The Migration Flyways and Protection of Cranes in China

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Abstract

In China, wetlands are being continuously developed for economic reasons, which results in the decrease and fragmentation of habitats of water birds such as cranes. In order to better understand China’s crane populations so that they may be better protected as a resource, we studied the migration and ecology of red-crowned and white-naped cranes as indicator species. Combining satellite-tracking results with a literature survey and collection of network information, we reviewed the migration flyways, current status of important habitats, and main existing issues that surround the conservation of red-crowned and white-naped cranes in China. Our results demonstrate that, due to the development of agriculture, animal husbandry, and industry, Chinese populations of red-crowned and white-naped cranes are under tremendous threat from habitat destruction, human disturbance, chemical pollution, and bird poaching. Current conservation measures are unlikely to be effective in the protection of crane populations. In order to ease the survival pressure on cranes, preservation of their habitats, protection of the environment along migration flyways, and development of effective management systems are of paramount importance.

Key words: crane conservation, habitat status, migration flyway, red-crowned crane, white-naped crane

1. Introduction

China has a rich and diverse crane population. Among the 15 crane species in the world, nine are observed in China (Su et al., 2000; Li, 2004). The red-crowned crane, Grus japonensis, and white-naped crane, G. vipio, are representative species in China and in the List of Endangered and Protected Species of China (1988), they are designated, respectively, as first- and second-class national protected animals. The red-crowned and the white-naped crane are species of large wading birds. Both have a similar habitat preference; usually nest and breed in large, open reed marsh; and feed on freshwater fish, mollusks, and plant roots. These two species that breed on the Chinese mainland are migratory, and travel thousands of kilometers between their breeding and wintering grounds. (Higuchi et al., 1996; 1998). Because wetlands are the main habitat of both species, red-crowned and white-naped cranes are often used as important indicator species in wetland ecological evaluations (Li, 2004). So far, a number of studies have been conducted on these two crane species (Su & Zou, 2012). Because they have similar habits and habitat preferences, some studies choose them comparing with each other (Li & Li, 1999; Li & Liu, 2005; Zou & Wu, 2006). Based on recent data, it is for sure that the number of red-crowned crane on the Chinese mainland has declined considerably (Su & Zou, 2012; Li Y et al., 2012). This decline is associated with increasing development of crane habitats, which has led to increasing survival pressure on crane populations (Qian, 2005).

The Chinese government has always attached great importance to the protection of cranes. In recent years, under the influence of sustainable and scientific development views, China ushered in a climate of change in the development of laws and regulations regarding crane conservation. For instance, a national strategy for biological diversity, which indicated China’s overall goal of protecting biodiversity up to 2030, was promulgated in 2011. In the second half of 2014, the Environmental Protection Law of the People’s Republic of China, originally promulgated in 1985, was completely revised, and was enforced on January 1, 2015. Revision of the Wildlife Protection Law of the People’s Republic of China is underway at the time of writing. Applications for the designation of national parks and world heritage sites in China are currently at the preparatory stage (Zhu, 2014). Under the background that the relevant policies for crane conservation gradually improved, in order to protect integrity of red-crowned and white-naped cranes better, we need to comb the existing relevant research and intelligence, analyze the factors that may cause a negative impact on crane population, and provide scientific basis for formulating more reasonable protection countermeasures.
Su et al. (2000) and Qian (2005) conducted macro analyses on the distribution and population status of all crane species in China. Based on vast amounts of data acquired in recent years, Su & Zou (2012) systematically collated the distribution of red-crowned cranes and the condition of their habitats. In order for policy-making to be effective in achieving conservation of cranes, a deeper understanding of migration flyways, current status of crane habitats, and existing issues surrounding protection of cranes is needed. To this end, we studied the migration and ecology of red-crowned and white-naped cranes, by collating satellite tracking results and relevant survey and crowd sourced wildlife data. Here, we present a review of the data on crane migration flyways and features of important habitats, and outline important issues surrounding conservation of red-crowned and white-naped cranes. By analyzing and understanding the current status of crane populations in China, we can better identify challenges to the conservation of these species, and make important contributions to the establishment of effective crane conservation laws and regulations.

2. Information Collection

Japanese, Russian, and American scientists used satellites to track the migration of 18 red-crowned and 20 white-naped cranes. Eleven of the 18 red-crowned cranes were captured in a breeding ground along the Amur River in Russia, and the other 7 along Lake Khanka on the border of Russia and China (Higuchi et al., 1998; Tamura et al., 2000). Nine of the 20 white-naped cranes were captured in Izumi in Kyushu, Japan, between 1992 and 1993 (Higuchi et al., 1996); the other 11 were captured in Daursky, Khingansky or Muraviovka in Russia, between 1991 and 1993 (Higuchi et al., 2004). Information on the migration flyways and critical habitats of these birds was obtained. Using these data, we have predicted the distribution of these two crane species.

Satellite tracking is an excellent research tool to study bird migration (Higuchi 2012, 2013), but the number of individual animals used for tracking is small. In order to determine the migration pattern, distribution, and abundance of cranes more accurately, we collected observation records from various sources such as papers, reports, online data, and observations of bird watchers. Critical habitats were assigned based on revision of relevant information on crane habitats, such as land use change, development history, and bird conservation status.

Bird poaching is common in China but there is little study in this field. We used online databases and social networking service (SNS) to collect recent bird poaching data for red-crowned and white-naped cranes on migration flyways and in important habitats, in order to better understand the current extent of crane poaching. As the main information-collecting platform, we selected the SNS Sina Weibo, as it had the largest number of registered and active users in mainland China. As of February 20th, 2013, the number of registered users of Sina Weibo was more than 500 million, and the number of active users had reached 4,620 million. We adopted the following two methods for collection of data between January 1st, 2012 and December 31st, 2014: (1) 200 active bird watchers were carefully selected from the list of SNS registered users, and all information regarding poaching of migratory birds that was posted online by these users was monitored throughout the study period; (2) keywords were used to seek other information on migratory bird capture, trafficking, transporting, purchasing, and consumption. Information was considered relevant if the following were detailed: a specific time, location, and clear images of the poaching event.

3. Migration Flyways and Habitat Conditions

3.1 Migration flyways and population status

The red-crowned crane

The global population of the red-crowned crane is approximately 2,800 individuals, divided into two entirely separate groups: island and continental subpopulations. The island subpopulation resides in Hokkaido in northern Japan. This subpopulation is non-migratory, and in 2008, was estimated at more than 1,300 birds (Masatomi, 2008). The continental subpopulation comprises 1,500 birds (Su et al., 2000; Masatomi et al., 2004; Su & Zou, 2012). This subpopulation is migratory, summering in northeastern China, Russia, and Mongolia, and wintering in the middle and lower reaches of the Yangtze Plain and the middle part of the Korean Peninsula along the Demilitarized Zone (DMZ) (Fig. 1, H). Because of these different wintering grounds, the continental subpopulation is approximately divided into two separate flyways: western (Fig. 1, α) and eastern flyways (Fig. 1, β) (Higuchi et al., 1998).

In China, there are three main breeding grounds for the red-crowned crane: Hulu Lake and the surrounding areas, where the borders of Russia, Mongolia and China meet (Fig. 1, A); the Songnen Plain in the northeastern Inner Mongolia Autonomous Region, Jilin Province, and western Heilongjiang Province (Fig. 1, B); and the Sanjiang Plain in eastern Heilongjiang Province, and the Amur Region in eastern Russia (Fig. 1, C) (Qian, 2005). Birds in the continental subpopulation, which uses the western flyway, probably all migrate through Shuangtaihekou Nature Reserve (Fig. 1, D). Migrating red-crowned cranes have been observed each year from 1991–2012 in the Shuangtaihekou Nature Reserve, in numbers ranging from 300 to 800, and the largest known breeding subpopulation (50 birds) was observed there (Li Y et al., 2012). The Xingkai Lake (Fig. 3, 6) and surrounding wetlands are probably critical for the migrating population of red-crowned cranes that use the eastern flyway (Liu & Wang, 2006). The Yancheng Nature Reserve (Fig. 1, G) in Jiangsu Province is the most important wintering ground for the continental subpopulation on the eastern flyway; here, approximately 800–1000 red-crowned cranes are observed each year, and in 2000 the maximum number of 1128 birds was recorded.
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In addition, wintering populations of red-crowned cranes were observed in the Yellow River Wetland Nature Reserve in Shaanxi Province (Fig. 1, E), the Poyang Lake in Jiangxi Province (Fig. 1, F), and the Yellow River Delta Nature Reserve in Shandong Province (Fig. 3, 9) (Su et al., 2000; Shan et al., 2007).

The white-naped crane

The global population of the white-naped crane is approximately 5,000 and is divided into two groups: one that breeds in western Songnen Plain (Fig. 2, A&B), migrates southward via the Yellow River Delta, and winters in the Poyang Lake (Fig. 2, F); and one that breeds in the Sanjiang Plain (Fig. 2, B&C) and the eastern Songnen Plain, migrates southward via the Korean peninsula, and winters in Kyushu, Japan (Fig. 2, H) (Su et al., 2000; Qian, 2005). The continental subpopulation is divided into two separate flyways: western (Fig. 2, α) and eastern flyways (Fig. 2, β).

In China, breeding grounds of the white-naped crane overlap those of red-crowned cranes except in Shuangtaihekou, where only red-crowned cranes breed. The Yellow River Delta (Fig. 3, 9) is an important stopover site for western flyway white-naped cranes, and the largest recorded flock (550 cranes) was observed there (Wang & Yang, 2005). White-naped cranes using the eastern flyway arrive at the Sanjiang Plain via the Xingkai Lake, where the largest bird flock (840 cranes) was recorded (Liu & Wang, 2006). For white-naped cranes on the western flyway, Poyang Lake (Fig. 2, F) in Jiangxi Province (Fig. 3, n) is the most important wintering ground. In this region, the number of wintering cranes was steady (at approximately 3,000 birds) between 1999 and 2003, and the largest number of 4,354 cranes was observed in 2000 (Li F et al., 2012). Wintering cranes have also been observed in the Dongting Lake (Fig. 2, E); Shanghai (Fig. 2, G); and southern Henan Province (Fig. 2, D) (Su et al., 2000).

3.2 The status of main crane habitats

Breeding grounds

The northeastern plain of China is the main breeding ground for red-crowned and white-naped cranes. The broader China northeastern region includes Heilongjiang, Jilin, and Liaoning provinces, and eastern Inner Mongo-
lia Autonomous Region. The region borders Russia to the north, Mongolia to the west, and North Korea to the southeast, and contains three plains: the Sanjiang Plain, in the northeast along the Amur, Songhua, and Ussuri rivers (Fig. 3, I); Songnen Plain, along the Songhua (Fig. 3, II) and Nen rivers; and Liaohe Plain, along the Liao River (Fig. 3, III). These regions are rich in wetland resources and contain important wetland reserves, such as the Honghe (Fig. 3, 5), Xingkai Lake (Fig. 3, 6), Zhalong (Fig. 3, 2), Momoge (Fig. 3, 3), Xianghai (Fig. 3, 4), and Shuangtaihekou nature reserves (Fig. 3, 7). All are important breeding sites for East Asian cranes. In addition to these regions providing abundant wetland resources, there is good agricultural development due to fertile soils and suitable latitudes and climate. Since the founding of the People’s Republic of China in 1949, the grain demand pressure brought about by rapid growth of the human population forced the northeastern plain to become the key area of national agricultural development (Sun et al., 2004). After 50 years of development, the landscape of the northeastern plain, previously dominated by wetlands, grasslands and virgin forest, was gradually replaced with farmlands. To the year 2000, the total cultivated area of the Songnen and Liaohe plains was more than 60% (up to 176,000 square kilometers) (Zhang et al., 2012), the land reclamation rate of the Sanjiang Plain rose from 7.22% to 50.01% (Liu & Ma, 2000); the wetland area decreased by 87%; and grassland and forest areas were substantially reduced (Li & Liu, 2008). Northeastern China has experienced several economic developments, and has become an important grain-producing area and the commodity grain base (Liu et al., 2004; 2005).

Land reclamation, drainage for economic development, and construction of agricultural conservancy facilities have caused tremendous environmental changes on the northeastern plain. Vegetation located at the upper reaches of the supply river on the plain suffered serious damage, wetlands in the middle region, which had the ability to impound water, have been reclaimed on a large scale, and a catastrophic flood broke out in 1998. Since 2000, the northeast region of the plain has experienced a long dry period. The Zhalong Nature Reserve had two fire disasters, in 2001 and 2005 (Zou & Wu, 2009). Since 2002, in Xianghai Nature Reserve, a large area of reeds has degenerated into Leymus chinensis grassland due to severe drought (Tian et al., 2004). This drought seriously affected traditional agricultural industry and reed harvesting, indirectly accelerating the local development of animal husbandry. Overgrazing and booming numbers of livestock caused vegetation destruction, soil erosion, and considerable soil salinization and alkalinization (Zhang et al., 2012). During this period, parts of the northeastern plain underwent desertification (Sun et al., 2004). To relieve drought conditions in the wetlands, the Chinese government adopted a method of regional water diversion, using existing river courses to transfer reservoir water oriented to the wetlands. Examples of this diversion method are the water supplement of the Zhalong and Xianghai nature reserves (in 2004, and 2003 and 2007, respectively). However, restoration of hydrology discontinuously did not seem to have any appreciable effect on wetland ecosystem recovery (Sun et al., 2014).

Stopover grounds

The Bohai Bay Rim is the most important stopover ground for red-crowned and white-naped cranes using the western flyway, and is the area in which birds stay for the longest time (Fig. 3, IV) (Higuchi et al., 1996; 1998; Higuchi, 2012). The Bohai Bay Rim is located at the border of Liaoning (Fig. 3, c), Hebei (Fig. 3, e), and Shandong provinces (Fig. 3, h) and Tianjin City (Fig. 3, y), and includes the Liao River Delta in the north, the Bohai Bay in the west and the Yellow River Delta in the south. The region contains many rivers, lakes, ponds, and reservoirs, and its shallow beach constitutes a diverse ecological wetland system. It is also an important stopover site on the migration flyway of other East Asian birds; about 120 species (over 1 million birds) pass through this
area each year (State Forestry Administration of China, 2007). In recent years, the region has also been a hot spot of China’s economic development, with the scale of coastal development activities increasing (Xu et al., 2013).

The Liaohе River Delta (Fig. 1, D) in the north has the world’s second largest original reed plain and China’s third largest oil field, and is the most important petrochemical and commodity grain base of Liaoning Province. Following large-scale development in the 1960s, the area of paddy fields increased to 1,270 km² (Xiao, 1994). Oil exploitation also played an important part in the development of this region. In the decade between 1989 and 1998, the area of infrastructure such as oil platforms and roads built for oil exploration increased by nearly 60 km², resulting in the fragmentation of original wetlands (Hu, 2004). In the Bohai Bay Rim in the middle, the area of residential land use has increased due to an accretion of the population, with a trend for increasing human disturbance and the conversion of agriculture land into forest land and fishponds. In the land use change of the Bohai Bay Rim between 2000 and 2012, the ratio of ports, fishery facilities and salt works were 36.87%, 24.49%, and 22.98%, respectively (Zhu et al., 2001).

Wintering grounds

The east coast of Jiangsu Province (Fig. 3, 10) has a long history as a wintering ground for the red-crowned crane (Ma et al., 1999), and remains the most important wintering site for the continental subpopulation that use the western flyway (Qian, 2005). The coastal region of Jiangsu Province is the estuary of the Yellow, Yangtze, and Huaihe rivers, where sediment transported from upstream is deposited, forming fertile tidal flats. Since the founding of the People’s Republic of China, exploitation of coastal areas has been intensive and has included aquaculture in shallow water areas; reed harvesting and grazing in coastal wetlands; and reclamation of old salt works (Gao et al., 2011). In 1983, the Jiangsu Provincial People’s Government established the Yancheng Nature Reserve, in order to protect local biological resources; this was upgraded to the National Nature Reserve in 1992. However, the establishment of the nature reserve did not prevent developmental impact. Sun et al (2010) showed that in the two decades between 1987 and 2007, the cultivated area on the coastline of Yancheng Nature Reserve had increased from 1,677.7 km² to 2,245.6 km², while natural wetland area had decreased from 2,028.57 km² to 1,266.3 km². Furthermore, the inner landscape of Yancheng Nature Reserve was significantly damaged with the exception of the core zone. In order to take full advantage of coastline wind energy resources, the Jiangsu Provincial People’s Government built the Dafeng Wind Farms in the south of the nature reserve, through two periods of constructions from 2006; the total area now is 58.3 km², with 247 turbines installed (Song et al., 2011).

Poyang Lake, located in Jiangxi Province, is the largest freshwater lake in China and is one of the major lakes on the Yangtze River Basin. In recent years, the population density around Poyang Lake has increased, and its natural environment has been profoundly affected by human activity. Due to illegal exploitation, the wetland area was reduced by 18.9% between 1964 and 1988, and vegetation degradation, soil erosion, and desertification had become increasingly severe (Wang, 2004). The Three Gorges Dam, constructed upstream of the Yangtze River, disturbed the balance of water supply between Poyang Lake and the Yangtze River, and increased the probability of drought and flood in Poyang Lake. In the rainy season (spring and summer), excessive rainfall and disruption to the smooth flow of water from Poyang Lake to the Yangtze River leads to flooding around the lake. On the other hand, during the dry season (autumn and winter), blocks in water upstream, and excessive water supplied from Poyang Lake to the middle and lower reaches of the Yangtze River, cause drought in the lake. Observation records demonstrate that the frequency of drought and flood in Poyang Lake has increased following the completion of the Three Gorges Dam (Jiang & Huang, 1997; Guo et al., 2011; 2012). In order to control the spread of human disease following flooding, a large area was sprayed with bactericidal drugs, which dramatically affected the biodiversity of the lake (Zhao et al., 2007). Continuous discharge of industrial, agricultural, and domestic sewage into Poyang Lake results in a decline in water quality and a tendency to eutrophication (Wang et al., 2006).

3.3 Existing issues surrounding the protection of crane populations

Environmental deterioration of crane habitats

Primary industries commonly identified within crane habitats include farming, grazing (Fig. 4), hunting, fishing, and forest plantation; secondary industries include oil exploitation, (Fig. 5) wind power generation, (Fig. 6) and dam construction; and tertiary industries include tourism. Over-exploitation of natural land and construction of highways have accelerated wetland fragmentation and disappearance. Air, water, and soil pollution, and anthropogenic interference brought indirectly by industry, have resulted in shrinking areas of suitable habitats, as well as a shortage of food resources for cranes. The nest spacing of red-crowned cranes in Zhalong Wetland declined from, on average, 1,600–2,000 m in the 1990s, to less than 1,000 m in 2008 (Wang et al., 2010; 2014). The number of breeding pairs of red-crowned cranes in Xianghai Wetland was 13–16 from 1999–2001, declined sharply to four in 2002, was only one in 2003 (He et al., 2004), and no breeding pairs were recorded in 2004 (Northeast institute of Geography and Agroecology, Chinese academy of sciences, 2005). The crane population declined not only in breeding grounds, but also in wintering grounds. The number of red-crowned cranes wintering in the Yancheng Nature Reserve declined from 967 birds in 2005, to 502 in 2009 (Lu, 2008). The number of white-naped cranes wintering in the Poyang Lake...
Bird poaching within crane habitats is a factor threatening crane populations. We documented 342 bird poaching cases between 2012 and 2014, and demonstrated that poaching occurred in all provinces and municipalities of China where red-crowned and white-naped cranes reside and migrate, including in main breeding grounds, stopover sites, and wintering grounds. Bird poaching methods predominantly used nettings, bird nets were weaved by thin lines and were similar to fowler nets used for the study of birds. Baits made by soaking bird foods such as sago, small fishes, and shrimps in toxic pesticides were also commonly used, and spread in areas where birds lived. Birds suffered from spasms and paralysis within a few minutes of ingesting these baits. Shotguns, trappings, and slingshots were also used as methods of poaching. The majority of poachers were farmers and the majority of prey was captured in remote areas, such as rural and suburban areas, and nature reserves. Poachers would sell birds quickly to reduce risk and loss associated with preserving poached birds; therefore, local poaching for local consumption was the mainstream. Often, restaurants that sold poached birds as game to attract customers were located around large poaching sites. A typical region in which poaching was seen is Poyang Lake, a well-known wintering ground for migratory birds, where the reduction of suitable habitat and food concentrates migratory birds, including cranes, to certain areas that have an increased risk of poaching.

4. Conservation Recommendations

It is clear from the status of crane habitats that continental subpopulation of red-crowned and white-naped cranes are under tremendous threat, due to habitat destruction and deterioration, human disturbance, chemical pollution, and poaching. However, the populations of red-crowned and white-naped cranes in other countries and regions have changed while the natural environment of China deteriorated. For example, the breeding population of white-naped cranes in north-eastern Mongolia increased from dozens in the late 1960s, to more than 1,000 now (Ute et al., 2005; USGS, 2013). Numbers of red-crowned cranes wintering in DMZ, and of white-naped cranes wintering in Izumi City, Kyushu, Japan have increased (Lee et al., 2007; Li Y et al., 2012). Changes in the distribution of cranes will greatly increase the ecological burden on habitats, as well as the risk of infectious diseases posed by large concentrations of birds. For example, in 2010–2011 and 2014–2015, there were outbreaks of Highly Pathogenic Avian influenza in the crane wintering ground in Izumi City, and some cranes were infected and died as a result (OIE home page, 2011; 2015). In order to avoid such risks, restoration of habitat in continental wintering and stopover grounds is of paramount importance. To achieve this goal, promotion of the protection of cranes, and the development of science-based laws and regulations, must be introduced as soon as possible. Survival pressure on red-crowned and white-naped cranes is rooted in national development policies, and strong protection policies are needed as a countermeasure to this. For a long time, the Chinese government has lacked a scientific understanding of cranes and their habitats and this has affected the formulation of laws and regulations for the preservation...
of biological diversity. On the one hand, laws and regulations have been largely “people-oriented” and on the other, there has been an insufficient understanding of the needs of cranes. Currently, maintaining biodiversity has a growing influence on sustainable development, and the value of crane species should be re-examined and their importance rearranged in light of this.

There is a need to improve assessment mechanisms of natural ecosystems and actively promote the eco-compensation service process. In China, crane habitat conservation is centered on nature reserves, but these reserves have been greatly affected and restricted due to unclear management; chaotic division of land use; and internal residents at the beginning of the establishment process. Since nature reserves not only protect animal species but also improve people’s livelihood, this conflict is vivid in the habitats of red-crowned and white-naped cranes. Adequate environmental evaluation of natural ecosystems will effectively distinguish positive impacts from negative ones arising from project development. Ecological compensation can maximally restrict unreasonable development and protect ecosystem integrity.

There is a need to develop a more comprehensive and extensive crane-monitoring network. Since 2000, the Chinese government has strengthened monitoring of cranes and has already achieved some success. For example, many new crane habitats have been identified in recent years and our knowledge of cranes has generally advanced. While the proportion of nature reserves is limited compared to the entire distribution range of red-crowned and white-naped cranes, it must be taken into account that, owing to insufficient staff numbers on nature reserves, crane monitoring is difficult in some areas. Through the three-year study of bird poaching outlined here, we have shown that a large number of bird lovers have a prodigious knowledge of birds and a prevailing sense of justice in support of abolishing poaching practices. Because bird monitoring requires a long-lasting and broad investigative approach, contributions from the NPO, research institutions, and ordinary citizens are desirable.

Finally, there is a need to strengthen the publicity and education surrounding the conservation of cranes. China is a vast and multicultural country, resulting in a great difference in the levels of importance and attention ascribed to the conservation of birds; in some areas, for example, the practice of eating these birds still exists. Actively popularizing knowledge of birds, and publicizing laws and regulations surrounding bird conservation, will help to improve the social morality surrounding these subjects. Crane conservation requires the joint efforts of the government and society. We sincerely hope that the natural and human environment will continue to improve in China, and that China can take more responsibility in its role in the international conservation of cranes.

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