

## Number and distribution of Black-necked Cranes wintering in Zhigatse Prefecture, Tibet

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**Abstract** We surveyed all known wintering areas of the Black-necked Crane (*Grus nigricollis*) in Zhigatse Prefecture of the Tibet Autonomous Region during three winters. Our surveys confirm that Zhigatse Prefecture is the most important wintering area for the species, accounting in some years for as much as 39% of the estimated world population. Counts ranged from a high of 4240 cranes in January 2007 to a low of 2636 in February 2009. Chick recruitment (chicks/100 cranes) ranged from 8.2 (January 2010) to 11.3 (January 2007). The highest concentration of cranes during all three surveys occurred on the 60 km stretch of the Yarlung Tsangpo (River) between Lhaze and Phuntsoling. To evaluate potential impacts of the Xietongmen Copper Mine, we monitored wintering crane numbers prior to mine installation in an intensive study area located between the Shab Chu Valley and the city of Zhigatse. Our surveys recorded on average  $820 \pm 83$  cranes (SE;  $n = 8$ ) in this area. With the installation of the mine at a location ~50 km west of Zhigatse, increased traffic and development on the north side of the Yarlung River will likely result in a shift in crane distribution away from the north side, to nearby suitable habitats. Based on our survey results, we recommend three areas hosting high numbers of cranes in the vicinity of the mine be added to the Yarlung Tsangpo Middle Reaches Black-necked Crane Nature Reserve. These areas are Nierixiong and Jiaqingze Villages in Nierixiong Xiang and the Shab Chu Valley.

**Keywords** *Grus nigricollis*, population, Tibet, Xietongmen, mining, conservation, recruitment, winter ecology

### Introduction

Black-necked Crane (*Grus nigricollis*), a Category I species in China, is the least known of all Chinese cranes. This species breeds across a vast area of the Tibetan Plateau from Ladakh north to Gansu. During winter,

however, Black-necked Cranes are concentrated in a handful of sites located in the Kingdom of Bhutan and in China's Tibet Autonomous Region, Yunnan and Guizhou provinces (Bishop, 1996; Li and Bishop, 1999). Based on counts at these winter sites, the world population of Black-necked Cranes is currently estimated at ~11000 birds (Bishop and Tsamchu, 2007).

Among the sites, the largest wintering populations of Black-necked Crane in China are found in the agricultural areas of the Yarlung Tsangpo (River) and its major tributaries in Zhigatse Prefecture of the Tibet Autono-

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mous Region (Bishop et al., 2000). In January 2007 during a survey of all known wintering areas in Tibet, Bishop and Tsamchu (2007) recorded the largest foraging flock (>300 cranes) while in the Zhigatse region. They found that most areas frequented by the cranes in this region are part of the 6143 km<sup>2</sup> Yarlung Tsangpo Middle Reaches Black-necked Crane Nature Reserve, a national level nature reserve established in 2003.

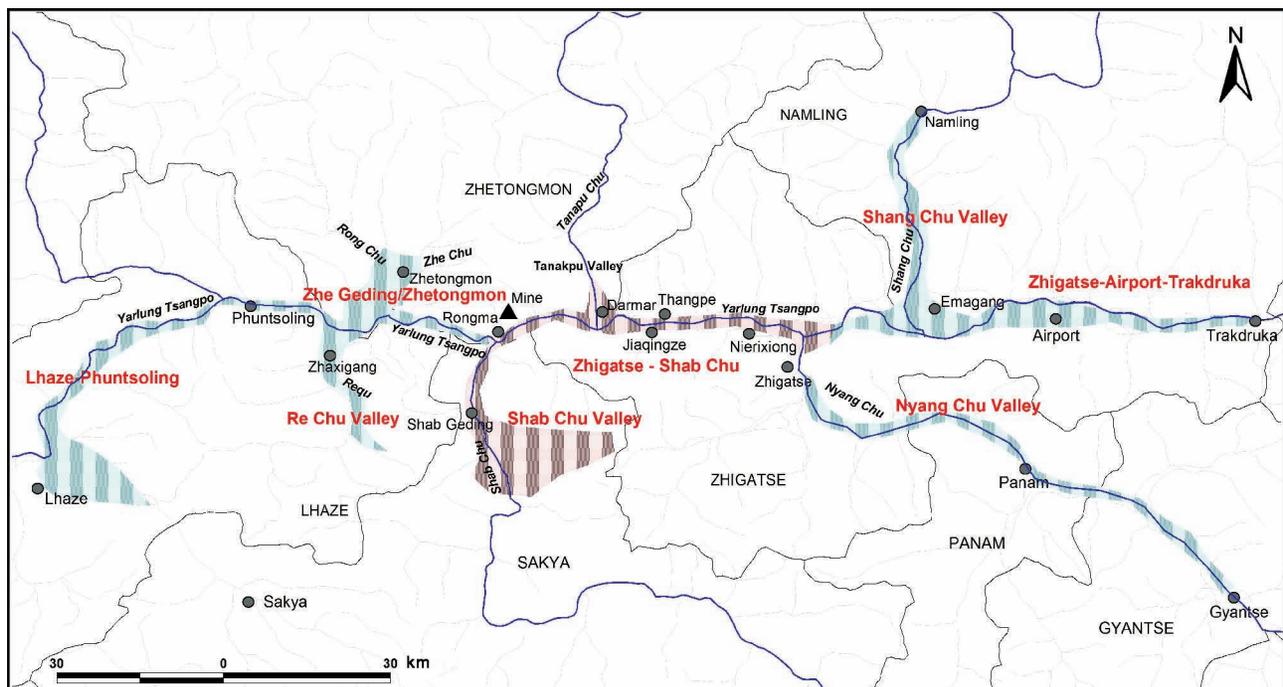
Similar to other parts of Tibet and the rest of China, the economy of Zhigatse Prefecture is developing rapidly. Mining is one sector that is beginning to grow in economic importance in the prefecture, in particular with the exploration and development of a porphyry copper-gold deposit, located ~50 km west of Zhigatse City. Known as the Xietongmen Copper Project, this mineral deposit borders the Yarlung Tsangpo and the Black-necked Crane Nature Reserve. The mine will require approximately 2000 employees during construction and 700 full-time employees during its projected 14 year operating life (Golder Associates, 2009).

Our study was designed to gather baseline data prior to an anticipated 2012 construction start-up for the Xietongmen Copper Project. During January 2007 and

throughout the 2008–2009 and 2009–2010 winters, the International Crane Foundation and Tibet Plateau Institute of Biology monitored Black-necked Crane populations in Zhigatse Prefecture. Our study included the following objectives: 1) to determine the abundance and distribution of cranes during the winter season, and 2) to provide recommendations for mitigating potential mine impacts to cranes and for enhancing conservation for cranes within the Zhigatse Prefecture portions of the Yarlung Tsangpo River Middle Reaches Black-necked Crane Nature Reserve.

### Study area

Our study was conducted in Zhigatse Prefecture around the Yarlung Tsangpo (hereafter referred to as the Yarlung River) Valley and its major tributaries. Our primary survey area stretched from Lhaze (29°10'N, 87°33'E) east to Trakdruka (29°20'N, 89°38'E; Fig. 1). We divided the prefecture into eight areas (Fig. 1) where cranes have been documented in the past and classified the areas into two categories: 1) in and around the Xietongmen Copper Project (hereafter referred to as the



**Fig. 1** Survey areas of wintering Black-necked Crane in Zhigatse Prefecture. Winter 2008–2009. Xietongmen Mine study area is shaded purple.

Xietongmen Mine study area); and 2) all other areas. Except for Xietongmen (Pinyin; Tibetan = Zhetongmon), throughout this paper we use the transliterated Tibetan place names.

Winters are cool and dry in south-central Tibet. Average monthly minimum and maximum temperatures at Zhigatse in January, the coldest month, are  $-12.6^{\circ}\text{C}$  and  $6.2^{\circ}\text{C}$ , respectively. The study area has a continental monsoon climate and an average annual precipitation of 430 mm (China Weather cited in <http://en.wikipedia.org/wiki/Shigatse>). The period from October to April is the dry season, characterized by low precipitation (< 3% of annual). Localized snowfall occurs infrequently and melts quickly. High winds occur regularly throughout south-central Tibet from January to April.

Agriculture is the dominant land use on the Black-necked Crane wintering areas with most lands managed for spring barley, spring wheat and winter wheat production. Other crops include potatoes, broad beans and oil seed rape with broad beans typically interplanted with spring wheat. While mechanized equipment is now used throughout this prefecture, in many areas, fields are tilled and planted using livestock (cattle and dzo, a hybrid yak-cow) and harvested with hand-held scythes. Crops are harvested in early autumn, August to September. Plowing takes place either immediately after harvest or in early spring. Irrigation is used extensively during the growing season, from April to September and to a lesser extent in the winter. Grazing is the second dominant land use with sheep and goats the most important livestock.

## Methods

The Black-necked Crane arrives in south-central Tibet from mid to late October and stays through April. We conducted eight crane surveys in the Xietongmen Mine study area including one survey during the 2006–2007 winter (10–12 January 2007), four surveys during the 2008–2009 winter (14–17 December 2008, 8–10 January 2009, 12–15 February 2009 and 31 March – 3 April 2009) and three surveys the following 2009–2010 winter (17–19 December 2009, 15–18 January 2010 and 2–4 March 2010). All other known crane areas in Zhigatse

Prefecture were surveyed once each winter: 8–12 January 2007, 9–19 February 2009 and 15–20 January 2010.

We surveyed wintering crane populations by driving a car along primary roads through each valley and their major tributaries. A team of two to three people conducted each survey. We stopped to scan with a 22 $\times$  telescope every 1–2 km in suitable foraging and roosting habitats (agricultural fields and riverine areas with secondary channels; Bishop et al., 1998), from any major vantage point, or whenever a flock was observed. Where visibility to the river was limited, we used secondary roads or climbed to vantage points. In some areas, one side of a valley was not accessible by car.

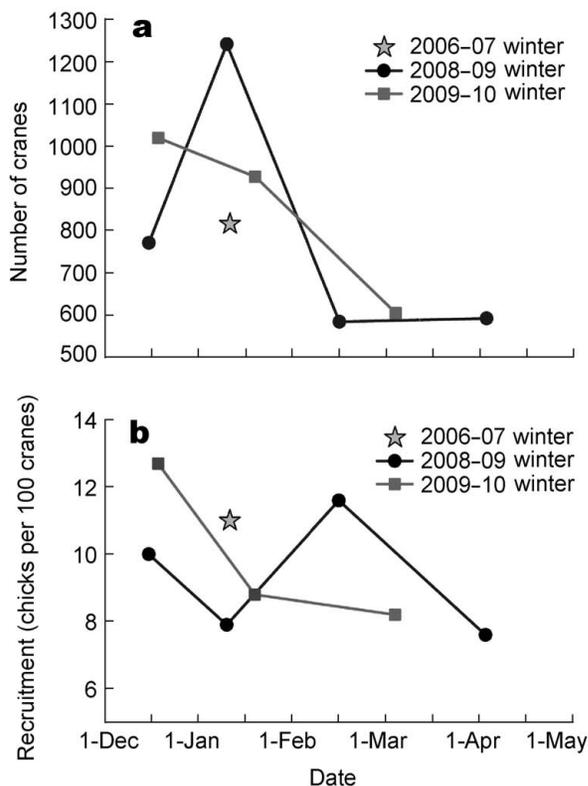
Whenever cranes were observed, information collected included date, time, GPS location, flock size and the number of juvenile-plumaged cranes. Care was taken not to double count flocks and when there was any doubt, the more conservative estimate was used. For each survey we determined a population estimate for each geographical area based on the number of cranes observed. In areas surveyed more than once, the higher count was used. Juvenile recruitment was determined only from flocks where all chicks could be identified. Recruitment was defined as frequency of juveniles/100 cranes (adults and juveniles).

## Results

### Xietongmen Mine study area surveys

The total number of cranes in the Xietongmen Mine study area averaged  $820 \pm 83$  (SE) for the eight surveys. During the two winters with multiple surveys, peak numbers were recorded in January 2009 ( $n = 1242$ ) and December 2009 ( $n = 1020$ ; Fig. 2a). In both winters, counts decreased to  $\sim 600$  cranes during February and March. Across the eight surveys, chick recruitment ranged from a low of 7.9 chicks/100 cranes in January 2009 to a high of 12.7 chicks/100 cranes in December 2009. Recruitment count patterns were not consistent within winters. During the 2008–2009 winter, observed chick recruitment was highest during the February 2009 survey while during the following winter, recruitment was highest during the December 2009 survey (Fig. 2b).

Cranes were concentrated in five locales: 1) Nierixiong Village, 2) Jiaqingze Village (both villages in Nierixiong Xiang, south side of the Yarlung River), 3) Thangpe (north side of the Yarlung River and across from Jiaqingze), 4) Darmar (Tanakpu Chu Valley), and 5) Shab Chu Valley (Fig. 3). Among the five areas, Nierixiong Village and the Shab Chu Valley had the most cranes. All four locales on the Yarlung River are located in wide reaches of the river and include large areas of farmland. The Shab Chu Valley is a large valley with a number of sizable wetlands and farmlands, providing good crane habitats. Within a radius of about 10 km around the Xietongmen Copper Mine, relatively small numbers of Black-necked Cranes were observed both winters, possibly due to the Yarlung Valley being narrow in this area. However, a large flock of 184 birds was observed on 16 January 2010 at the mouth of the Shab Chu River, approximately 4 km west of the mine site.



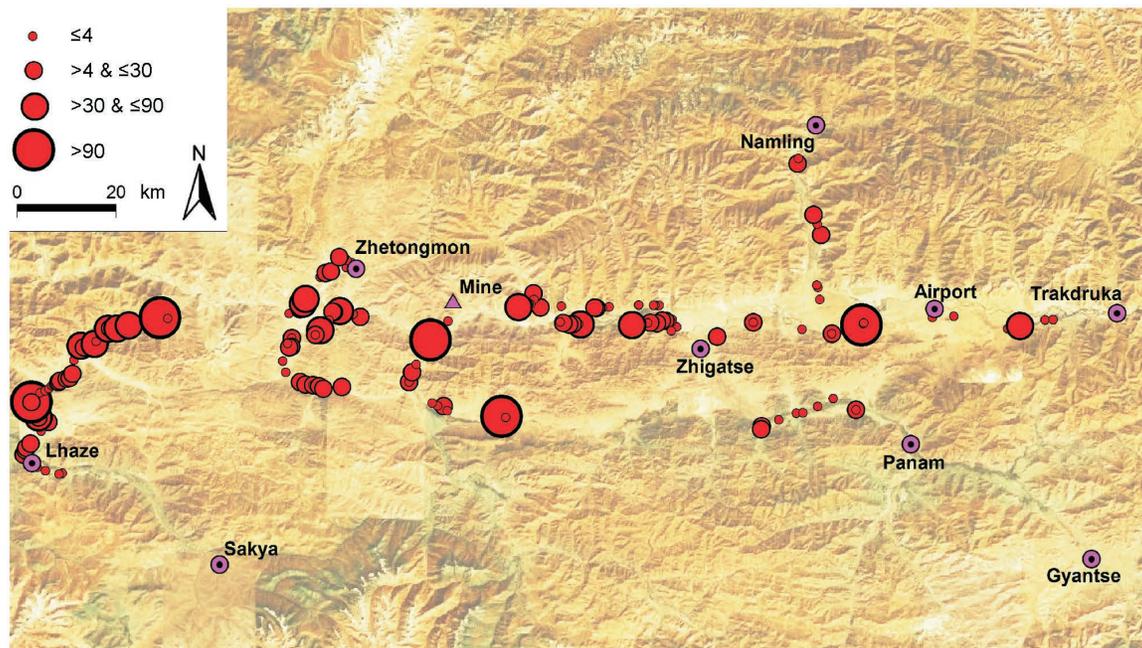
**Fig. 2** Black-necked Crane survey counts in Xietongmen Copper-Gold Mine study area, winter seasons 2006–2007 ( $n = 1$ ), 2008–2009 ( $n = 4$ ), and 2009–2010 ( $n = 3$ ). (a) Number of Black-necked Cranes and (b) chick recruitment (number of chicks/100 cranes).

### Zhigatse Prefecture surveys

The highest number of cranes observed during surveys of the all known crane wintering areas in Zhigatse Prefecture, including the Xietongmen Mine study area, occurred during the January 2007 survey when 4240 cranes were recorded. Markedly lower counts of 2636 and 2867 cranes were recorded during the February 2009 and January 2010 surveys, respectively (Table 1). Chick recruitment from all areas combined was 11.3 chicks/100 cranes ( $n = 3228$ ) during the January 2007 survey, 9.9 chicks/100 cranes ( $n = 2080$ ) during the February 2009 survey and 8.2 chicks/100 cranes ( $n = 2740$ ) during the January 2010 survey. Excluding areas with low counts (<100 cranes), the highest chick recruitment during the January 2007 survey, 13.9 chicks/100 cranes ( $n = 216$ ) was recorded at the Zhe Geding/Zhetongmon Valley while the lowest recruitment (8.7 chicks/100 cranes,  $n = 652$ ) occurred at the Shang Chu Valley. During both the 2008–2009 and 2009–2010 winter surveys, highest chick recruitment was observed in the Xietongmen Mine study area: 13.4 chicks/100 cranes at the Shab Chu Valley ( $n = 149$ ) in February 2009 and 11.0 chicks/100 cranes along the Yarlung River from the Dongkar Bridge to Shab Chu ( $n = 556$ ) during the January 2010 survey. Lowest chick recruitment (6.4 chicks/100 cranes) was recorded both winters at the Re Chu Valley (Fig. 1; February 2009,  $n = 109$  cranes; January 2010,  $n = 311$  cranes).

**Table 1** Number of Black-necked Cranes wintering in Zhigatse Prefecture in January 2007, February 2009 and January 2010

Area	Jan 2007	Feb 2009	Jan 2010
Yarlung River: Zhigatse Dongkar Bridge to Shab Chu	550	435	515
Shab Chu Valley	266	149	413
Zhe Geding/Zhetongmon	238	186	193
Re Chu Valley	426	434	335
Yarlung River: Zhigatse to Trakdruka	340	285	281
Shang Chu Valley	652	482	58
Lhaze to Phuntsoling	1604	633	1030
Nyang Chu Valley	164	32	42
Total	4240	2636	2867



**Fig. 3** Distribution of Black-necked Cranes wintering in Zhigatse Prefecture, January 2010

The largest concentration of cranes in the Zhigatse Prefecture during all three surveys occurred between Lhaze (Chushar) and Phuntsoling (Table 1; Fig. 3). During each winter survey, we recorded 1 or 2 flocks with >90 birds (maximum size = 164 cranes) and from 6–14 medium-sized flocks (30–90 cranes) in this area. Elsewhere, we recorded flocks numbering >90 cranes during two winters at Shang Chu Valley/Emagang and at the Re Chu Valley, as well as during one winter survey each at Nierixiong, Bianxiong and Jiangdang Xiang (all in Zhigatse Municipality), Chexiu Xiang and near Shab Geding (both in the Shab Chu Valley; Fig. 3). The largest flock observed during surveys occurred at Emagang during the January 2007 count when 330 cranes were observed foraging in a potato field.

## Discussion

Our surveys confirm that Zhigatse Prefecture is the most important wintering area for Black-necked Cranes. Based on the January 2007 survey results, cranes in Zhigatse Prefecture accounted for 39% of the estimated world population. The only comparable population occurs in Guizhou and Yunnan provinces

where ~3600 cranes overwinter (Li and Yang, 2005). Cranes there, however, are scattered over a much larger area — from the Caohai Lake area in western Guizhou to Napahai in northwestern Yunnan.

Comparing our three counts of all cranes in Zhigatse Prefecture, the January 2007 count was unusually large (Table 1). In particular, this 2007 count found as many as 971 and 574 more cranes in the Lhaze to Phuntsoling area than during the 2009 and 2010 surveys, respectively. These count differences suggest either a possible decline in Zhigatse Prefecture's Black-necked Crane population since the 2006–2007 winter or overlooked flocks during prefecture counts. Recruitment frequencies support the idea that count differences more likely stemmed from overlooked flocks. Frequencies in Zhigatse Prefecture during our three years of surveys ranged from 8.2–11.3 chicks/100 cranes. Among populations of the well-studied Sandhill Crane (*Grus canadensis*) in North America, ~6 chicks/100 cranes approximates the lowest documented mortality rates (Drewien et al., 1995), suggesting that the population in Zhigatse Prefecture is stable, if not increasing. Long-term monitoring of Black-necked Cranes will be critical to obtain an accurate picture of the population trend.

Within Zhigatse Prefecture, the highest crane concentrations were consistently found along the Yarlung River Valley between Lhaze and Phuntsoling. This ~60 km stretch of river is heavily braided with small and large channels and slow-moving streams. Except around Lhaze, the valley is narrow (1–3 km wide) and relatively isolated with few villages and unpaved roads running on both sides of the river. We suggest that the high number of wintering cranes may result from the close proximity of roosting habitat (riverine areas with secondary channels), sufficient crop fields and low human disturbance due to both the relative isolation of the valley and an agrarian culture highly tolerant of cranes and geese (Bishop et al., 1998).

In contrast to the Lhaze-Phuntsoling area, the lowest number of cranes in Zhigatse Prefecture consistently occurred along the 86 km survey route along the Nyang River Valley, between Gyantse and Zhigatse. No cranes were observed during any survey of the ~40 km between Gyantse and Gadong (Panam County), even though historically Black-necked Cranes were common around Gyantse (Ludlow, 1928). Interestingly, this same area remains an important wintering ground for 3000–5000 Bar-headed Geese (*Anser indicus*; Bishop et al., 1997; Bishop and Tsamchu, unpublished data), a species that often overwinters in the same habitats of Tibet as the Black-necked Crane.

The Nyang River was channelized in the early 1980s, creating more than 1300 ha of new farmland and 2000 ha of woodland. In addition, 1300 ha of existing farmland are now flood-free (Anonymous, 2009). The Nyang watershed since then has become the largest crop production region in Tibet. The river now is confined by dikes on both sides and is less than 40 m wide. A previous study of crane habitat use along the Yarlung River by Zhigatse found that riverine habitats (within 5 m of the river and floodplain pastures) were the most frequently used diurnal habitats and that cranes tended to shift to riverine habitats during afternoon hours for resting (Bishop et al., 1998). We suggest that despite the abundance of suitable foraging habitat along the Nyang, few cranes winter in this productive valley because of the lack of suitable diurnal and nocturnal roosting habitats.

In the Xietongmen Mine study area, we documented that crane numbers dropped as the season progressed during the two winters of multiple surveys. Nevertheless, the overall counts for Zhigatse Prefecture for 2008–2009 and 2009–2010 were similar, implying that the variation in the number of cranes within the Xietongmen Mine study area were due to cranes moving to other areas of Zhigatse Prefecture. Within the Xietongmen Mine study area, our results indicate that along the Yarlung River crane distribution was affected by proximity to paved roads. The primary road on the north side of the Yarlung is provincial highway S204, a wide, well-maintained and paved thoroughfare with a high traffic volume. We observed few small flocks (<4 individuals) and no large flocks (>30 cranes) within 100 m of this road. Instead, cranes, including larger flocks, were more likely to be found on the south side of the Yarlung River (*cf.* Fig. 3) and within 100 m of the primary access road, a dirt road characterized by very little traffic (Li et al., unpublished data). With the projected increase in vehicle traffic during the installation and operation of the Xietongmen Mine, we suggest that the number of cranes on the north side will decrease as cranes shift to other areas with less human disturbance.

### Management recommendations

In the Xietongmen Mine study area, Nierixiong Village, Jiaqingze Village, Thangpe, the Tanakpu Chu Valley around Darmar and the Shab Chu Valley are the five most important areas for the wintering Black-necked Cranes. Among these five areas, Thangpe and the Tanakpu Chu Valley will most likely feel the greatest impact from the Xietongmen Mine project, because they are located on the transportation corridor between Zhigatse and the mine. Based on the map prepared by Liu (2007), the remaining three areas (Nierixiong Village, Jiaqingze Village and Shab Chu Valley) are currently not included in either the core or buffer areas of the Yarlung Tsangpo Middle Reaches Black-necked Crane National Nature Reserve. We recommend that these three areas be included in the core area of the nature reserve as part of any future boundary adjustment. Similarly, the Shang Chu Valley, including Emagang, is currently out-

side of the nature reserve boundary. The large number of cranes wintering in and around the Shang Chu Valley would benefit, should this area be included as part of the Black-necked Crane nature reserve.

In the area between Zhigatse and the Xietongmen Mine, the installation of distribution power lines is expected to increase dramatically in order to satisfy the energy needs of the mine as well as other economic development projects in the area. Power line collisions by Black-necked Cranes, as well as other waterbirds such as the Bar-headed Goose, will become more frequent and could become an important source of mortality, especially when power lines are sited near important roost and foraging areas. We recommend that mitigation of existing power lines and future power line installations include marking devices (flight diverters) to reduce collisions by increasing the visibility of the power lines (Li et al., 2011).

In conclusion, the river valleys of Zhigatse Prefecture provide critical habitat for a substantial portion of the global Black-necked Crane population. To conserve this critical population amidst China's rapid economic development, we recommend that future efforts concentrate on regularly monitoring both the cranes and the farming practices that sustain them.

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## 西藏日喀则地区越冬黑颈鹤的数量和分布

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**摘要:** 我们在西藏自治区日喀则地区越冬的黑颈鹤 (*Grus nigricollis*) 进行了三个冬季的数量调查, 结果确认日喀则地区是黑颈鹤最为重要的越冬地。在一些年份, 这里越冬的黑颈鹤可占其世界种群的 39%。计数的最高数量为 2007 年 1 月份的 4240 只, 最低为 2009 年 2 月的 2636 只。幼鹤新增率 (100 只鹤类中幼鹤的数量) 最低为 2010 年 1 月的 8.2, 最高为 2007 年 1 月份的 11.3。在 3 个冬季, 黑颈鹤分布最为集中的是拉孜至彭措林之间 60 km 长的雅鲁藏布江河谷地带。为了评估距日喀则市西约 50 km 的谢通门铜矿对黑颈鹤带来的潜在影响, 我们在铜矿投产前对日喀则市和下布曲河谷之间的研究区重点进行了监测, 在这个研究区记录到  $820 \pm 83$  只鹤 (SE;  $n = 8$ )。随着谢通门铜矿渐趋开工, 雅鲁藏布江北岸的交通和和经济将会快速发展, 由此极有可能导致北岸黑颈鹤分布区的移位, 使得黑颈鹤离开北岸到附近其它适宜栖息的地方。基于我们调查的结果, 建议把矿区附近的黑颈鹤数量集中的 3 个地区 (包括聂日雄乡的聂日雄和甲庆则村以及下布曲河谷) 纳入到雅鲁藏布江中游河谷黑颈鹤国家级保护区范围内。

**关键词:** *Grus nigricollis*, 种群, 西藏, 谢通门, 采矿, 自然保护, 幼鹤新增率, 越冬生态