

Power line strikes by Black-necked Cranes and Bar-headed Geese in Tibet Autonomous Region

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Abstract We investigated collisions with power lines by Black-necked Cranes (*Grus nigricollis*) and Bar-headed Geese (*Anser indicus*) along the Yarlung Tsangpo River in the Tibet Autonomous Region during two winters. Three segments of a 35 kV transmission line were surveyed each winter for injured and dead birds. Injured birds disappeared within five days of their initial detection; most dead birds encountered had been scavenged. We recorded two dead geese on transects and two injured geese and two dead cranes adjacent to transects. We found a higher incidence of bird strikes along power line segments close to roosting and foraging areas. We recommend that power lines, new or old, located in the flight path from nocturnal roosts, near important foraging areas or crossing the mouths of important agricultural valleys should be marked with colored and/or reflecting devices that have been proven to reduce crane and goose collisions.

Keywords *Grus nigricollis*, *Anser indicus*, power line collision, marking devices, Tibet

Introduction

Collision with overhead power lines has become one of the leading causes of mortality to populations of large terrestrial birds (Smallie, 2008). The highest risk species are bustards, as well as various waterbirds such as cranes, storks and flamingos (Fiedler and Wissner, 1980; Ledger et al., 1993; Bevanger, 1998; Janss, 2000). These kinds of birds have limited maneuverability in the air and have difficulty making swift, evasive actions to avoid colliding with power lines (Smallie, 2008).

In 2008 we initiated the first power line surveys for bird strikes in China. Our objective was to assess collision mortality in Black-necked Cranes (*Grus nigricollis*) and Bar-headed Geese (*Anser indicus*). With a world population estimated at about 11000, the Black-necked Crane is

listed as vulnerable in the IUCN's Red Book (BirdLife International, 2009). This crane breeds on the Qinghai-Tibet Plateau and winters on the Qinghai-Tibet and Yunnan-Guizhou Plateaus. While currently not a species of immediate concern with respect to conservation, the Bar-headed Goose is often found in the same breeding and wintering habitats as the Black-necked Crane (Bishop et al., 2000).

The largest wintering population of Black-necked Cranes and Bar-headed Geese in China occurs around the Yarlung Tsangpo (a river) and its major tributaries in Zhigatse Prefecture of the Tibet Autonomous Region (Bishop et al., 1997, 2000; Bishop and Tsamchu, 2007). Similar to other parts of Tibet and the rest of China, this area is rapidly developing and demand for electric power is high. With plans to increase transmission capability for this region in the near future, bird collisions with power lines are likely to increase. We present here our results from power line surveys for crane and goose strikes conducted during two winters along the Yarlung Tsangpo in Zhigatse Prefecture. We also provide recommendations for mitigating the impact of power lines and for enhancing conservation for cranes, geese and other birds in China.

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Study area and methods

Our surveys of power lines took place in Zhisgatse Prefecture along a 35 km-section of the Yarlung Tsangpo valley from Dongkar Bridge near the city of Zhisgatse west to the Tanakpu Chu valley (Fig. 1). In the wider portions of the valley and the major side valleys, barley, wheat and to a lesser extent vegetables such as potatoes and rape seed are the major crops. Cranes and geese forage on the harvested and winter crop (primarily winter wheat) fields throughout the day, flying to and from the river for both diurnal and nocturnal roosting (Bishop et al. 1997, 1998). Mid-winter counts in January 2009 and 2010 each recorded about 600 Black-necked Cranes and 1500 Bar-headed Geese in the area between the Dongkar Bridge and the mouth of the Shab Chu (Bishop et al., unpublished data).

Currently, one 35 kV transmission power line is situated in the study area. From Zhisgatse City, the power line goes north and crosses the Yarlung Tsangpo, parallel and adjacent to the Dongkar Bridge. The transmission line then continues west, veering north to a power transmission station in Tanakpu Valley and then south out of this valley before continuing west towards Zhetongmen. Branching off from and often parallel to the 35 kV power line are many 10 kV distribution lines from which additional, low-voltage distribution lines branch off to villages. Most support poles are about 15 m high and consist of two parallel wires strung ~1.5 m apart. Distance between support

poles is 50–100 m depending on location and land configuration. In our study area, only small sections of the 35 kV power line have ground wires, the topmost and non-conducting wire that is used to minimize power outages caused by lightning strikes.

During each of the two winters, we established and surveyed three transects along the 35 kV power line. Each transect was ~4 km long (Fig. 1). Due to logistical constraints, the Dongkar Bridge transect was not continuous but instead was located on the south and north sides of the river for a total of ~4 km. For our surveys, transects were searched in the morning for dead or injured birds by two observers walking zig-zag under the power line. Using a support pole as the transect center, each observer surveyed a 30 m strip. When a crane or goose was encountered, the type of injury and condition was assessed and recorded along with the location and the presence or absence of ground wires. We also interviewed local farmers and government employees about power line strikes by cranes and geese. Whenever possible, we visited sites identified as having had a recent strike. In addition, to understand the role of weather in power line strikes better, we examined wind data from the closest weather station (~12 km west of Tanakpu Valley) for the 2008/09 and 2009/10 winters.

In the 2009/10 winter, we opportunistically recorded flight responses of cranes and geese to power lines observed while either conducting the power line transects or surveying the habitat the cranes use. Flight response data

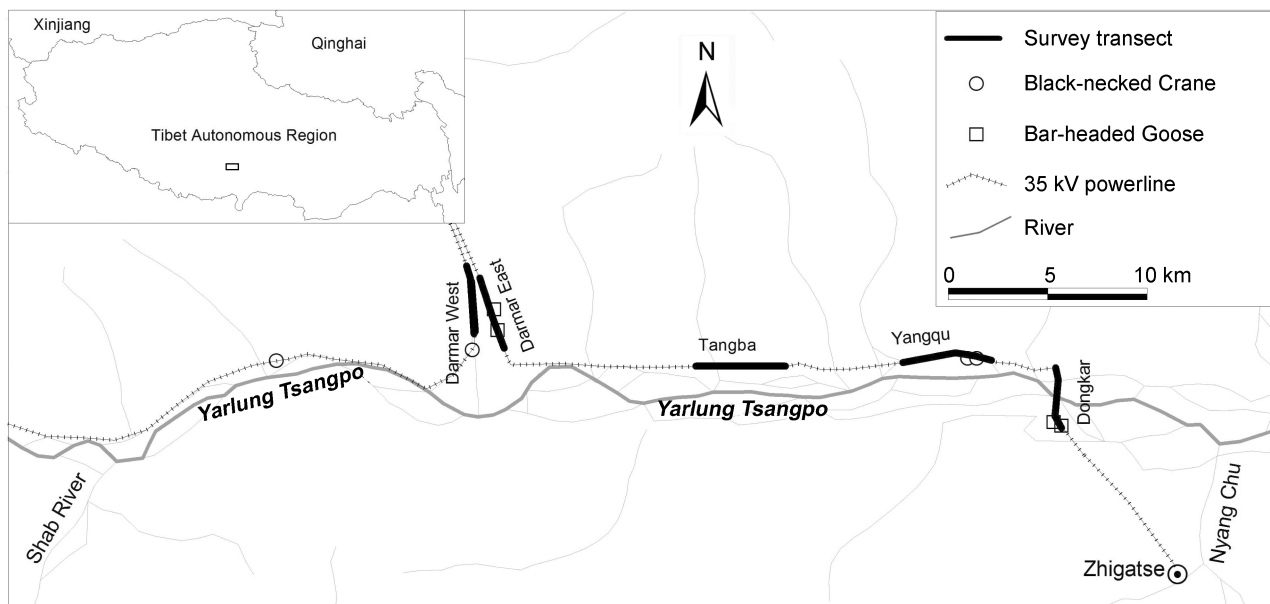


Fig. 1 Location of injured/dead birds along Yarlung Tsangpo River. Two cranes, one injured and one dead, were located in the general study area.

recorded included species, flock size and behavior (avoidance, altitude flown above or altitude flown below lines).

Results

We conducted power line surveys between 21 January – 9 February 2009 and 16 December 2009 – 8 January 2010. In total, we recorded on transects two dead geese, both on the Dongkar transect and in year 2. Parallel to, but outside of the 60 m transect strip, we recorded an additional two dead cranes, both in year 1 (Table 1). Distance from the center of the power line to carcasses ranged from 20–48 m. Additionally, local sources informed us and led us to a dead crane < 80 m from a powerline located ~7 km west of the Darmar West transect. We recorded three injured birds, all near the Darmar East transect. These included two injured geese observed 40 and 200 m, respectively, from the power line transect and an injured crane < 0.5 km from the power line. Both injured geese were observed for 2–3 days and the injured crane for five days after which they disappeared. In all, we documented broken wings in two of the three crane mortalities and the one injured crane. Of the two injured Bar-headed Geese, we observed a broken wing and a broken leg, respectively. Carcasses of

Table 1 Survey results for 35 kV powerlines by transect and year. Year 1 = 21 January to 9 February 2009 and year 2 = 16 December 2009 to 8 January 2010). Transect width = 60 m. BHG = Bar-headed Goose; BNC = Black-necked Crane.

Powerline transect	Surveys	On transect		Off transect	
		Injured	Dead	Injured	Dead
Year 1					
Darmar East	10	0	0	2 BHG ^a	
Tangba	10	0	0		
Yangqu	8	0	0		2 BNC ^b
Year 2					
Darmar West	17	0	0		
Dongkar	11		2 BHG		
Yangqu	9	0	0		

^a one goose 10 m and one goose 130 m from transect edge;

^b both cranes together and 18 m from transect edge.

one crane and two geese had been scavenged precluding an assessment of injuries.

We observed a total of 151 cranes and 1982 geese in flight approaching the power lines in the 2009/10 winter. Most cranes and geese flew over power lines that were encountered while in flight (Fig. 2). At the Darmar West transect in Tanakpu Valley, 85% of all cranes (*n* = 151)

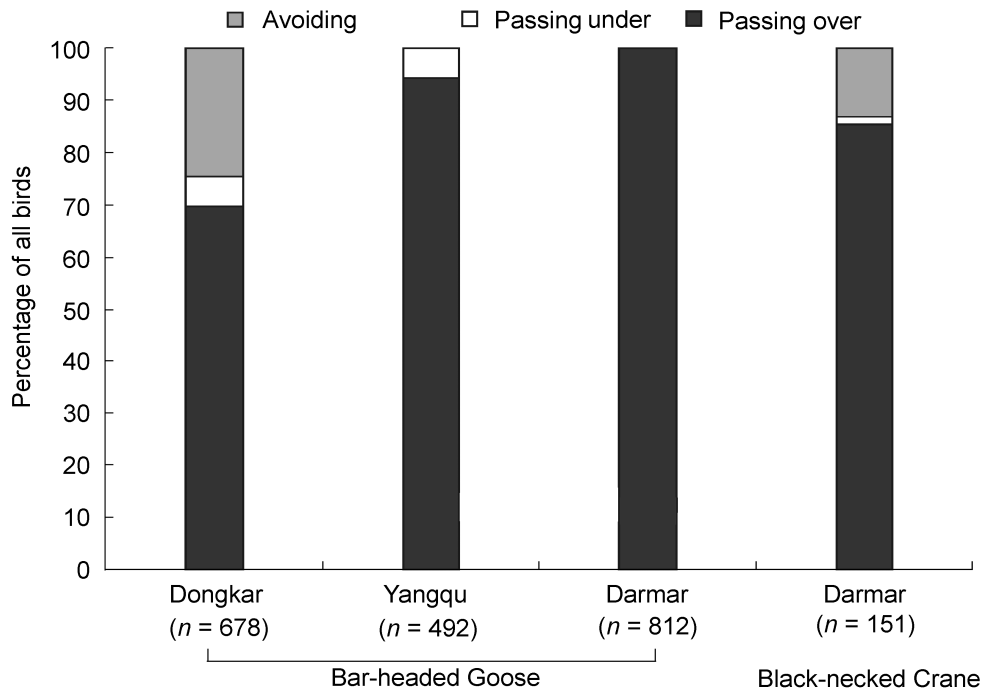


Fig. 2 Flight reactions of cranes and geese to powerlines, by transect: 16 December 2009 – 8 January 2010. No cranes were observed flying near powerlines at Dongkar and Yangqu.

and 100% of all geese ($n = 812$) flew over power lines. At Yangqu and Dongkar transects, 94% and 70%, respectively, of all geese (Yangqu, $n = 492$; Dongkar, $n = 678$) flew over power lines; however, no observations were recorded of cranes in flight at these transects.

Discussion

Our results show that power lines are an important source of injuries and mortality for both Black-necked Cranes and Bar-headed Geese. Based on either injuries and/or proximity to the power line, all crane and goose mortalities recorded, as well as the one injured crane and two injured geese observed, were likely caused by power line strikes. Two of the geese and one crane carcass, located on and near transects had been scavenged, suggesting that the power line strikes had occurred weeks to months earlier. However, we believe that we detected the two injured geese and one injured crane almost immediately after their injuries. At the same time, the rapid disappearance of all three injured birds shortly after their detections suggests that injured birds quickly die as a result of predation or from internal injuries.

Inclement weather can affect the likelihood of bird strikes (Brown et al., 1987; Brown and Drewien, 1995). For example, at Dashanbao Nature Reserve in northeastern Yunnan, six Black-necked Cranes were killed as a result of power line strikes. All strikes occurred when fog persisted over a period of several days (Kong, 2008). While low-lying fog sometimes occurs along the Yarlung Tsangpo, it rarely persists with the onset of daylight. More frequently, inclement winter weather consists of high winds, gusts and dust storms along the Yarlung Tsangpo (Table 2), especially during late winter. In our study area, daily maximum wind speeds almost always occur in the afternoons between 14:00 and 19:00 hours. From late February through March, instant extreme winds with a Beaufort scale wind force ≥ 8 (> 17.2 m/s) occur almost daily. We found that cranes and geese tended not to fly during sustained high

winds and dust storms unless they were disturbed. While we could not link avian mortality to wind factors due to our small sample size, we suggest additional research be conducted to determine the effect of high winds and wind gusts on crane and goose power line strikes, especially during the late winter period.

Studies in the U.S.A. have found an increased incidence of power line collisions by Sandhill Cranes (*G. canadensis*) and Canada Geese (*Branta canadensis*) associated with proximity to feeding and roosting areas (Brown et al., 1987; Brown and Drewien, 1995). Our results suggest a similar relationship to power line strikes. We observed no injured birds nor did we discover any mortality at Tangba, while all other transects had at least one injury or mortality. However, no diurnal or nocturnal roost occurred in the vicinity of Tangba for either cranes or geese whereas the four other power line transects were all within 1–2 km of a roost site and on the flight path to the farm fields.

Flight paths of birds to concentration areas such as roost sites and foraging areas are affected by topographic features (Welty, 1962; Faanes, 1987). Similarly, the location of the power line relative to the mountains also affects bird strikes. The Darmar East transect in the Tanakpu Chu Valley had the largest number of injuries. The Darmar East and West power lines run north-south to and from a power station located near the head of the valley. Darmar East is sited away from the edge of the mountains, towards the center of the valley. The Tanakpu Valley is a relatively small side valley of the Yarlung Tsangpo. This valley is an important agriculture area, however, and as a result attracts large numbers of cranes (maximum = 200) and geese (maximum = 700). The combination of a small valley and two large, 35 kV power lines most likely contributed to the high numbers of injuries observed in this area.

We most likely underestimated mortalities and injuries around the Dongkar Bridge because our transect survey did not cover the power line where it crosses the river. Several hundred geese roost in the river near the bridge and cross this power line to fly southeast to the Nyang River Valley to forage during the day. Bird strikes would tend to

Table 2 Daily wind speed (km/hr) for the 2008/09 and 2009/10 winters (1 October to 31 March). Wind data recorded continuously once every hour for 10 min, except for instant maximum speed. Xietongmen Project weather station, Zhigatse Prefecture.

Statistics	2008/09 winter			2009/10 winter		
	Speed	Maximum speed	Instant maximum speed	Speed	Maximum speed	Instant maximum speed
Average (STD)	9.27 (2.45)	27.33 (6.42)	52.96 (16.00)	9.38 (2.41)	27.52 (6.79)	54.22 (16.03)
Maximum	18.35	41.02	98.59	17.99	46.77	103.26
Minimum	4.68	10.80	13.31	4.68	11.88	19.42

fall into the river and may not have been noticed. In addition, Dongkar's 35 kV power line is the only section along the 35 km stretch of river with ground wires. Power lines with ground wires pose more danger to flying birds because ground wires are the topmost wire and are thinner in diameter than electric transmission wires, making them less visible (Brown et al., 1987; Brown and Drewien, 1995).

Management recommendations

The impact of power lines to both cranes and geese can best be mitigated through a combination of careful siting of future power lines and power line marking. Prior to the decision of where a power line should be sited, waterbirds should be monitored for at least one season to establish flight patterns and locations of nocturnal roost sites. Brown et al. (1987) recommended that new power lines be located more than 2 km from traditional roost and feeding sites. In addition, routing of new power lines closely

parallel to existing power lines, or other existing sources of disturbance such as highways, is generally preferable to putting lines across low areas without any current obstruction or sources of disturbance.

Marking power lines appreciably reduces mortality (Hunting, 2002). Power lines, new or old, located in the flight path from nocturnal crane and goose roosts, crossing the mouths of important agricultural side valleys or near important foraging areas, should be marked at intervals with devices that increase visibility of the lines. Power line marking devices that have been developed include bird flight diverters, bird flight flappers and fire-fly diverters (Fig. 3). Bird flight diverters used in South Africa decreased strikes by waterfowl, flamingos and cranes (Ledger et al., 1993). Bird flappers, also used in South Africa to reduce crane collisions, have been shown to be more effective than the bird flight diverters (McCann, 2001). The fire-fly diverter has been designed to reflect ultraviolet and visible light in moonlight or under dim light conditions. This device has been used in South Africa and Botswana

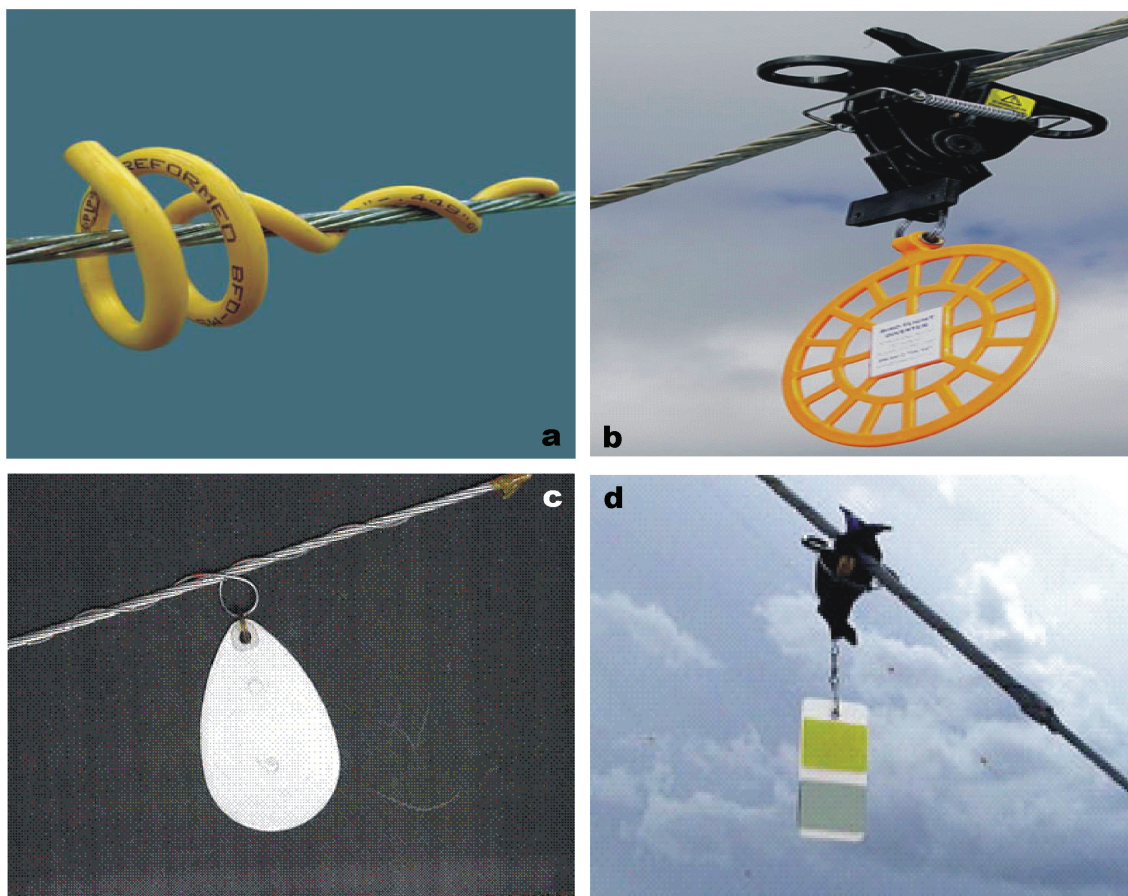


Fig. 3 Examples of powerline marking devices. (a) bird flight diverter; (b) bird flight diverter; (c) bird flapper; (d) fire-fly diverter. Device d, the fire-fly diverter, has been designed to reflect ultraviolet and visible light in moonlight or under dim light conditions.

and is reported to have worked well for curbing flamingo mortality on overhead lines (Smallie, 2008). Because both cranes and geese often leave and return to roosts under dim light or in near darkness, marking devices that are visible in the dark would be most effective if attached to power lines located close to roost sites.

Ground wires pose a special problem. Ground wire removal has been demonstrated to reduce mortality (Brown et al., 1987) and should be employed where possible. However, because ground wire removal increases the probability of a lightning-caused power outage, other means of ground wire modification should be explored. Options include marking ground wires with technically and economically feasible power line marking devices (see Fig. 3) at specific, critical areas where strikes perennially occur (Brown and Drewien, 1995).

In conclusion, large waterbirds in China will continue to face a gauntlet of power lines in the future. Power line strikes can be mitigated through careful planning and mitigation devices. Given the rapid growth of electric transmission and distribution lines currently underway in China, a special effort should be made to educate engineers and managers about the importance of bird conservation and the methods available to mitigate power line strikes.

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西藏黑颈鹤和斑头雁碰撞输电线的研究

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摘要: 我们在西藏自治区雅鲁藏布江河谷进行了为期两个冬季的黑颈鹤 (*Grus nigricollis*) 和斑头雁 (*Anser indicus*) 碰撞输电线路的调查。每个冬季, 在一条 35 kV 的输电线路设置 3 条样线, 观察受伤和死亡的个体。受伤的个体在发现 5 天以后就不见了, 而多数死亡个体的残骸发现时已经严重残缺不全。在样线调查时, 记录到两只死亡的斑头雁; 另外, 在紧邻样线附近的地方见到两只受伤的斑头雁和两只死亡的黑颈鹤。调查发现鸟类碰撞输电线多发生在靠近夜宿和觅食地的地方。我们建议, 在位于碰撞敏感区 (如夜宿地、觅食地以及有农田的河谷谷口的雁鹤飞行通道) 的新旧输电线路增加颜色鲜艳的标志物, 以便减少鹤类和雁类的碰撞。

关键词: *Grus nigricollis*, *Anser indicus*, 输电线碰撞, 标志物, 西藏