Species and populations of waterbirds wintering in the Yarlung Zangbo and its tributaries in Tibet，China

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Abstract: To promote avian influenza surveillance, wetland conservation and management, surveys on the wintering waterbird community were conducted in the Yarlung Zangbo River valley of Tibet in January of 2009 and 2014. The two surveys recorded a total of 33 species and 90,407 individuals, and 24 species and 95,106 individuals, respectively. The geese and ducks accounted for over 90% of the total waterbirds counted. We recorded a total of 5,558 Black-necked Cranes in 2014. Lazi County has the highest count of 1,555 Black-necked Cranes, and other counties with high numbers include: Dazi (639), Nanmulin (598), Rikaze (572), Sajia (540), and Linzhou (395). There were no Black-necked Cranes recorded in Lhasa City, Duilongdeqing, Jiacha, Langkazi, Renbu and Nimu. By valleys, Yarlung Zangbo main valley had the highest number of 2,730 Black-necked Cranes, while Lhasa River valley had 993, Pengbo valley and Xiabuqu Chu each had 395 and 393 birds. A total of 45,681 and 67,031 of Bar-headed Geese (*Anser indicus*) were recorded in 2009 and 2014 respectively, mostly in Rikaze, Jiangzi, Bailang, Qushui, Dazi and Linzhou. Nyang Chu Valley, Pengbo Valley and Yarlung Zangbo Valley each had more than 10,000 Bar-headed Geese in 2014. The Bar-headed Geese usually moved in large flocks and foraged in winter wheat fields in the valleys.

Keywords: Waterbird community; Bar-headed Goose; Yarlung Zangbo; Tibet

西藏雅鲁藏布江流域越冬水鸟资源现状

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摘要：为了掌握水鸟群落特征以及禽流感疫源鸟类斑头雁的重要的分布地和数量及其变化，于 2009 年 1 月和 2014 年 1 月分别对雅鲁藏布江河谷的越冬水鸟进行了调查。共记录到越冬水鸟 39 种，2009 年和 2014 年分别记录到越冬水鸟 33 种 90 407 只和 24 种 95 106 只。在雅鲁藏布江河谷越冬的水鸟种类主要是雁鸭类，而鸻鹬类和鸥类的数量相对较少。斑头雁是越冬水鸟中最为优势的物种，2009 年和 2014 年分别记录到 45 681 只和 67 031 只，数量较多的地点是日喀则、江孜、白朗、曲水、达孜、林周。斑头雁在年楚河谷、澎波河谷和雅鲁藏布江河谷 3 个河谷数量达万只以上；斑头雁在沼泽中的群体较大，而冬小麦地则是斑头雁利用频次最高的栖息地。

关键词：水鸟群落；斑头雁；雅鲁藏布江；西藏

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The Yarlung Zangbo valley (including Yarlung Zangbo River and its two major tributaries of Lhasa River and Nyang Chu River) is located in southern Tibet. Information on its bird resources has been limited due to the harsh natural geographic conditions in the area (Stone, 1933; Vaurie, 1972; Walton, 1946). From the 1950s to early 1980s, the Qinghai-Tibetan Plateau Integrated Survey Team of the Chinese Academy of Sciences conducted 13 scientific expeditions in Tibet to create a bird inventory and fauna baseline as well as for specimen collection; 72 waterbird species were recorded in total (1983). Over the two decades, studies on the bird resources of the Yarlung Zangbo valley have been carried out by many scholars from China (Cangjue et al, 1994, 2005；Song et al, 1994; Yang et al, 2011, 2013).

The Yarlung Zangbo valley is not only one of the most important migration and wintering sites for the migratory birds in China, especially geese and ducks, in the Central Asian Flyway (Bishop et al, 2012; Song et al, 1994), but also one of the major wintering sites of the Black-necked Crane (*Grus nigricollis*) in the world, as this area supports over 90% of its western populations (Bishop, 1993).

The Black-necked Cranes and geese and ducks breeding in western Mongolia, as well as southeastern Xinjiang, northern Tibet, Qinghai and Gansu, China, either stop at the Yarlung Zangbo valley during their migration or spend their winter there (Prosser et al, 2009; Zhang et al, 2011). A great part of the Bar-headed Goose (*Anser indicus*) populations wintering in the Yarlung Zangbo valley are from Qinghaihu Lake where they breed (Zhang et al, 2011). Because of the H5N1 highly pathogenic avian influenza outbreak in 2005, the Bar-headed Goose population, distribution and movement patterns have aroused extensive attention worldwide. In January 2009 and 2014, two comprehensive surveys in the Yarlung Zangbo valley were conducted to understand: (1) waterbird resources and the population changes of the wintering waterbird species in the Yarlung Zangbo valley; (2) locations and numbers of the Black-necked Cranes and Bar-headed Geese in the valley; and (3) the human disturbance to the wintering areas of waterbirds.

SURVEY AREAS AND METHODS

Survey areas

The basin ofthe Yarlung Zangbo valley is bounded by the Himalayas in the south and Kang Rinpoche and Nyenchen Tanglha Mountains in the north, with an altitude of over 3,000 m a.s.l. The Yarlung Zangbo River flows through China, India and Bangladesh. The climate is the temperate semi-arid plateau monsoon climate, dry, oxygen-poor, windy, significant temperature difference within a day, and with the highest and lowest temperature at 28 ℃ and –14 ℃, respectively.[1]

The valley was divided into the following survey areas: (1) the Yarlung Zangbo valley (including Lazi-Rikaze-Qushui-Zhanang-Jiacha-Milin, and the Yamzho Lake); (2) the Lhasa valley (including Lhasa City, Dazi, Duilongdeqing and Mozhugongka); (3) the Nyang Chu valley (including Jiangzi and Bailang); (4) the Pengbo valley (Linzhou); (5) the Mozhu valley (including Mozhugongka); (6) Xiabuqu (including Sajia's Jiding, Chexiu and Xiongma); (7) Requ (including Lazi's Zhaxigang); (8) the Xietongmen valley (including Rongqu and Chenzhequ of Tongmen Xiang of Xietongmen County); (9) the Danada valley (including Xiementong's Danapuqu); (10) the Xiangqu River valley (including Nanmulin); (11) the Zhanang valley (southern Zhanang); (12) the Yalong River valley (southern Naidong); (13) the Niyang valley (the confluence of Yarlung Zangbo River and Niyang River).

Study methods

The same methods were applied in the two surveys. Investigators chose 320 observation sites along riversides, the surrounding farmlands or marshes with bird aggregations. Species and number of waterbirds and their habitats were recorded, with the aid of binoculars and telescopes (20−60×, SWAROVSKI), and their locations were determined with Global Positioning System units. The observation duration at each site varied, depending on the time in identifying, counting and recording of waterbirds in the view field.

The taxonomic classification and scientific names of the waterbirds used in this report are from *A Checklist on the Classification and Distribution of the birds of China (second edition)* (Zheng, 2011)

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Statistical Analysis

Results of the January 2014 waterbird survey were used in analyzing waterbird community characteristics and Bar-headed Goose habitat use. Differences in the population size of the Bar-headed Geese from various habitats were analyzed by the nonparametric *Kruskal Wallis* test. The biodiversity of waterbirds was evaluated by the *Shannon-Wiener* diversity index *H*.

$$H = \sum Pi \ln Pi \quad (1)$$

Here, *Pi* represents the percentage of the numbers of species*i*to the numbers of the species in total.

Evenness was determined by *Pielou* evenness index *J*.

$$J=H/H\max \quad (2)$$

Here, *H* is the observed biodiversity; *H*max is the highest biodiversity.

$$H\max=\ln S \quad (3)$$

Here, *S* is the numbers of species.

$$D = \sum (Pi)^2 \quad (4)$$

Here, *D* is the degree of dominance (Sun, 2006).

RESULTS

Habitat types of the waterbirds in the Yarlung Zangbo valley

Rivers: with abundant food resources, such as aquatic plants, Lhasa and Nyang Chu Rivers were the ideal wintering sites for geese and ducks, e.g., Bar-headed Goose, Mallard (*Anser platyrhynchos*), Ruddy Shelduck (*Tadorna ferruginea*), Goosander (*Mergus merganser*), Eurasian Wigeon (*A.penelope*) and Eurasian Teal (*A.crecca*).

Lakes: The Yamzho Lake is a major lake in the Yarlung Zangbo valley. Because this is a large lake at a high altitude (4,400 m a.s.l.) and because it has strong sunlight a portion of the lake surface does not freeze during the winter, therefore the lake becomes a great feeding site for the migratory birds. Our surveys found large numbers of Red-crested Pochards (*Netta rufina*), Bar-headed Geese, Ruddy Shelduck, Common Pochard (*Aythya ferina*), Tufted Ducks (*A. fuligula*), Spotbill Ducks (*Anas poecilorhyncha*), Common Coots (*Fulicaatra*), and Common Goldeneye, while species in Charadriidae, Scolopacidae and Laridae were rare.

Sand beaches: Numerous sand beaches in different shapes along the Yarlung Zangbo River were good resting and roosting habitats for Ruddy Shelducks and Bar-headed Geese because of their low human disturbance. Great Cormorants (*Phalacrocorax carbo*), Great Black-headed Gulls (*Larus ichthyactus*) and Brown-headed Gulls (*L. brunnicephalus*) were occasionally sighted lingering on the sand beaches.

Farmlands: Large farmlands, especially the ones with plantings of barley and winter wheat in the Yarlung Zangbo valley are the ideal feeding sites for birds. In our survey, Ruddy Shelducks, Black-necked Cranes and Bar-headed Geese were all feeding in the farmlands. However, other ducks were rarely sighted there.

Reservoirs: Linzhou County of Lhasa City has two reservoirs, Kazi and Hutoushan reservoirs, and the edge areas of thereservoirs are not frozen during winters. Many Common Pochards, Tufted Ducks, Red-crested Pochards, Northern Pintails (*A. acuta*), Gadwalls (*A. strepera*) and Common Coots, Bar-headed Geese and Black-necked Cranes used these areas as their roost sites.

Species compositions

Our survey, covering 23 counties, recorded 39 waterbird species from 5 orders and 11 families, including Podicipedidae, Phalacrocoracidae, Ardeidae, Anatidae, Gruidae, Rallidae, Recurvirostridae, Ibidorhynchidae, Charadriidae, Scolopacidae and Laridae (Table 1). 33 species and 90,407 individuals were recorded in January 2009, and 24 species and-95,106 individuals in January 2014. The most common species were geese and ducks, especially the Bar-headed Goose and Ruddy Shelducks; the Black-necked Cranes were also in large numbers; other species, such as Ardeidae, Laridae, Charadriidae and Scolopacidae were in relatively small numbers.

Species wintering in the Yarlung Zangbo valley were mainly geese and ducks, such as the Bar-headed Goose, Ruddy Shelducks, Red-crested Pochards, Common Pochards, Goosanders and Black-necked Cranes, whereas, there were few Charadriidae and Scolopacidae, such as Common Redshanks (*Tringatotanus*), Common Greenshanks (*T. nebularia*) and Common Sandpipers (*T. hypoleucos*), as well as Laridae, such as Great Black-headed Gulls and Brown-headed Gulls.

Characteristics of the waterbird populations at different locations

Significant diversities among the waterbird populations at different locations were found in our surveys (Table 2). In general, waterbird populations at the Yarlung Zangbo valley were low in diversity. Because of the large populations of the Bar-headed

Goose, the waterbirds at Qushui, Linzhou and Rikaze were high in total numbers (10,000–20,000 individuals), and high in dominance, but low in evenness. Gongga, Linzhi and Duilongdeqing all adjacent to either Lhasa River or Niyang River, had relatively high waterbird diversities (these counties had relatively large numbers of Mallards, Northern Pintails and Common Sandpipers), however, their-numbers were low.

Large numbers of ducks inhabiting the Hutoushan and Kanzi reservoirs, such as the Mallards and Eurasian Teals, increased the species richness at Linzhou, however, a large population of Bar-headed Goose (19,000 individuals) induced the low diversity but high dominance there. Similar waterbird populations were observed in Rikaze. The dominant species in Lazi were the Bar-headed Goose, Ruddy Shelducks and Black-necked Cranes, while other species were in small numbers, therefore, both the diversity and the dominance there were low. The numbers of waterbird individuals at Dazi, Jiangzi, Bailang and Nanmulin exceeded 5,000 respectively, but the high numbers of the Bar-headed Goose decreased their diversity.

Characteristics of the Bar-headed Goose population and their habitat utilization

Our survey recorded 255 Bar-headed Goose flocks and the average flock size was 262.86±36.42 (1–6,350) individuals. The statistical results indicate that most of the Bar-headed Geese prefer group activities and a single individual was only recorded twice. There were 136 small flocks (flock size with 2–100 individuals; 23 large flocks (flock size with 401–1,000 individuals; 13 super-large flocks (size over 1,000 individuals. The largest flock of 6,350 individuals was sighted at a marsh near Rikaze.

Significant differences were found among the flocks of the Bar-headed Geese at different habitats (*Kruskal Wallis* test, χ^2=200.9, *df*=5，*P*=0.000). The flock sized from large to small were at marshes (871.26±267.52 individuals, *n*=23), natural waters (373.58±56.00 individuals, *n*=24) and farmlands, especially winter wheat fields, (41.34±30.48, *n*=139) (Table 3).

The habitats that the Bar-headed Goose utilized the most and least frequently were winter wheat fields (56.28%) and uncultivated farmlands (2.83%), respectively (Table 3).

Numbers and distribution of Black-necked Cranes

We recorded a total of 5,558 Black-necked Cranes in 2014. Lazi county had the highest count with 1,555 Black-necked Cranes, and other counties with high numbers include: Dazi (639), Nanmulin (598), Rikaze (572), Sajia (540), and Linzhou (395). There were no Black-necked Cranes recorded in Lhasa City, Duilongdeqing, Jiacha, Langkazi, Renbu and Nimu. In the valleys, the Yarlung Zangbo main valley had the highest number with 2730 Black-necked Cranes, while Lhasa River valley had 993, Pengbo valley and Xiabuqu Chu each had 395 and 393 birds.

Numbers and distribution of the Bar-head Geese

The survey of January 2009 recorded 45,681 Bar-headed Geese 10,160 at Linzhou, 9,380 at Rikaza (including Nanmulin), 5,216 at Jiangzi, 4,633 at Bailang and 4,982 at Lazi. The numbers of the Bar-headed Geese at the Rikaze region was 27,322, which was higher than that at the Shannan region (18,359) (Table 4).

The survey of January 2014 recorded 67,031 Bar-headed Geese in total and significant differences were found among different survey sites. Based on administrative divisions, locations with numbers of Bar-headed Geese from high to low were Linzhou (19,260), Rikaze (15,495), Qushui (4,755), Jiangzi (4,700), Dazi (4,108) and Bailang (4,055). The number of the Bar-headed Geese at the Rikaze region (34,014) was slightly higher than that at the Shannan region (33,017). The locations with large numbers of the Bar-headed Geese were Rikaze City, Jiangzi and Bailang ofthe Rikaze region, as well as Linzhou and Dazi of the Shannan region, whereas, none were observed in Milin, Jiacha and Renbu (Table 4). According to the survey results, in 2014, 6,692 and 4,658 individuals of the Bar-headed Goose increased at the Rikaze region and Shannan region from 2009, respectively.

Based on geographic divisions, over 10,000 Bar-headed Goose were recorded in three valleys. The valleys with numbers of individuals from high to low were the Nyang Chu valley (20,830), Pengbo valley (19,260), Yarlung Zangbo valley (16,911), Lhasa valley (6,541) and Danada valley (1,146), while other valleys each with populations of less than 100 individuals (Table 5. Figure 1)

DISCUSSION

The investigation Yang et al (2011) conducted at the Yarlung Zangbo valley mainly focused on numbers of bird species. 37 species of wintering and migratory

Table 1 Checklist of wintering waterbirds in the Yarlung Zangbo River valley, Tibet, China, in 2009 and 2004

Species No.	English name	Scientific name	Number (2014) (*n*)	Number (2009) (*n*)
	Podicipedidae			
1	Little Grebe	*Tachybapus ruficollis*	1	–
2	Great Crested Grebe	*Podiceps cristatus*	–	3
	Phalacrocoracidae			
3	Great Cormorant	*Phalacrocorax carbo*	62	33
	Ardeidae			
4	Black-crowned Night Heron	*Nycticorax nycticorax*	4	–
5	Little Egret	*Egretta garzetta*	1	2
6	Great Egret	*E.alba*	–	2
	Anatidae			
7	Greater White-fronted Goose	*Anser albifrons*	–	1
8	Greylag Goose	*A. anser*	–	1
9	Bar-headed Goose	*A. indicus*	67,031	56,646
10	Ruddy Shelduck	*Tadorna ferruginea*	17,513	12,628
11	Common Shelduck	*T. tadorna*	9	3
12	Eurasian Teal	*Anas crecca*	63	188
13	Mallard	*A. platyrhynchos*	1,458	1,599
14	Spot-billed Duck	*A. poecilorhyncha*	26	29
15	Eurasian Wigeon	*A. penelope*	–	257
16	Gadwall	*A. strepera*	113	714
17	Northern Pintail	*A. acuta*	191	294
18	Common Shoveler	*A. clypeata*	–	2
19	Red-crested Pochard	*Netta rufina*	1,230	11,587
20	Common Pochard	*Aythya ferina*	210	1525
21	Tufted Duck	*A. fuligula*	–	661
22	Common Goldeneye	*Bucephala clangula*	10	6
23	Goosander	*Mergus merganser*	1,105	414
	Gruidae			
24	Black-necked Crane	*Grus nigricollis*	5,558	3,657
25	Common Crane	*G. grus*	4	–
26	Demoiselle Crane	*G. virgo*	2	2
	Rallidae			
28	Common Coot	*Fulicaatra*	405	84
	Recurvirostridae			
29	Black-winged Stilt	*Himantopus himantopus*	–	1
	Ibidorhynchidae			
30	Ibisbill	*Ibidorhyncha struthersii*	1	–
	Charadriidae			
31	Northern Lapwing	*Vanellus vanellus*	–	10
	Scolopacidae			
32	Common Snipe	*Gallinago gallinago*	3	1
33	Common Redshank	*Tringa totanus*	6	15
34	Green Sandpiper	*T. ochropus*	7	6
35	Greenshank	*T. nebularia*	6	4
36	Common Sandpiper	*T. hypoleucos*	–	1
	Laridae			
37	Great Black-headed Gull	*Larus ichthyactus*	84	27
38	Brown-headed Gull	*L. brunnicephalus*	3	2
39	Common Black-headed Gull	*L. ridibundus*	–	2

–: Waterbird species were not recorded during the surveys.

Table 2 Waterbird communities at different counties in the Yarlung Zangbo River valley, Tibet, China, in 2014

Survey site by county	Number of species (*n*)	Number of individuals(*n*)	Diversity (*H*)	Dominance (*D*)	Evenness (*J*)
Lhasa	7	144	0.92	0.59	0.47
Duilongdeqing	13	1,563	1.68	0.25	0.65
Qushui	8	12,021	1.04	0.42	0.50
Dazi	9	5,452	0.87	0.59	0.40
Mozhugongka	6	467	1.21	0.37	0.68
Linzhou	10	22,549	0.50	0.75	0.22
Linzhi	6	901	1.48	0.25	0.83
Milin	5	77	1.10	0.41	0.68
Jiacha	1	2	–	–	–
Sangri	5	1,098	0.76	0.58	0.47
Naidong	8	2,183	0.89	0.56	0.43
Zhanang	5	426	1.01	0.43	0.63
Gongga	10	2,480	1.25	0.45	0.54
Langkazi	8	1,541	0.75	0.65	0.36
Jiangzi	3	5,584	0.46	0.73	0.42
Bailang	6	5,381	0.65	0.62	0.36
Rikaze	9	18,309	0.54	0.73	0.25
Nanmulin	7	5,820	0.93	0.51	0.48
Lazi	12	5,625	0.96	0.45	0.39
Xietongmen	4	1,794	0.59	0.67	0.43
Sajia	4	1,550	1.03	0.39	0.74
Renbu	1	5	–	–	–
Nimu	7	274	1.58	0.25	0.81

Table 3 Flock size of the Bar-headed Geese at different habitats in the Yarlung Zangbo River valley, Tibet, China, in 2014

Habitat types	Average flock size(*n*)	*SD*	Number of populations (*n*)
Winter wheat farmlands	41.34	30.48	139
Cultivated farmlands	136.20	15.67	35
Uncultivated farmlands	168.71	7.29	7
Grasslands	231.16	45.32	19
Natural waters	373.58	56.00	24
Marshes	871.26	267.52	23

birds in total inhabiting rivers, farmlands and marshes were reported. Our surveys of 2009 and 2014 found slightly more waterbird species than Yang et al (2011). The farmlands–include winter wheat fields, cultivated farmland and uncultivated farmland (the latter two are reaped highland barley fields) in the Yarlung Zangbo valley and are vital feeding sites of the Bar-headed Goose and Black-necked Cranes (Bishop et al, 2002). The winter wheat fields are an important proportion of the farmlands in the valley (Song et al, 1994) and wheat seeds are one of the major food resources of the Bar-headed Goose and Black-necked Cranes. To facilitate barley planting next spring, local farmers irrigate the cultivated farmlands; therefore, compared with the uncultivated farmlands, the cultivated farmlands are more frequently chosen by the Bar-headed Goose and Ruddy Shelducks. The reason the Bar-headed Goose prefer farmlands over marshes or natural waters is probably because they usually use marshes and natural waters for resting and roosting.

The Yarlung Zangbo valley is a vital wintering site for the endangered Black-necked Crane (Cangjue et al, 1994; Bishop & Li, 2012; Yu et al, 1993). From 1990 to 1993, Cangjue (1994) reported 3,041 and 3,910 Black-necked Cranes wintering in Tibet in 1991 and 1992, respectively. According to our surveys of 2009 and 2014, the numbers of the wintering populations in the Yarlung Zangbo valley have increased during the past two decades. We assume that two reasons induced the increase of population numbers of 2014 over 2009: (1) survey routes and observation sites used in the two

Table 4 Number of the Bar-headed Geese at different counties in the Yarlung Zangbo River valley, Tibet, China, in 2014

Survey site	Number of 2014(*n*)	Number of 2009*(*n*)	Survey site	Number of 2014(*n*)	Number of 2009* (*n*)
Lhasa	15	–	Gongga	1,621	2,774
Duilongdeqing	223	330	Langkazi	190	511
Qushui	4,755	2,017	Jiangzi	4,700	5,216
Dazi	4,108	355	Bailang	4,055	4,633
Mozhugongka	130	–	Rikaze	15,495	9,380
Linzhou	19,260	10,160	Nanmulin	3,997	0
Linzhi	302	–	Lazi	3,303	4,982
Milin	0	–	Xietongmen	1,443	1,468
Jiacha	0	–	Sajia	786	1,643
Sangri	802	–	Renbu	0	–
Naidong	1,579	1,300	Nimu	45	–
Zhanang	222	912	Total	67,031	45,681

–: Locations not covered in the surveys; 0: Data of the Black-necked Cranes at Nanmulin were included in data of Rikaze; *: Data from the survey results of National Bird Banding Center at the Yarlung Zangbo River, Tibet, China.

Table 5 Numbers of Bar-headed Geese at different wetlands in the Yarlung Zangbo River valley, Tibet, China, in 2014

Survey site	Yarlung Zangbo valley	Lhasa valley	Pengbo valley	Mozhu valley	Yalong valley	Zhanang valley	Niyang valley
Numbers(*n*)	16,911	6,541	19,260	130	521	186	302
Survey site	Xiabuqu	Nianchu	Requ	Xietongmen vallay	Danada vallay	Xiangqu	
Numbers(*n*)	683	20,830	211	91	1,146	219	

surveys of 2009 and 2014 were slightly different; (2) the actual numbers of the individuals of Black-necked Cranes increased. For example, the numbers of Black-necked Cranes recorded at Jiangzi, Bailang and Linzhou in 2014 were higher than those of 2009.

Song et al (1994) investigated the population numbers of the Bar-headed Goose at the Yarlung Zangbo valley during the winter of 1991 and found 10,081 wintering individuals in total. In the 1991 winter survey, the Rikaze region reported the highest numbers of individuals (4,465), and the second highest was Linzhou (2,300), while the numbers in other counties were less than 600. Our survey recorded 9,000 Bar-headed Geese more in Linzhou than that in 2009, indicating Linzhou has abundant food resources and a suitable natural environment. Since 2013, in Jiangzi and Bailang, arable land was widely used to cover farmlands. Because fresh earth covered the food (scattered grains) on the crop fields and the related human disturbance by truck loading and distributing the dirt increased, the numbers of the Bar-headed Geese decreased. In the long-term, however, we would expect the numbers of the Bar-headed Goose and Black-necked Cranes to recover or even increase once this earth adding project is done.

The Bar-headed Geese were the species with the highest mortality during the outbreak of avian influenza at the Qinghaihu Lake. The populations usually aggregate in wintering sites mixing with Ruddy Shelducks. There are over 10,000 Bar-headed Geese in the Yarlung Zangbo valley. Because the avian influenza virus can be transmitted among individuals either directly (e.g., through respiratory droplets) or indirectly (e.g., through excretion), the surveillance and prevention measures at some locations in this region with large concentrations of the Bar-headed Geese, such as Linzhou, Rikaza and Lazi, should be strengthened.

Due to religious belief, the local Tibetan residents would not hurt the Black-necked Cranes, Bar-headed Geese, Ruddy Shelducks, or other wildlife. It was reported, however, that some people from outside were poisoning birds at some of the areas with aggregations of Black-necked Cranes and Bar-headed Geese, e.g., incidents of poisoned Bar-headed Geese occurred at Linzhou.

Another potential threat of the birds' habitats is the cutting of trees and shrubs in some areas, such as Nanmulin. The cuttings have led to soil erosion and desertification locally in the valley. If these phenomena

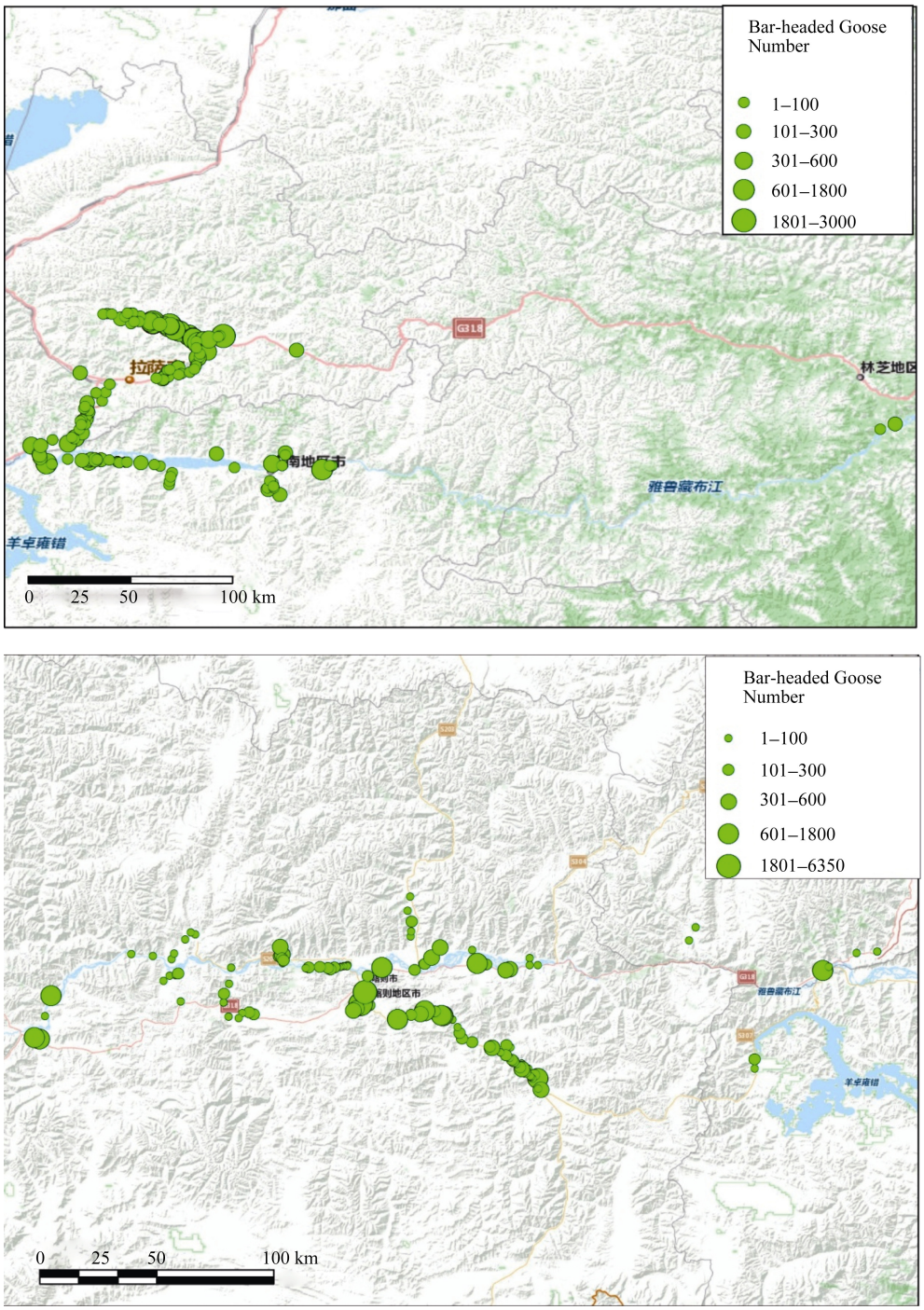

Figure 1 Population number and distribution of wintering Bar-headed Goose in the Yarlung Zangbo River valley, Tibet, China, in 2014
Above: east area; Below: west area.

continue to grow, adverse effects would soon show on the survival environments for both wild animals and humans.

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