation status analysis, the wetland hosts a considerable number of nationally protected bird species, with a predominance of Accipitriformes. Accipitriformes, positioned at the top of the food chain, primarily prey on herbivorous mammals

unique to high-altitude environments, aligning with the distinctive environmental characteristics of high-altitude alpine meadows and grasslands (Tang *et al.*, 2021).

We compared similarities and differences in the composition of bird species in Mapamyumco wetlands with other key lake wetland regions across the Qinghai-Tibet Plateau. When comparing the bird species diversity of high-altitude lake wetlands in the Palaearctic Realm, such as Selincuo Lake, Yangzhuoyong Lake, and Nam Co Lake, all these regions display a similar bird species composition. Passeriformes are the dominant group, with the prevalence of Charadriiformes and Anseriformes among non-Passeriformes. In terms of faunal composition, Palaearctic Realm species are dominant in all of these regions. In terms of residency types, resident birds or summer migrants are predominant. In terms of conservation status, most bird species listed in the national key protected species directory belong to Accipitriformes. This indicates a strong consistency in bird species composition in similar habitats across the highlands of the Qinghai-Tibet Plateau.

On the other hand, we recorded two species, the Himalayan Buzzard and the Oriental Honey-Buzzard, which were listed as National Category II protected species. These species, along with the Eurasian Collared Dove (*Streptopelia decaocto*) and the Northern Shoveler (*Spatula clypeata*), were not documented in the wetlands such as Selincuo Lake, Yangzhuoyong Lake, and Nam Co Lake. This difference implies a certain level of uniqueness of the Mapamyumco. Comparing the existing bird species composition in the urban natural wetland of Lahu Wetland located in the northwest corner of Lhasa (Zhou *et al.*, 2020), it is observed that in both wetlands, Passeriformes account for the highest proportion of bird species (approximately 50%). Among non-Passeriformes, Anseriformes and Charadriiformes have relatively high proportions in both wetlands. However, there are notable differences. In Mapamyumco Wetland, Accipitriformes have a higher proportion among non-passeriformes, while Pelecaniformes have a lower proportion. Within Passeriformes, the proportion of Alaudidae is higher, while that of Phylloscopidae is lower in Mapamyumco Wetland. This reflects the variation in the composition of wetland bird species in different regions, habitats, and under different degrees of human disturbance on the Qinghai-Tibet Plateau.

The analysis for migratory types reveals that, apart from resident birds, the recorded migratory species are predominantly summer visitor birds or passage migrants, constituting a relatively high proportion (48.08%) of the total bird species. Winter visitors are notably scarce, with only 2 species recorded out of 104, indicating a clear seasonal difference. There are three possible reasons for

this pattern: First, the region around Mapamyumco may provide suitable climate conditions for bird breeding during the summer, making it an important area for the reproduction and chick-rearing of migratory birds on the Qinghai-Tibet Plateau, hence the abundance of summer migratory bird species is significantly high. Second, due to the high altitude and harsh winter climate of Mapamyumco Wetland, with extremely low temperatures in winter, these environmental factors may contribute to the limited diversity of winter living birds. Third, the seasonal bias in the data may be attributed to the fact that the field surveys conducted are very difficult, as the similar situation for those data supplemented from eBird and the China Birdwatching Records Center, which were mainly obtained during the summer. This could lead to a bias in the investigation work, and the lack of winter data may contribute to the underestimation of winter migratory bird species in the wetland. Given that Mapamyumco is located in the hinterland of Tibet, experiencing harsh winter conditions, extreme temperatures, and restricted access, field surveys during winter are challenging. This limitation in survey intensity and frequency during winter may be a significant factor contributing to the marked decrease in the recorded number of species. This also suggests that the bird species diversity in this wetland during winter might be underestimated. Therefore, further investment and efforts are needed for winter surveys in compensation for the knowledge of winter bird species in this wetland.

Significance and prospects on bird species diversity in Mapamyumco wetland

Mapamyumco is an important wetland in the western part of the Qinghai-Tibet Plateau, designated as a nationally protected wetland and a national-level nature reserve. As one of Tibet's three holy lakes, the splendid scenery of Mapamyumco Wetland attracts pilgrims and tourists worldwide. However, due to its location in the high-altitude arid climate zone, the ecological structure of the ecosystem is relatively vulnerable to disturbance. With the progress of economic development and urbanization, the potential conflict between economic development and ecological conservation in Mapamyumco Wetland may be intensified. Protecting the natural environment and biodiversity of this high-altitude sacred lake in a scientifically effective manner is a crucial challenge. Birds, being a vital component of the ecosystem, serve as important indicators of environmental quality through their diversity. Our research results presented in this paper provide preliminary scientific data on the avian fauna in Mapamyumco Wetland. We expect that our efforts would contribute to optimizing measures related to biodiversity conservation and management in this region.

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Statement of conflict of interest

The authors have declared no conflict of interest.

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