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Migration routes and important resting areas of Siberian cranes (*Grus leucogeranus*) between northeastern Siberia and China as revealed by satellite tracking

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Abstract

In 1995 and 1996 thirteen Siberian cranes (*Grus leucogeranus*) were fitted with satellite transmitters on the breeding grounds in northeastern Siberia. Eleven of these 13 birds were successfully satellite tracked, and five of these 11 provided complete migratory information from their breeding grounds in Yakutia, Siberia, to their wintering area at Poyang Lake, in China. Several stopover sites were identified, the most important being in Qiqihar-Baicheng (China), Shuangtaizi River delta (China), and Yellow River delta (China). Birds rested more frequently in Russia than in China, suggesting availability of suitable wetland habitat in Russia and absence of adequate, suitable wetland habitat in China. Wintering habitat in China also faces numerous threats. Habitats utilized by Siberian cranes are also important to other threatened wetland birds that have been satellite-tracked recently. If Siberian crane habitat needs fail to be addressed, this critically endangered species will be further endangered.

Keywords: Migration; Siberian cranes; *Grus leucogeranus*; Siberia; China; Satellite tracking

1. Introduction

The Siberian crane (*Grus leucogeranus*) is one of the most endangered bird species in the world. It is designated as "Critically Endangered" under the IUCN Red List category (BLI, 2000). There are three populations of Siberian cranes. They all breed in northern Russia and they all migrate thousands of kilometres to spend the winter respectively in Iran, India and China (Meine and Archibald, 1996). The populations that winter in Iran and India have declined to c. eight and two birds respectively (G. Archibald, personal communication). The attrition of these populations is attributed to habitat loss, hunting, and lack of "conservation attention" until recently. The population that winters in China numbers between 2500 and 3000 birds and holds great potential for the welfare of the species. These cranes breed in northeastern Siberia, between the Yana and Kolyma River, and most of them winter in Poyang Lake in southern China (Meine and Archibald, 1996). This suggests that most of the birds may migrate along the same route. Thus, if their important stopover sites are lost, they may not be able to complete their migration, they will become exhausted and their population may suffer immense damage, resulting in further decline in numbers. However, their migration route and important stopover sites were not known until this study.

Satellite-tracking is a useful means for tracking the migration of large birds, such as cranes (Higuchi et al., 1992, 1996), waterfowl (Lorentsen et al., 1998; Kanai et

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al., 1997), eagles (Ueta et al., 1998, 2000) and spoonbills (Ueta et al., in press). Satellite location data are used to show migration routes, migration patterns through time (Higuchi et al., 1994, 1998), and the relative importance of each stopover site (Higuchi et al., 1996; Kanai et al., 1997; Harris et al., 2000).

In this paper, we describe all these aspects and discuss conservation issues at some stopover and wintering sites.

2. Methods

Siberian cranes were captured along the lower Indigirka River (71°N, 144–148°E), northeastern Siberia. This area is the main breeding area of the cranes (Meine and Archibald, 1996). We captured three adult Siberian cranes that were flightless due to moulting on 1–5 August 1995, and 10 cranes in 20–28 July 1996, all with the aid of a helicopter.

The satellite transmitter (Platform transmitter terminal, PTT) T-2050, made by the Nippon Telegraph and Telephone Corporation (NTT) and Toyo Communication Equipment Corporation. (TOYOCOM) was 70× 34×23 mm in size and weighed 65 g including an antenna of 18 cm. PTTs were harnessed to the backs of the cranes with Teflon-treated ribbons as described by Nagendran et al. (1994). Each transmitter had an individual number (ID). The pulse interval of PTTs was 60 s, and duty cycle and battery life of PTTs and other tracking information are given in Table 1. In addition to the PTT, colour bands were attached to the legs of each crane.

Location data were received through the Argos satellite system. Location data were categorized into seven Location Classes (LC) that showed increasing accuracy, labelled Z, B, A, 0, 1, 2 to 3. The one-standard-deviation accuracies reported by Argos (1992) were >1000 m for LC 0, 350–1,000 m for LC 1, 150–350 m for LC 2, and <150 m for LC 3. Accuracies for the lowest location classes, A, B and Z, Argos system cannot be estimated.

In general we used LC 1–3 for data analysis, but LC 0, A, B and Z data were included when they were spatially and temporally close to location estimates. The period of stay at a particular site was calculated as the difference between the first day of arrival at the site and departure from the site. In cases when we had no located day(s) between one stopover site and another, we divided the time equally between the two sites.

3. Results and discussion

3.1. Migration routes

Of the 13 cranes marked in 1995 and 1996, five cranes were tracked over the entire distance to their wintering grounds, and six cranes were tracked for part of their migration routes (Table 1). Three cranes tracked in 1995 started migration on 1–4 October, and eight cranes tracked in 1996 started migration on 16–19 September. The earlier migration start in 1996 was associated with the weather condition of the year. Temperatures started to drop earlier during the autumn of 1996 (Fig. 1), and cranes started migration when the lowest temperature of the day fell to about −5 °C. This temperature factor probably initiated an early onset of migration from the breeding area.

All cranes migrated along a similar route (Fig. 2) in a straight line down to Qiqihar-Baicheng area in northeastern China. From here, they moved to the Shuangtaizi

Table 1
Thirteen Siberian cranes equipped with transmitters in 1995–1997, including their tracking information

PTT ID	Duty cycle of PTTs[a]	Battery life expected (days)	Tracking period	Number of locations	Tracked[b] distance (km)	Days for migration
21420	6/12	119–170	19 July 95–24 October. 95	411	(3066)	–
21627	6/12	119–170	03 August 95–07 January 96	454	5586	41
21628	6/12	119–170	05 August 95–03 January 96	361	5423	41
19312	6/18	153–219	20 July 96–26 October. 96	80	(3555)	–
19313	6/18	153–219	20 July 96–30 November 96	350	(981)	–
19314	6/18	153–219	24 July 96–19 November 96	341	5235	48–53
19315	6/18	153–219	19 July 96–03 December 96	136	4903	61
21629	6/12	119–170	23 July 96–05 January 97	449	5417	59–62
22446	6/12	119–170	23 July 96–12 October 96	606	(3078)	–
22447	6/12	119–170	23 July 96–14 October 96	508	(3155)	–
22452	6/42	265–378	29 July 96–12 November 96	112	(4935)	–
25327	9/15	83–119	26 July 96–22 August 96	93	–	–
25328	9/15	83–119	30 July 96–01 August 96	8	–	–

[a] On/off time (h) is shown.
[b] Number with parenthesis is the distance of crane that was tracked part of migration way.

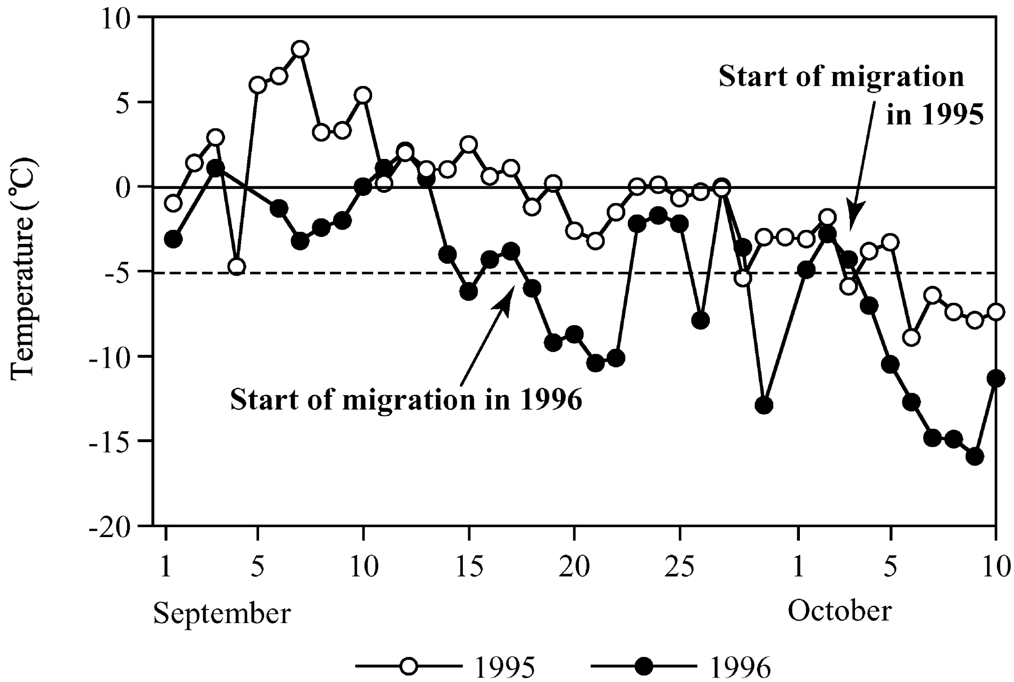

Fig. 1. Fluctuation in minimum daily air temperature in lower Indigirka River, northeastern Siberia in autumn 1995 and 1996 (data from JMA, 1999).

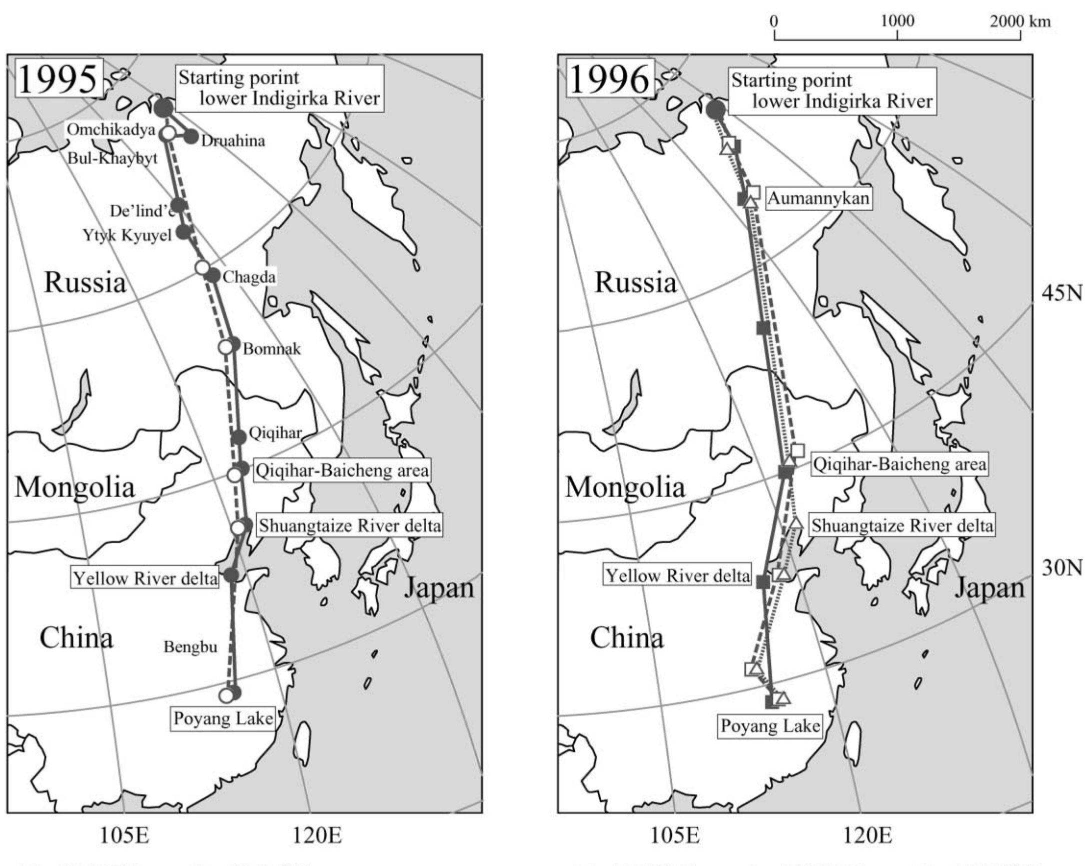

Fig. 2. Migration routes of Siberian cranes tracked from northeastern Siberia in 1995 (left) and 1996 (right).

Table 2
Migration route and stopover sites reached by a Siberian crane ID 2167 in 1995–1996

October 1	3	4	5
To NW Ozhogino	NW Syangannakh	Druahina	E Omchikadya
6–7	8	9–11	12
NE Bul-Khaybyt	De'lind'e	NW Ytyk Kyuyel	E Chagda
13	15	October16–November 6	7
SE Bomnak	W Qiqihar	SE Baicheng	Shuangtaizi River delta
8–9	10	November 11–January 7	
Yellow River delta	SE Bengbu	Poyang Lake	

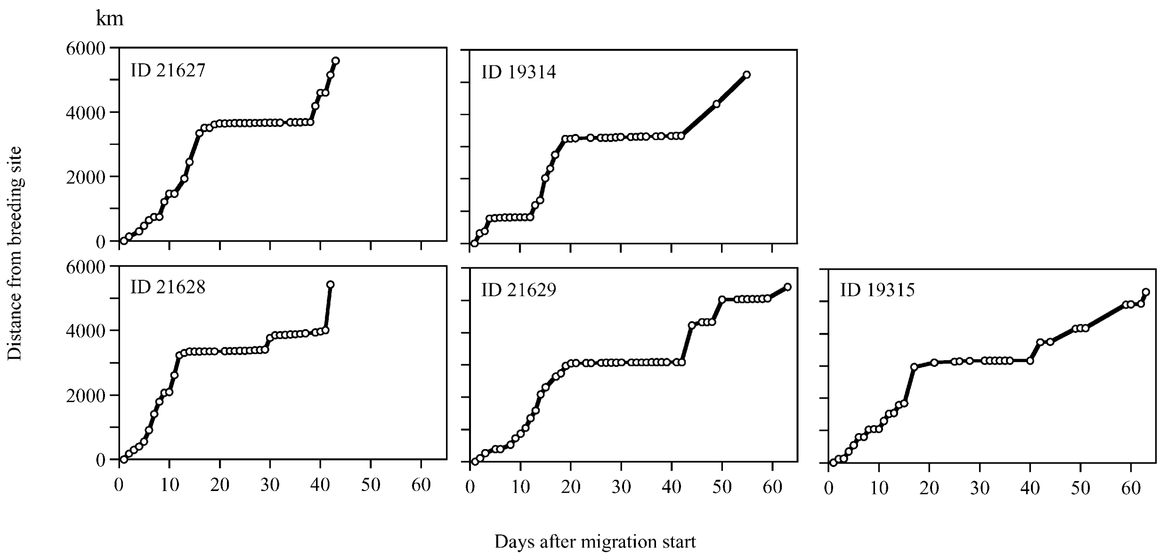

Fig. 3. Migration patterns of satellite-tracked Siberian cranes, represented as distance travelled over time. Horizontal lines represent rest at a single location, while upward lines represent movement.

River delta and/or Yellow River delta in eastern China. Their final destination was Poyang Lake along the middle part of the Yangtze River in southeastern China. The total entire migration distance was 5312.8±260.6 (SD) km (range = 4903–5586 km, n = 5).

As an example, we give the details for ID 21627 tracked in 1995 (Table 2 and Fig. 1). This bird started migration on 1 October, reached northeastern China on 16 October and its wintering site at Poyang Lake on 8 November after a total of 41 days. Here it remained until its PTT stopped signalling on 7 January 1996.

3.2. Migration pattern through time

Five successfully tracked cranes rested for a long period at one or two stopover sites and spent only 1 or 2 nights at the other sites (Fig. 3). They migrated quickly between their breeding sites and Qiqihar-Baicheng area (Russian territory). We identified 88 stopover sites between their breeding sites and Qiqihar-Baicheng. Most sites were used for only 1 or 2 days but seven sites were used for 3–4 days, and two sites for 8–9 days by some birds (overall mean 1.51 days, n = 110). From Qiqihar-Baicheng to the wintering area of Poyang Lake in Chinese territory, the birds used fewer stopover sites but for longer periods at each: Qiqihar-Baicheng area 18–28 days (mean 23.6 days, n = 6), Shuangtaizi River

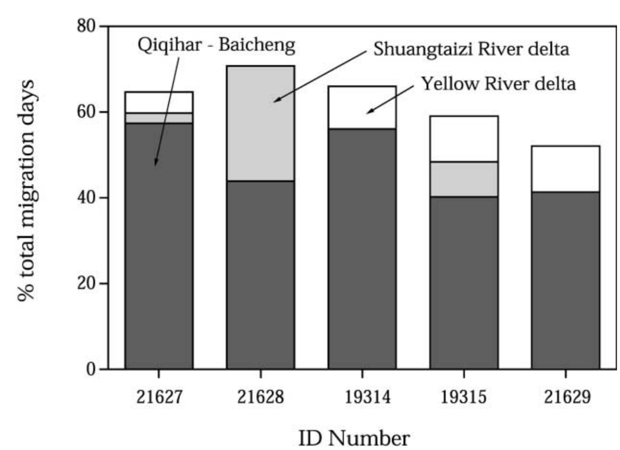

Fig. 4. Percent total migration days at each stopover site for five successfully tracked Siberian cranes.

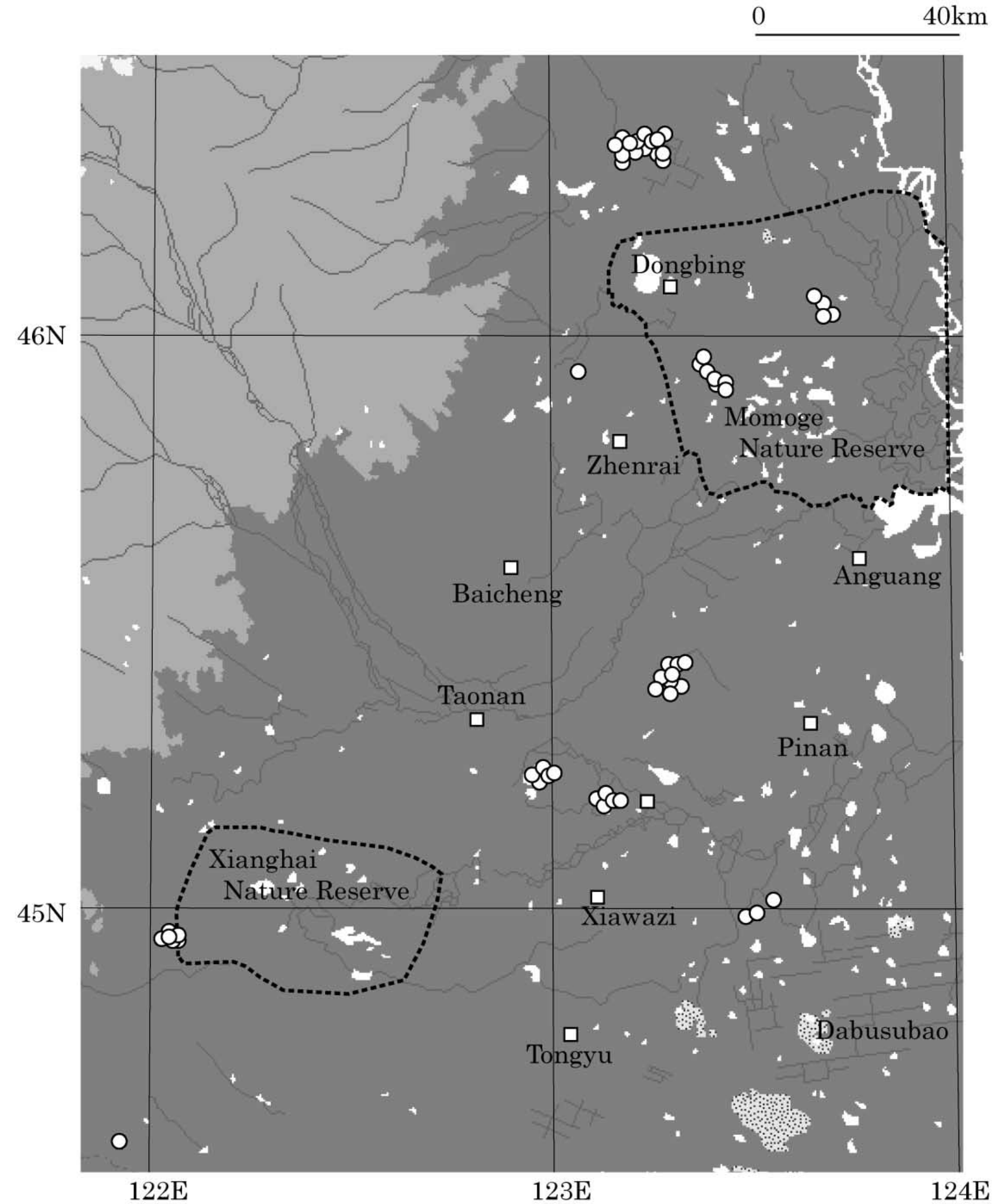

Fig. 5. Satellite locations of Siberian cranes around Baicheng, northeastern China.

delta 1–12 days (mean 7.3 days, $n=3$), and Yellow River delta 2–9 days (mean 5.8 days, $n=4$). The mean distances between these sites and the resting periods to restore energy were thus significantly greater in Chinese than in Russian territory (distance 470.0 ± 139.9; $t=1$, $z=1.75$, $n=5$, $P=0.04$). This is because many wetlands in China that would normally serve as stopover sites for the cranes are heavily developed (Scott, 1989), and potential stopover sites are few. Therefore, cranes might have to migrate longer distances without a stop in Chinese territory, and rest for a longer period at each available stopover site to restore their nutritional and energy requirements.

3.3. Important stopover sites

The four areas (Qiqihar Baicheng area, Aumannykan area, Shuangtaizi River delta, and Yellow River delta), which were used by a high proportion of cranes and for longer periods, are considered to be the most important stopover points for the migrating cranes. All 10 cranes marked in 1996 rested at Qiqihar-Baicheng and the time

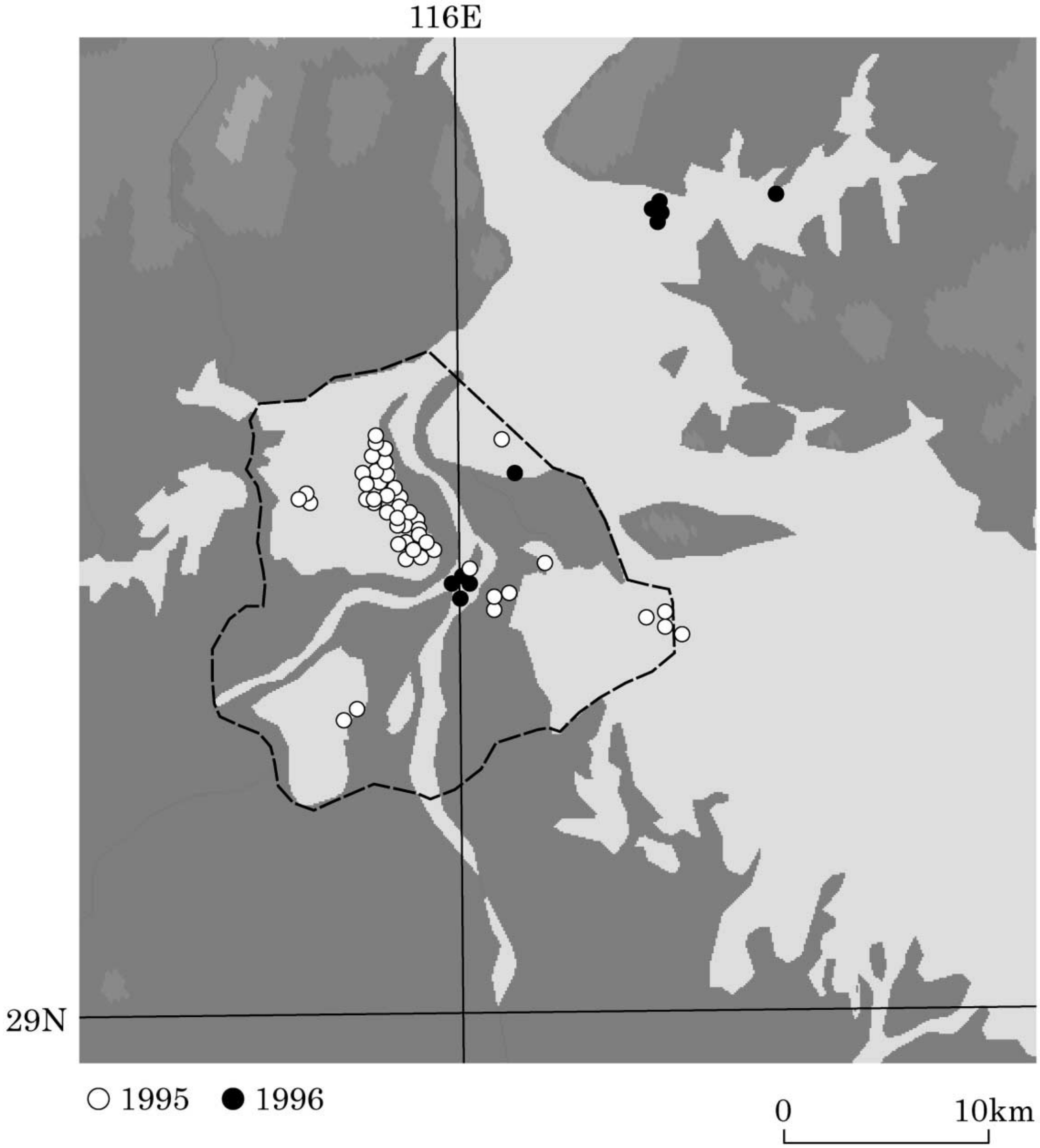

Fig. 6. Satellite locations of Siberian cranes at Poyang Lake, southeastern China. Dashed line indicates the boundary of Poyang Lake Nature Reserve.

spent here by the five fully tracked cranes represents c. 40–55% of their total migration time (Fig. 4), which indicates that this is a particularly important stopover point. He et al. (2000) observed more than 577 cranes here in spring of 2000, and they stayed c. 36 days there. It is likely that the Qiqihar-Baicheng area is an important stopover point also for spring migration. This area was not listed in North East Asian Crane Site Network (WIJ, 1998) but should be included.

Only five of the 10 cranes rested within the Momoge and Xianghai Nature Reserves in Qiqihar-Baicheng area and most of the locations were outside these two reserves (Fig. 5). These data suggest that wetlands outside of the reserve are important for the cranes, and the protected area should be expanded. In this area, wetlands become dry because of over-use of river water for agriculture (S. Chan, personal communication). Siberian cranes use shallow water for feeding (Meine and Archibald, 1996), hence it is necessary to control the use of water for conservation of the crane.

The Shuangtaizi River delta is the breeding site of red-crowned cranes (*Grus japonensis*), Saunders's gulls (*Larus saundersi*) and Japanese marsh warbler (*Locustella pryeri*) (Kanai et al., 1993), and listed as a site in the East Asian–Australasian Shorebird Site Network. More than 400 Siberian cranes were observed there during spring and autumn 1995 and 1996 (Yang et al., 1998). All crane locations were within the Liaoning Shuangtai Hekou Nature Reserve. However, there are many potential threats to the nature reserve and management of the reserve is apparently not adequate to preserve the habitat (Scott, 1989; Kanai et al., 1993). There are >100 oil drilling sites within the reserve, the road for the oil fields cuts through the wetlands, activities of oil field workers disturb the cranes, and there is possibility of oil spill. Other problems are excessive cutting of reeds, reclamation, and water pollution. The reserve should be managed to keep wetland condition healthy.

The Yellow River delta is the breeding area of grebes, herons and gulls, the staging area of shorebirds, cranes and storks, and the wintering area of ducks and swans (Zhao and Song, 1995). It is an important wintering ground of red-crowned and Eurasian cranes. It is also probably the most important wintering ground of great bustards (*Otis tarda*) in eastern Asia (S. Chan, personal communication). It is listed as a network site on both North East Asian Crane Site Network and East Asian–Australasian Shorebird Site Network (WIJ, 1998). All crane locations were within the Huang He Delta Nature Reserve. The Yellow River delta is the third largest oil field in China (S. Chan, personal communication). The cranes are therefore probably facing the same problems of oil spill and pollution as at Liaoning Shuangtai Hekou Nature Reserve. Poison baits used by farmers (illegally) to protect wheat fields from nomad sheep, and economic activities such as fishing and harvesting of reeds are also conservation problems in this area (Lu et al., 1998).

The Qiqihar-Baicheng area, Shuangtaizi River delta, and Yellow River delta are also important stopping points on the migration route of red-crowned cranes (Higuchi et al., 1998) and white-naped cranes (*Grus vipio*) (Higuchi et al., 1994). Satellite-tracked eastern curlews (*Numenius madagascariensis*) have also been recorded as resting in the Qiqihar-Baicheng area and Shuangtaizi River delta, showing that these areas are probably important habitats for many water bird species.

In northern areas between the breeding sites to Qiqihar-Baicheng area, wetlands are not intensively developed. However, south of Qiqihar-Baicheng area to the wintering ground, wetlands are heavily developed and converted to agricultural areas, and are fragmented (Scott, 1989). It is likely that these remaining fragmented wetlands are critically important for migrating Siberian cranes. If these areas are lost, the cranes may not be able to complete their migration.

3.4. Poyang Lake, wintering ground

All five cranes that we monitored for the whole route (two in 1995 and three in 1996) wintered at Poyang Lake. In 1995, 98.4% of locations were within Poyang Lake Nature Reserve (PLNR), but 50% of locations were outside PLNR in 1996 (Fig. 6). During 24 February–2 March 1997, no Siberian cranes were observed within PLNR (Harris et al., 2000). About 600 were just outside the nature reserve and were feeding exclusively in shallow water, where numerous tubers and leaves of *Vallisneria spiralis* (a submerged aquatic plant) were present. This plant species is presumed to be an important food for Siberian cranes (Zhou and Ding, 1987; Liu and Chen, 1991). While published information is lacking on the ecology of *Vallisneria* at Poyang, the distribution of the closely related *Vallisneria americana* is sensitive to changes in turbidity and water depth (Korschgen and Green, 1988). At Poyang Lake, changes in water levels from year to year are likely to affect distribution of aquatic plants and wintering cranes, and are likely to be affected by changes in hydrology caused by the Three Gorges Dam and other development projects in the basin. Our satellite locations indicate that the wetlands currently protected within PLNR are insufficient to provide wintering habitat for the cranes throughout each winter. It is highly recommended that the variety and extent of protected wetland habitats be expanded to provide cranes with numerous alternative sites for use through the different hydrologic conditions present during any one winter and during different years.

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