S12-1 Satellite-tracking the migration of cranes and storks

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Abstract We satellite-tracked demoiselle (Anthropoides virgo), red-crowned (Grus japonensis), Siberian (Grus leucogeranus), and white-naped (Grus vipio) cranes and the oriental white stork (Ciconia boyciana) between their breeding and wintering grounds in Asia. With the aid of helicopters, birds for tracking were captured after baiting with wheat coated with the oral tranquiliser alpha chloralose. Platform transmitter terminals were then attached to them with a harness system. Cranes tended to make one long and several shorter stops on migration, and covered considerable distances between rest stops. Storks made much shorter daily flights and rested for longer. Cranes and storks breeding in far eastern Russia used several common resting and wintering sites, notably Bohai Bay and the Yellow River delta in China, the Korean Demilitarized Zone, Lake Khanka in Russia, and Poyang Lake, the Qiijhar Baicheng area, the Three Rivers Plain and Yangcheng Nature Reserve in China. Threats to resting and wintering sites are diverse, from development, human disturbance, hunting, mining, pesticide use, and pollution. We emphasize the need to protect habitats used by these species over the entire course of their migrations, and for continued research into and mitigation of the many threats to their survival.

Key words Migration, Asia, Cranes, Storks, Satellite tracking, Conservation

1 Introduction

In recent years, the study of animal movements has been greatly enhanced by the development and application of satellite-tracking technology. Satellite tracking allows relatively precise monitoring of animal positions from remote locations. The technique has enabled progress in the study of bird migration otherwise impossible from the use of more conventional methods, such as ringing (e.g. Berthold et al., 2001a), and it has been applied to a variety of bird species over the last 15 years.

In Asia, avian research incorporating satellite-tracking has been in operation for about 10 years (Higuchi et al., 1991; Higuchi et al., 1992). This approach is especially applicable to Asia, because of its vast area, sensitive political environment, and urgent conservation problems. Wetland conservation is particularly pressing due to the extremely rapid conversion of these habitats to agriculture and industry (APMWCC, 2001). Because cranes (Gruidae) and storks (Ciconiidae) tend to be wetland-dependent, loss and degradation of wetland habitats render these birds vulnerable to extinction. At the same time, limited knowledge of their requirements hampers initiatives for their conservation. Consequently, the goal of our ongoing research is to identify the migration routes, migration patterns and habitat use of threatened cranes and storks in Asia.

In this paper, we briefly review recent research involving the demoiselle crane (Anthropoides virgo), red-crowned crane (Grus japonensis), Siberian crane (Grus leucogeranus), white-naped crane (Grus vipio), and oriental white stork (Ciconia boyciana). Except for the demoiselle crane, these species are listed as globally vulnerable, endangered or critically endangered (IUCN, 2000).

2 Materials and methods

Birds were first captured on their breeding or wintering grounds using helicopters and by distributing wheat coated with the oral tranquiliser alpha chloralose (Kanai et al., 2000). Captured birds were marked with leg bands or neck rings, and saddled with satellite transmitters as described in Nagendran et al. (1994): transmitters were secured by teflon ribbon transmitter harnesses. The transmitters (Platform Transmitter Terminals, PTT) were made by NTT Corp. (Japan), Toyo Communication Equipment Co. (Japan), and Microwave Telemetry (USA) and weighed 30–80 g, about 1%–2% of body weight (Higuchi et al., 1996; Higuchi et al., 1998).

PTTs were set to cycle 6 hours on and 12 hours off. Location data were received by and accessed from ARGOS satellites, which categorized them into Location Classes 0–3 and A, B, and Z. We used classes 0–3 in analyses; accuracy of location increases from classes 0 through 3 (Keating et al., 1991; Service ARGOS, 1994). Due to the potential inaccuracy of class A, B and Z data, we only considered these locations when points fell on migration pathways determined from classes 0 through 3.
Satellite-tracking was also complemented by some local ground-based studies of tracked birds. Such work included observational studies and investigations of local movements in tracked birds on their staging areas in China, and their wintering grounds in China, Korea, Japan, and India.

3 Results

3.1 Demoiselle crane

In 1995, we satellite-tracked the partial migrations of 11 cranes, and the complete migrations of another four. Complete migration routes were monitored from crane breeding sites at Har Us Lake in Mongolia and Kopa in Kazakhstan to wintering sites in northern India (Fig. 1; Kanai et al., 2000). The cranes spent 18–35 days (x=25.75, SE=4.05) migrating 2710–3332 km (x=3031, SE=171), and rested at 7–9 locations (x=8, SE=0.41) for 1–20 days en route. One rest period extended for 9–20 days but the remainder lasted only a day.

3.2 Red-crowned crane

In 1993–1994 and 1998–1999, complete migration routes were tracked for 11 cranes from their breeding

Fig. 1  Satellite-tracked migration routes of demoiselle cranes captured in Kazakhstan, Mongolia, and far eastern Russia
From Kanai et al. (2000).

Fig. 2  Complete migration routes of five Siberian cranes satellite-tracked from north eastern Siberia
From Kanai et al. (2002).
grounds on the Amur River in Russia and another 7 from Lake Khanka on the border of Russia and China (Higuchi et al., 1998; Tamura et al., 2000). Birds migrating from the Amur covered 1 626–2 509 km \((x=2 073, SE=122)\) in 3–39 days \((x=22, SE=5)\), and birds from Lake Khanka 871–948 km \((x=874, SE=19)\) in 3–9 days \((x=5, SE=1)\). Amur cranes took 0–3 \((x=1.6, SE=0.6)\) rest stops of 3–37 days each \((x=16, SE=7)\) in 1998–1999. Sites around Liaodong and Bohai Bay and the Yellow River delta (China) are important stopover grounds for cranes from the Amur. Lake Khanka cranes rested around the Tumen River (Russia) and at Odaejin-nodonjagu (North Korea). Wintering sites were Yangcheng Nature Reserve (China) and the Korean Demilitarized Zone (DMZ), where extensive local short-term movements occurred (Higuchi et al., 1998).

### 3.3 Siberian crane

In 1995–1996, we tracked the partial migrations of 11 critically endangered Siberian cranes and the complete migrations of another 5, from their breeding area in Yakutia, Siberia, to their main wintering area at Poyang Lake in China (Kanai et al., 2002). The cranes took some 41 to 60 days \((x=50, SE=4)\) to migrate 4 903–5 868 km \((x=5 313, SE=117)\) between their breeding and wintering areas (Fig. 2). They stopped over from 1 to around 30 days \((x=3, SE=0.3)\) en route; most rests lasted no more than a day, but several were longer. The most important rest sites were the Aumannykan area in Russia, and the Qiqihar Baicheng area, Shuangtaizi River delta and Yellow River delta, all in China.

### 3.4 White-naped crane

Since the early 1990s, the complete migration of 20 cranes and the partial routes of another 11 have been tracked from their breeding sites in far east Russia (16 birds) and one of their wintering sites in Izumi, Japan (15 birds) (Higuchi et al., 1996; Higuchi et al., submitted). The post-breeders from Russia spent 8–68 days \((x=38, SE=6)\) migrating 2 205–2 897 km \((x=2 558, SE=63)\), with 4–12 \((x=8, SE=1)\) stopovers on the way. They spent 1–52 days \((x=6, SE=1)\) at stopover sites, where most birds took multiple short but only one long rest. Important stopover sites included Bohai Bay and the Yellow River delta, the Three Rivers Plain and Tianjin, all in China, as well as the Korean DMZ and Lake Khanka. Most birds wintered at Izumi and around Poyang Lake.

When white-naped cranes migrated from Izumi, they took them 17–85 days \((x=44, SE=8)\) to travel 1 820–2 728 km \((x=2 278, SE=90)\) to their breeding areas on the Three Rivers Plain and in Zhalong Nature Reserve near Qiqihar, China. On migration, these birds spent 1–53 days \((x=9, SE=2)\) at 1–9 \((x=5, SE=1)\) stopover sites. Most birds made only one longer stopover. Important rest sites were around the Korean DMZ (Cholwon, Panmunjom), Lake Khanka, Kumya and Sonbong (Fig. 3).

### 3.5 Oriental white stork

The partial migrations of four storks and the complete migrations of another nine captured in the Amur region,
periods than the cranes. This key difference in strategy could be correlated with the tendency of cranes to store fat, while storks may not (Berthold et al., 2001b). If this is the case, oriental white storks may be especially sensitive to the destruction of stopover sites along their migration routes, because it limits their food resources.

Given that the species we tracked are obligate wetland birds, it is not surprising that we have recorded more than one species using the same wetland areas. Bohai Bay, in particular, appears to be a critical habitat for the birds we studied, and all species except demoiselle cranes made extensive use of this area when migrating. Other areas that are similarly important are locales along the Amur River and at Lake Khanka, the Korean DMZ, Poyang Lake, the Qiqihar area, the Shuangtaizi River including the delta, the Three Rivers Plain, and the Yellow River delta.

Common use of particular sites by multiple species of wetland birds is to be expected, based on the tracking of major migration flyways across Asia. Recognition of such flyways has led to their being advocated as useful management units for conservation purposes (APMWC, 2001). However, because many sites were used by each species alone in our study, and because of potential differences in migration strategies, species-specific protection measures must also be taken into account with migration networks. Regardless of whether migrating birds gravitate to flyways, it is necessary to treat migration routes as a network of functionally connected sites. If any one site is lost from the network, birds may be unable to complete their migrations successfully.

There are numerous threats to important sites used by migrating cranes and storks in east Asia. Our study identified the Korean DMZ, in particular, as critically important. Although currently secure and including some protected areas, development and human disturbance associated with reunification of the two Koreas has the potential to degrade the region generally. The Three Rivers Plain in China is another particularly important yet sensitive area, where development appears to be continuing apace with little provision for conservation.

Those reserves that are established may be insufficient to protect birds. This may be because the birds frequent sites outside the areas designated to protect them, as at Lake Khanka and Poyang Lake (Higuchi et al., 2004), or because enforcement of protective regulations is altogether inadequate (Chong et al., 1994; Higuchi et al., 2004; Kanai et al., 1994; Scott, 1989). Upstream disturbances must also be considered, particularly the damming of wetland feeder streams. The Three Gorges dam currently under construction on the Yangtze River will bring massive changes in upstream water levels, as well as greatly affecting downstream flows. Although our study species do not occupy areas around the dam, they will probably be affected by changing hydrologic regimes downstream and disruption of food bases.

The diversity and severity of conservation issues, combined with relatively sensitive political and economic situations and a huge spatial scale, render conducting scientific research and conservation in Asia difficult. However, addressing the conservation challenges in this region can be greatly facilitated by applying satellite-tracking to long-distance migrant birds. Beyond technical and logistic difficulties, the greatest challenge lies in applying research results to achieve practical and effective conservation outcomes. As the migration routes of large wetland birds become known around Asia, the greatest obstacle to their preservation will not be lack of knowledge but lack of human action in conservation.

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