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Migratory stopover and wintering locations in eastern China used by White-naped Cranes *Grus vipio* and Hooded Cranes *G. monacha* as determined by satellite tracking

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Conservation efforts for the threatened White-naped *Grus vipio* and Hooded Cranes *G. monacha* have focused on breeding and wintering areas, in part because of a lack of information on migratory habitats. From 1991–1993, satellite tracking was used to determine stopover locations for these species. This paper reports on migratory sites in eastern China and also on the Russian side of Lake Khanka, near the international border with China. In addition, satellite tracking documented local crane movements in winter at Poyang Lake. Ground surveys provided valuable supplementation of satellite data. We discuss the conservation implications of our study, particularly the need to expand protected areas for both migratory and wintering habitats.

North-east Asia has seven crane species, more than any other region on earth (Table 1). Like most waterbirds breeding in northern latitudes, the cranes perform long migrations each spring and fall. These migrations pass through some of the most heavily populated areas on earth, including the eastern plains of China. Rapid economic development has created intense pressure on wetlands and other natural ecosystems along these migration corridors. Six of the seven cranes of northeast Asia migrate across eastern China; four of these six species are threatened. The threatened White-naped Crane *Grus vipio* and Hooded Crane *G. monacha* nest along the Russian-Chinese border and winter in southern Japan, the Korean Peninsula, and the Chang Jiang river basin of southern China (Figure 1).

Table 1. Cranes of north-east Asia

Species	Status[1]	Range[2]
Demoiselle Crane *Grus virgo*	Lower risk	Breeds across central Asia from northeast China through Mongolia and Kazahkstan to the Ukraine. Winters in Indian subcontinent and Africa.
Common Crane *Grus grus*	Lower risk	Breeds across northern Eurasia from far eastern Russia to Norway and Germany. Winters from eastern China across southern Asia, and also in north-east and north Africa, France, and Spain.
Hooded Crane *Grus monacha*	Vulnerable	Breeds in far eastern Russia north to southern Yakutia and west to Lake Baikal. Winters in southern Japan, southern Korea, and the Chang Jiang basin of China.
Red-crowned Crane *Grus japonensis*	Endangered	Breeds in Hokkaido, Japan and in north-eastern China and far south-eastern Russia. Winters in Hokkaido, the Korean Peninsula, and the east coast of China.
Sandhill Crane *Grus canadensis*	Lower risk	Breeds in north-eastern Siberia, Alaska and Canada, and in northern parts of the United States from Oregon to Michigan. Winters from California to Texas, northern Mexico, also Florida. Non-migratory subspecies in Mississippi, Florida, and Cuba.
Siberian Crane *Grus leucogeranus*	Endangered	Breeds in limited areas of northern Siberia. Winters in very localized parts of the Chang Jiang basin of China, northern India, and by the Caspian Sea in Iran.
White-naped Crane *Grus vipio*	Vulnerable	Breeds in north-eastern China, south-eastern Russia, and eastern Mongolia. Winters in Izumi, Japan, the Korean Peninsula, and the Chang Jiang basin of China.

[1] As proposed in Meine and Archibald (1996), in accordance with revised IUCN Red List guidelines.
[2] From Meine and Archibald (1996).

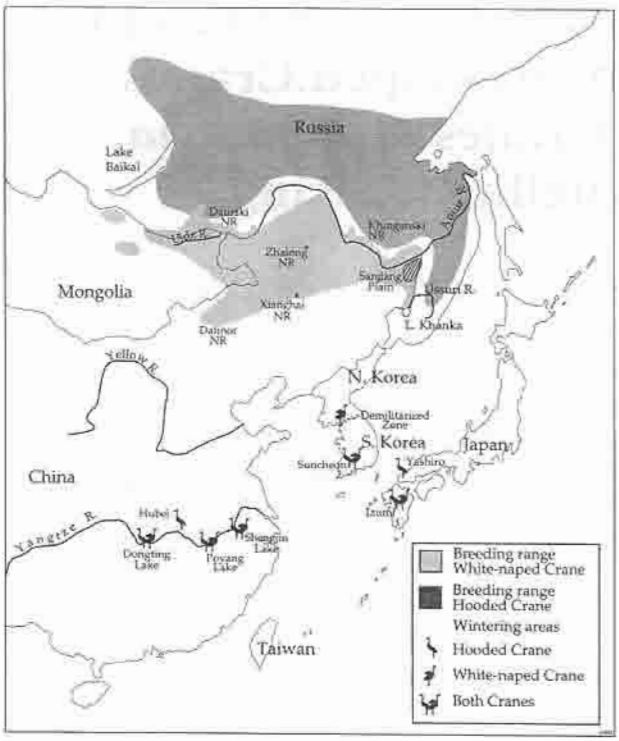

Figure 1. Distribution of White-naped Crane *Grus vipio* and Hooded Crane *G. monacha* [adapted from Meine and Archibald (1996)].

Figure 2. Locations of wetland nature reserves along crane flyways in eastern China.

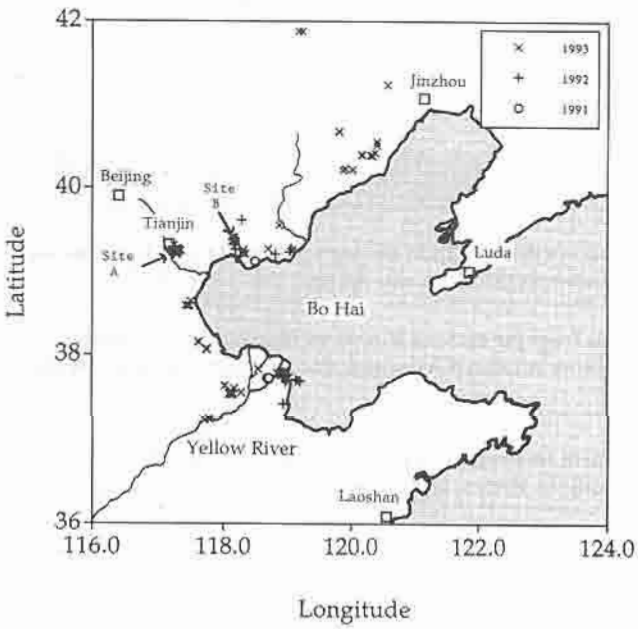

Figure 3. Locations at Bohai of White-naped Cranes *G. vipio* tracked from Russia during autumn, 1991–1993.

While the Chinese Government took little action for bird or wetland conservation during the period before 1976, since then remarkable efforts have resulted in establishment of a large and expanding network of nature reserves. As of 1993, over 700 nature reserves covered 560,666 km^2 or over 5.5% of China's land area (National Environment Protection Agency 1994). Since then, many additional nature reserves have advanced China toward its goal of protecting over 10% of its land area (MacKinnon *et al.* 1996). Cranes, because of their rarity, beauty, and cultural significance, inspired establishment of numerous reserves. Over 20 nature reserves protect wetlands along the migratory flyways of the east Asian cranes (Figure 2). Most of these reserves were established because of breeding or wintering cranes and other birds, with populations present for long periods each year. The survival of cranes and many other waterbirds, however, depends in part upon preserving the habitats used for brief periods in spring and fall during the migrations. Unless these transitory resting and feeding areas persist, the cranes will have great difficulty passing between the protected areas of their breeding and wintering grounds.

The rapid movement of cranes across long distances makes study of migration, and identification of migratory habitats, difficult. Recent developments in the technology of satellite tracking have allowed small, lightweight satellite platform transmitter terminals (PTTs) to be placed successfully on cranes. Several studies have helped elucidate the migration routes of cranes in eastern Asia (Chong *et al.* 1994, Higuchi *et al.* 1994 and 1996).

This paper reports on the locations used by migratory White-naped and Hooded Cranes in eastern China and immediately adjacent areas of Russia, during the period 1991–1993. We also report on duration of use of different areas, protected status of the sites, and implications for conservation. In addition, we report on locations used by White-naped and Hooded Cranes on one of their most important wintering grounds at Poyang Lake in the Chang Jiang river basin.

METHODS AND DATA

The methods used in these satellite tracking studies have already been reported (Higuchi *et al.* 1994 and 1996). During the current study, those cranes migrating through Xingkai Hu (called Lake Khanka in Russia) in spring were captured using rocket nets at their wintering grounds in Izumi, Japan. Cranes migrating through Bohai and through Xingkai Hu in autumn were captured during their flightless moult period on the breeding areas in Russia.

The PTTs were fitted to the backs of the cranes either by epoxy resin or by harnesses that were affixed around the chests of these birds. Different PTTs were used in different years, and weighed between 44 and 80 g. The batteries had an expected life of 3-6 months, although actual life varied among transmitters. The threads that were used to secure the harnesses wear out after roughly a year.

The PTTs emitted a unique frequency detected by one of several circling Argos satellites. The signals were relayed to Argos headquarters in France, and then provided to researchers in Tokyo. To extend the battery life, the PTTs were set to emit signals for 6 hours out of every 12 hours. Depending on satellite location and time, from 0-4 locations would be obtained per day. Signal strength varied, and thus accuracy of the locations varied in precision. For this report, we only used data with a relatively strong signal strength rating (of location class '1' or higher) to plot locations in Figures 3-9. Signals with lower ratings yielded less reliable locations for the birds, and were discarded.

Data are reported for the years 1991–1993 (see Table 2). The migration routes of White-naped Cranes tracked from Japan in 1991–1993 (Higuchi *et al.* 1992, 1996) and White-naped and Hooded Cranes from Russia in 1991 and 1992 (Higuchi *et al.* 1994) have already been published. The migration routes of White-naped Cranes tracked from Russia in 1993 have not yet been published, and will be shown elsewhere with the names of Russian collaborators (Fujita *et al.* in prep.).

From 10-14 November 1996 (3-5 years after the PTT data were collected), two areas heavily utilized by migratory cranes were visited on the ground, to determine habitat types, human activity, and threats to cranes or their habitats. These two areas were chosen because of their proximity to Tianjin municipality, China's fourth largest city. The two crane sites had previously lacked any known significance for waterbirds, and were neither within nor near any designated nature reserves. Locations were determined on the ground using a Trimble Geoexplorer Geographical Positioning System (GPS) receiver.

The GPS locations had a reliability of roughly 100 m. PTT location accuracy varied from <150 m to 1,000 m, depending on location class. This degree of error meant that precise quantitative conclusions could not be made on habitats used by cranes. Cranes, however, could be located within a mosaic of habitat types, and conclusions drawn on the characteristics of landscapes used by migratory cranes.

JH visited Poyang Lake Nature Reserve (PLNR) from 24 February – 2 March 1997 to examine habitats identified by crane PTT data. He had previously studied habitat use by cranes at PLNR during six different winters (including two of the three winters of this PTT study), and seen the wetlands under varying conditions of drought.

RESULTS

Locations for migrating White-naped Cranes in the Bohai area of eastern China are mapped in Figure 3, for autumn 1991–1993. Multiple PTT location data are provided for each bird. The largest number of crane locations were recorded at (1) the mouth of the Yellow River in Shandong Province, (2) close beside the edge of Tianjin City (Site A on Figure 3), and (3) just outside the Tianjin City administrative boundaries in Hebei Province (Site B). The only protected area used by migrating White-naped Cranes was the Yellow River delta, a national level nature reserve. The other nature reserves near Bohai (Figure 2) were not used by these cranes.

Figure 4 summarizes the relative use of locations by cranes in the Bohai area, compared to the entire migration. Of nine White-naped Cranes and one Hooded Crane, four stayed at Bohai for 70% or more of the entire migratory period (migratory period is the number of days spent by each bird between the breeding and wintering areas). Two more of the 10 birds stayed at Bohai for over 25% of their migrations, while only 1 bird failed to stop near Bohai.

Table 2. Cranes successfully tracked by satellite between Russia and wintering grounds in China and Japan, 1991–1993.[1]

Species	Number	Year	Location captured
White-naped Crane	1	1991	Daurski Nature Reserve, Chita Region, Russia
White-naped Crane	3	1992	Daurski Nature Reserve, Chita Region, Russia and Khinganski Nature Reserve, Amur Region, Russia
White-naped Crane	4	1992	Izumi, Kyushu, Japan
Hooded Crane	1	1992	Daurski Nature Reserve, Chita Region, Russia
White-naped Crane	7	1993	Daurski Nature Reserve, Chita Region, Russia and Khinganski Nature Reserve, Amur Region, Russia
White-naped Crane	3	1993	Izumi, Kyushu, Japan

[1] Two additional cranes were tracked, one from Russia to Japan in 1993 and two from Japan to China in 1993, but their data are not included in this paper.

Figures 4b-e show the relative importance of different parts of the Bohai area. Northern Bohai (including the eastern vicinity of Tianjin) and the Yellow River Delta were most significant for migrating cranes.

The two locations near Bohai, that were ground-checked in 1996, shared similar features. Site A (see Figure 4) is at Yixingfu just outside urban areas of Tianjin City, and consists of farmland with scattered small villages. Crane locations were in farm fields of 100 ha or larger, mostly harvested rice fields; winter wheat and vegetable fields were also present. Presumably, the cranes were feeding on waste rice after the harvest. This site has no sizable wetlands, except a reservoir heavily used by people with water too deep for cranes. Only one crane location was beside the reservoir. A shallow river channel extends near the reservoir, with a slow current and areas of emergent vegetation with shallow water that might be suitable for cranes to roost at night.

During the 10-12 November 1996 visit, no cranes were seen on the ground although 41 Common Cranes *Grus grus* flew low overhead. Interviews with local farmers indicated that Red-crowned Cranes *G. japonensis*

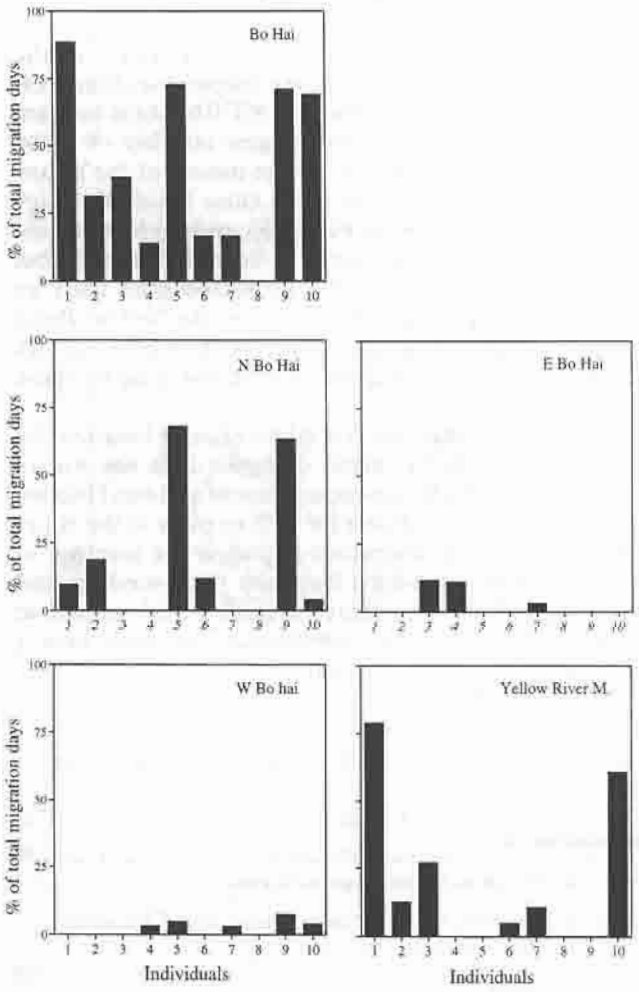

Figure 4. Percentages of migration days spent at Bohai by migrating White-naped and Hooded Cranes in autumn, 1991–1993. The horizontal axis represents individual birds. North Bohai refers to areas north and east of the Hai River that passes through Tianjin to enter the sea. West Bohai refers to locations south of the Hai River and up to (but not including) the Yellow River Mouth. East Bohai refers to all areas east of (but not including) the Yellow River Mouth.

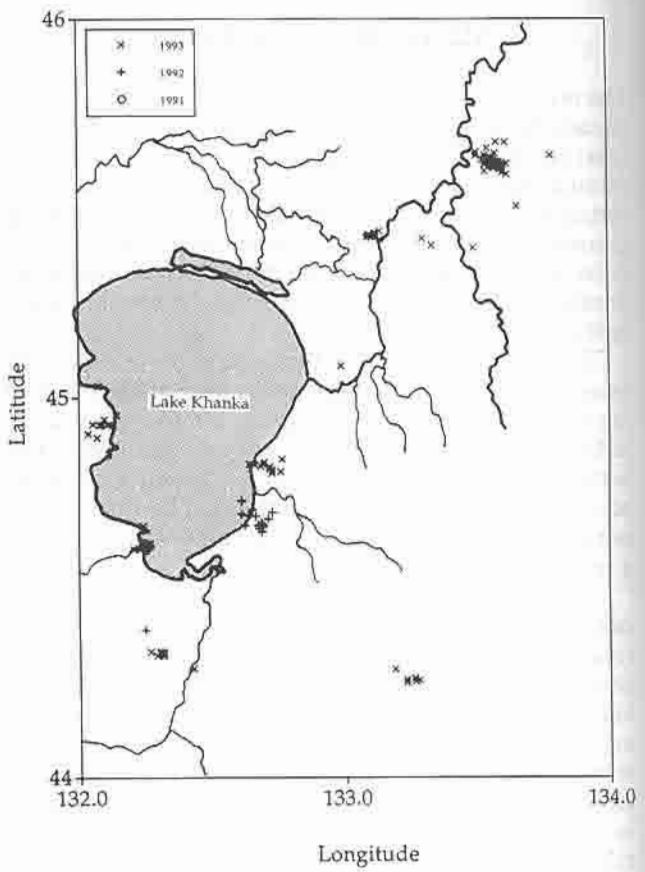

Figure 5. Locations of White-naped Cranes at Xingkai Hu (Lake Khanka), tracked from Izumi, Japan in spring, 1991–1993.

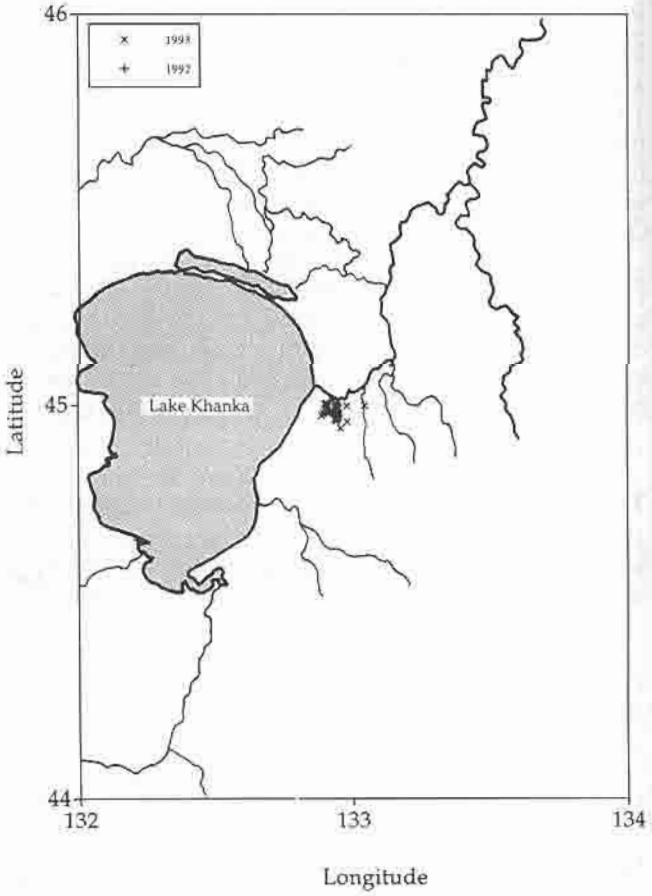

Figure 6. Locations of White-naped Cranes at Lake Khanka, tracked from Russia in autumn, 1992–1993.

had recently been present at one rice field (that also had satellite tracking locations from the previous years) and at another field planted in winter wheat. According to these people, cranes stop in some fields every year.

Land use appeared relatively stable at Yixingfu, although a new wine-making factory had been developed and one village was trying to develop cooperation with the Republic of Korea. Most agriculture currently is by private farmers utilizing hand tools or small tractors. The proximity of Yixingfu to the city makes further development likely.

The second site, just over the border in Hebei Province, is marked B on Figure 4. Crane locations were in farmland, owned by private farmers and the army. Only rice is grown here. Several small rivers pass through the area, with water heavily polluted by industry. A short distance south of the crane locations is extensive reed marsh, and farther south one of the larger salt pond complexes in the region.

Neither Site A nor B includes wetlands that appear to have significant value for waterbirds. Tianjin City has ten reservoir or other wetland areas used by migratory waterbirds; only one of these sites (Qikou and Mapengkou) had crane PTT locations, substantially fewer locations than either Site A or B. Yixingfu is noteworthy for its large, relatively undisturbed fields, but similar areas exist to the north that also have shallow river channels that might be suitable for roosting. A single Common Crane was flushed from one of these channels a year later.

Figures 5 and 6 indicate locations used by White-naped Cranes near Xingkai Hu (Lake Khanka) in the border area of China and Russia in 1991–1993. This area includes two national level nature reserves, Xingkai Hu in China and Khankaiski in Russia. The two countries have signed an agreement designating this reserve complex as an international nature reserve. Most crane locations were outside the boundaries of these nature reserves, where many wetlands in both countries have been converted to agriculture (Harris and Su, unpublished observations, 1988, 1990, 1992 and 1994).

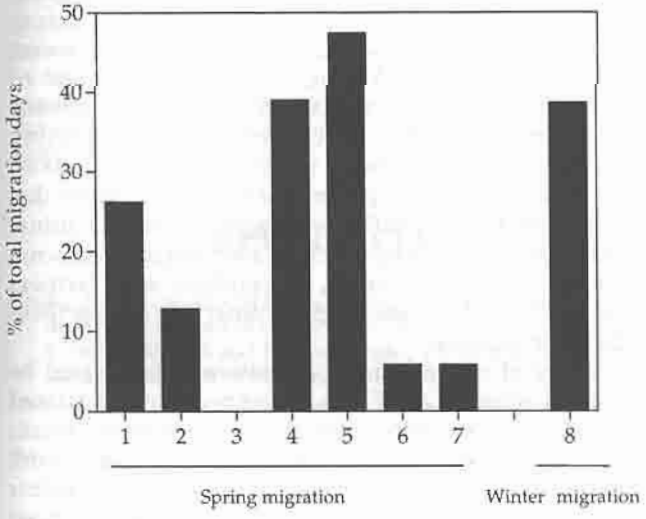

Figure 7. Percentages of migration days spent at Xingkai Hu (Lake Khanka) by migrating White-naped Cranes, spring and fall, 1992–1993. Locations from both China and Russia are included. Locations from one bird (ID 9377) for fall 1992 are not included because the sample size was too small. The horizontal axis represents individual birds.

These data indicate that additional wetlands should be protected in both countries. Initial boundaries of these reserves were smaller than might have been desired in response to a variety of local concerns. Currently, threats of continuing wetlands loss are greater in China, even within reserve buffer or experimental use zones (S. Feng, Xingkai Hu Nature Reserve, pers. comm. 1998), in part because the economic downturn in Russia has slowed agricultural activity. White-naped Cranes, particularly non-breeding birds, do use farmlands for feeding (Meine and Archibald 1996). But wetlands are critical for crane breeding and roosting, and also support numerous other birds.

Figure 7 indicates the high importance of Xingkai Hu (Lake Khanka) for cranes migrating between Izumi, Japan and Russia. Of eight cranes, four spent over 25% of migration days in this area. Only one crane did not stop here.

Figures 8 and 9 show the locations of White-naped and Hooded Cranes tracked from Russia to their wintering grounds at Poyang Lake, in Jiangxi Province, China. The data indicate substantial local movement within the wintering period. During the winter dry season, lowering water levels expose 330,000 hectares of wetlands (Melville *et al.* 1992). Only a small part of Poyang Lake is protected within Poyang Lake Nature Reserve (PLNR, with an area of 22,400 hectares). While Hooded Cranes primarily remained within PLNR, many White-naped Crane locations were outside PLNR, particularly in the south-eastern part of Poyang Lake 50 km distant from PLNR.

White-naped Crane PTT locations indicated almost exclusive use of wetland habitats. Within PLNR, this species primarily occurred at the three areas with most expansive wetland habitat in winter – Bang Hu, Dahu Chi, and Dacha Hu. This result was consistent with ground observations 1986–1994 (Harris 1986, Harris *et al.* 1995; PLNR staff, pers. comm. 1997). PTT locations from Hooded Cranes during the winter of 1992–1993, however, indicated that this species often used dry areas near the western and south-eastern boundaries of the nature reserve. Winter 1992–1993 was unusually dry, and the wetlands within PLNR held little water; few cranes of any species were present within the nature reserve (Harris *et al.* 1995).

Winter 1996–1997 had apparently suitable water conditions for wintering cranes, but Harris found few cranes within the PLNR during his visit 24 February–2 March. Furthermore, habitats used by Hooded and especially White-naped Cranes were distinctly different than in earlier years. On three occasions, White-naped Cranes were observed in shallow water (flocks of 2, 121, and about 30; for the first two instances, they were loafing, not feeding). Foraging White-naped Cranes were primarily observed in dry areas of grasses and forbs with scattered patches of *Phragmites*, both inside PLNR and a short distance outside (flocks of 7, 66, 100, 270, and 289 birds at four locations). This habitat is flooded only during summer periods of high water. In early 1986 and 1987, White-naped Cranes were never observed feeding in dry locations of this type but only on shallow water or wet mudflats, usually together with Siberian Cranes *Grus leucogeranus* (Harris 1986, unpublished data). In 1997, only two families of Hooded Cranes were seen, foraging with White-naped Cranes at two locations

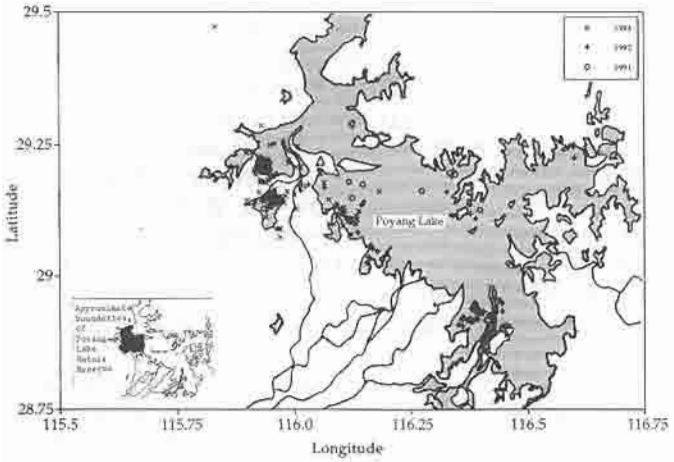

Figure 8. Locations at Poyang Lake of White-naped Cranes tracked from Russia in winter 1991–1993.

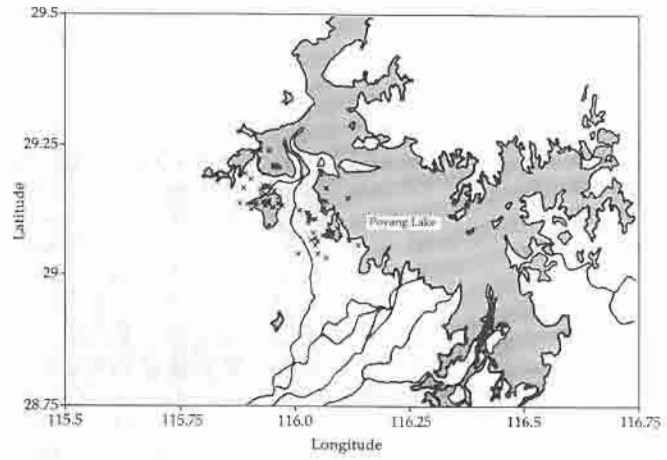

Figure 9. Locations at Poyang Lake of Hooded Cranes tracked from Russia in winter, 1992.

distant from open water. In contrast, in the mid 1980s, while Hooded Cranes often foraged in mud edging wetlands, they always remained near open water areas.

This change in behaviour by White-naped and Hooded Cranes may be a result of changes to their preferred habitats – perhaps submergent aquatic plants had declined in wetland portions of PLNR in 1997 so that the cranes switched to alternative, drier habitats. Alternatively, the cranes might have been limited to water in the mid 1980s to avoid proximity to people. Possibly a decade of protection within PLNR has allowed the cranes to use drier feeding areas close to human activity.

During this same period in 1997, no Siberian Cranes were observed within PLNR. About 600 were present just outside the nature reserve and not far from White-naped and Hooded Cranes. The Siberian Cranes, however, were feeding exclusively in shallow water, where numerous tubers and leaves of *Vallisneria spiralis* (a submerged aquatic) were also present. This plant species is presumed to be an important food for the Siberian Crane (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 affected by changes in turbidity and water depth (Korschgen and Green 1988).

DISCUSSION

The significance of the Bohai region for migratory White-naped and Hooded Cranes, as well as for other crane species, suggests that more intensive studies should be undertaken during spring and fall. Studies elsewhere have indicated the importance of both feeding and roosting habitats for migratory cranes (Meine and Archibald 1996). While Whooping Cranes *Grus americana* use both croplands and wetlands for feeding during migration, all stopover locations include proximity to some type of wetland; wetlands are used for roosting, loafing, and feeding (Howe 1987, Lingle *et al.* 1991). Given the wide availability of agriculture fields for cranes to feed, wetland habitat may be limiting in Tianjin. Additional studies should focus on wetlands used by cranes for roosting in the Tianjin area, including less obvious sites such as Yixingfu where crane use has already been proven by the PTT data.

Our study indicates that ground surveys are a highly useful complement to PTT studies, even when undertaken years after the crane migrations actually followed by satellite tracking. During the time the satellite-tagged cranes are actively migrating, it can be extremely difficult logistically to organize field teams to visit widely separated sites at short notice. Yet future PTT studies would benefit from having the ground component organized and funded, to occur either during or as soon as possible after the migrations. Our studies of cranes migrating through Tianjin are continuing, building a knowledge base that will prove highly valuable if further PTT work is attempted.

While cranes during breeding and wintering periods in eastern China use vast wetland areas as free as possible of human activity, the crane PTT locations at Tianjin indicate that cranes do utilize the human landscape during migration. Sites such as Yixingfu cannot feasibly be protected as nature reserves. Crane conservation therefore must include strategies other than nature reserves designation and management in order to protect migrating cranes. At Yixingfu, the cranes appear to depend on agriculture, and thus the local people already have a positive role for cranes. Public education programmes for the people in these areas can focus on this positive role. Our preliminary studies suggest that the cranes do not conflict with agriculture, but future field investigation should include assessment of any crop damage caused by cranes, as conflicts with farmers would render the cranes highly vulnerable during these migration periods.

Study of cranes during migration is hampered by the brief appearance of cranes over numerous scattered locations. It is difficult for field scientists to obtain enough sightings of cranes. During our continuing work near Tianjin, we are attempting to recruit volunteer observers from these locations, particularly school teachers and students. Education efforts, as well as field studies, can be greatly enhanced by close interaction among field researchers and local schools.

Bohai is important for all species of migratory cranes in eastern China (Williams *et al.* 1991). Red-crowned

and Siberian Cranes are more aquatic than White-naped and Hooded Cranes (Johnsgard 1983), and thus may be more limited by suitable resting places on migration. Particularly urgent is a similar study of the Siberian Crane, the most aquatic and most endangered of eastern China's cranes, through satellite tracking and ground surveys.

The PTT data indicate that migratory and wintering cranes are frequently outside protected areas. In the case of Xingkai Hu (Lake Khanka), the cranes are relying on extensive wetland areas currently unprotected. Xingkai Hu and Khankaiski Nature Reserves also have strong significance for nesting Red-crowned and White-naped Cranes (Shibaev and Glushchenko 1988, Li *et al.* 1994). The boundaries of both reserves should be expanded, and also the areas designated for strict protection as core zones within these reserves.

At Poyang Lake, changes in water levels from year to year affect distribution of aquatic plants and wintering cranes, and are likely to be affected by changes to hydrology caused by Three Gorges Dam and other development projects in the basin. Our PTT data from 1991–1993 and ground observations in 1997 indicate that the wetlands currently protected within PLNR are insufficient to provide wintering habitat for cranes throughout each winter. It is highly important 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. Another wetland reserve, Nanjishan Nature Reserve, has recently been designated and protects 3,300 ha in the south-eastern part of Poyang Lake (Jiangxi Nature Reserve Management Office, pers. comm. 1997). But design of an adequate complex of protected wetlands depends upon further study of crane distribution at Poyang, and particularly investigation of the ecology of both the cranes and the aquatic food plants on which they depend.

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REFERENCES

Chong, J., Higuchi, H. and Pak, U. (1994) The migration routes and important rest-sites of cranes on the Korean Peninsula. Pp. 41-50 in H. Higuchi and J. Minton, eds., *The future of cranes and wetlands*. Tokyo: Wild Bird Society of Japan.

Harris, J. T. (1986) Report on Poyang Lake Nature Reserve. Unpubl. ms. International Crane Foundation, Baraboo, Wisconsin, USA.

Harris, J. T., Goroshko, O., Labutin, Y., Degtyarev, A., Germogenov, N., Zhao, J., Zeng, N. and Higuchi, H. (1995) Results of Chinese-Russian-American investigation of cranes wintering at Poyang Lake Nature Reserve, China. Pp. 57-72 in C. H. Halvorson, J. T. Harris and S. M. Smirenski, eds., *Cranes and storks of the Amur River*. Moscow: Art Literature Publishers.

Higuchi, H., Ozaki, K., Fujita, G., Soma, M., Kanmurui, N. and Ueta, M. (1992) Satellite tracking of the migration routes of cranes from southern Japan. *Strix* 11: 1-20.

Higuchi, H., Ozaki, K., Golovushkin, K., Goroshko, O., Krever, V., Minton, J., Ueta, M., Andronov, V., Smirenski, S., Ilyashenko, V., Kanmuri, N. and Archibald, G. (1994) The migration routes and important rest-sites of cranes satellite tracked from south central Russia. Pp. 15-25 in H. Higuchi and J. Minton, eds., *The future of cranes and wetlands*. Tokyo: Wild Bird Society of Japan.

Higuchi, H., Ozaki, K., Fugjita, G., Minton, J., Ueta, M., Soma, M. and Mita, N. (1996) Satellite tracking of White-naped Crane migration and the importance of the Korean Demilitarized Zone. *Conservation Biology* 10: 806-812.

Howe, M. A. (1987) Habitat use by migrating Whooping Cranes in the Aransas – Wood Buffalo corridor. Pp. 303-311 in J. C. Lewis and J. G. Vanderwalker, eds., *Proceedings 1985 Crane Workshop*. Grand Island, Nebraska: Platte River Whooping Crane Habitat Maintenance Trust and U.S. Fish & Wildlife Service.

Johnsgard, P. (1983) *Cranes of the world*. Bloomington: Indiana University Press.

Korschgen, C. E. and Green, W. L. (1988) *American wildcelery (*Vallisneria americana*): ecological considerations for restoration*. U. S. Department of the Interior, Fish and Wildlife Service, Fish and Wildlife Technical Report 19.

Li W., Peng, K. and Piao, R. eds. (1994) [Resources and research on wildlife in Xingkai (Khanka) Lake Nature Reserve.] Harbin, China: Northeast Forestry University Press. (In Chinese with English abstract.)

Lingle, G. R., Wingfield, G. A. and Ziewitz, J. W. (1991) The migration ecology of whooping cranes in Nebraska, U.S.A. Pp. 395-401 in J. T. Harris, ed., *Proceedings 1987 International Crane Workshop*. Baraboo, Wisconsin: International Crane Foundation.

Liu, Z. and Chen, B. (1991) The wintering ecology of the Siberian crane. Pp. 109-111 in J. T. Harris, ed., *Proceedings 1987 International Crane Workshop*. Baraboo, Wisconsin: International Crane Foundation.

MacKinnon, J., Meng, S., Cheung, C., Carey, G., Zhu, X. and Melville, D. (1996) *A biodiversity review of China*. Hong Kong: World Wide Fund for Nature International, China Programme.

Meine, C. and Archibald, G. W. (1996) *Status survey and conservation action plan, the cranes*. Gland, Switzerland: IUCN – The World Conservation Union.

Melville, D. S., Mackinnon, J. R., Wang, B., Wang, H. and Song, X. (1992) Management plan for Jiangxi Poyang Lake National Nature Reserve. Beijing: Ministry of Forestry, People's Republic of China and Hong Kong: World Wide Fund for Nature.

National Environment Protection Agency (1994) *China biodiversity conservation action plan*. Beijing, China.

Shibaev, Y. and Glushchenko, Y. N. (1988) The status of populations of *Grus japonensis* (P. L. S. Muller) and *Grus vipio* (Pallas) of the Khanka Plain in 1986. Pp. 184-187 in N. M. Litvinenko and I. A. Neufeldt, eds., *The Palearctic cranes*. Vladivostok: Institute of Biology and Soil Sciences, Academy of Sciences of the USSR. (In Russian.)

Williams, M. D., Bakewell, D. N., Carey, G. J., Hsu, W. and Jin, L. (1991) Migration of cranes at Beidaihe beach, Hebei Province, China. Pp. 139-151 in J. T. Harris, ed., *Proceedings 1987 International Crane Workshop*. Baraboo, Wisconsin: International Crane Foundation.

Zhou, F. and Ding, W. (1987) Siberian Cranes wintering in the lower Yangtze in China. Pp. 171-172 in G. W. Archibald and R. F. Pasquier, eds., *Proceedings of the 1983 International Crane Workshop*. Baraboo, Wisconsin: International Crane Foundation.

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