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S12-3 Changes in red-crowned crane (*Grus japonensis*) habitats in Yancheng Nature Reserve in the last 20 years

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Abstract Over the last 20 years we studied changes in winter habitat use by red-crowned cranes *Grus japonensis* at Yancheng Nature Reserve, China. The number and distribution of red-crowned cranes, as well as habitats occupied, were recorded. In the 1980s, the birds occupied almost all tidelands in the Reserve, but by the early 1990s had become confined to middle and southern sectors, and then, in the late 1990s, to the center itself, the core area of the Reserve. Currently, more than 70% of cranes occur there and in its surrounds, over an area of about 200 km^2. Over the past two decades, habitats used by the cranes have changed from original wetlands (1980s) to artificial and semi-artificial wetlands (1990s) and now artificial wetlands, semi-artificial wetlands and wheat/paddy fields (1999–2000). Wheat/paddy fields began to be used by the cranes in 1995, and by the winter of 2000 were occupied by nearly 40% of the Reserve's total population. Changes in habitats and habitat use are due to large-scale development of the tidelands. We consider that, with suitable management, artificial wetlands are a viable alternative to natural wetlands for red-crowned cranes at winter quarters.

Key words Red-crowned crane, *Grus japonensis*, Habitat change, Habitat use, Yancheng Nature Reserve, China

1 Introduction

The red-crowned crane (*Grus japonensis*) is an endangered species endemic to North-East Asia, where it survives in a migratory continental population and a resident non-migratory population in Japan (Meine and Archibald, 1996; BirdLife International, 2001). Its present population stands at 2200, of which about 1 600 belong to the migratory population (Chan, 1999). Yancheng Nature Reserve in China is one of its most important wintering grounds: nearly 1000 birds have been wintering there in recent years, more than half of the migratory population.

Due to the sedimentation of silt carried by the Yangtze River, the tidelands at the southern part of Yancheng Nature Reserve extend eastward to the sea, creating large expanses of natural wetlands that are good habitat for red-crowned cranes (Ma et al., 1998). Over the last two decades, however, simultaneous pressure from a growing human population and an urgent need for land resources has led to both reclamation of tidelands and concomitant development in the Reserve. Intensive exploitation of the tidelands continues to destroy the natural wetlands, formerly the main habitat of the red-crowned crane (Ding and Zhou, 1982). Because the rate of land reclamation is much faster than natural tideland expansion, the area of natural wetlands continues to diminish. The changes in land use have already affected the crane and its habitat seriously (Ma et al., 1998), because of which Reserve managers need to know how to conserve the crane as the tidelands are developed.

Accordingly, this study aims to (1) understand how the changes in habitat have affected the distribution and habitat use of the red-crowned crane at Yancheng Nature Reserve, (2) analyze the effects of development activities on the cranes, and 3) provide conservation strategies for sustaining the crane in the future.

2 Materials and methods

2.1 Study area

Yancheng Nature Reserve is located in the central part of the eastern tidelands of China, between 32°34'N and 34°28'N, and 119°48'E and 120°56'E. The coastline of the Reserve is 584 km long and the total area covered is about 4 530 km^2. The major conservation targets of the Reserve are management of the red-crowned crane and other waterbirds, together with their habitats.

The tidelands are important for the crane. Coincident with the natural expansion of the tidelands, the vegetation shows successional sequence. Its pioneer plant is *Suaeda salsa*, changing to *Aeluropus littoralis* in a transitional zone to the climax community of *Imperata cylindrica* and *Phragmites communis* (Ma et al., 2000). In recent years, *Spartina alterniflora*, an introduced species from America, has spread rapidly and now covers large areas. An abundant zoobenthos (crabs, snails, clamworms) and aquatic

animals (fishes, shrimps) provide food resources for the crane (Liu, 1990).

2.2 Bird counts

Every October, red-crowned cranes arrive on the Reserve from their breeding grounds, and remain until March. Bird counts were conducted in every December or January over the last two decades when the numbers and habitats of cranes are stable. To cover the entire area of the Reserve, two to four groups of observers conducted counts simultaneously, using 30× telescopes. The numbers and habitats occupied by cranes were both recorded, and the point location of cranes marked on landuse maps (1:10 000). After 1997, the locations of cranes were determined by GPS.

2.3 Habitat analysis

Following Ma et al. (1999), the major habitats of red-crowned cranes were classified into six types: saltworks, aquacultural ponds, reed lands, grassy tidelands, beaches with salt-living wormwood, and wheat/paddy fields. The number of cranes in each habitat type was recorded. All habitats used by cranes were regrouped into four further types to add a historical dimension: natural wetlands, semi-artificial wetlands, artificial wetlands, and wheat/paddy fields. They are categorized as follows: (1) natural wetlands, formed naturally and without disturbance from human activities, (2) semi-artificial wetlands, formed naturally but affected by human activities, such as reed-harvesting, and catching of crabs, mollusca and gastropods, (3) artificial wetlands, converted from other types of land use into wetlands and dominated by human activities, such as fishponds and aquaculture, and (4) wheat/paddy fields, which are uncultivated after harvest and through the winter, and available to cranes for foraging then. In these fields, the cranes forage for seeds and malts.

Landuse data for the Reserve were collected from local government sources. Satellite imagery (Landsat5 TM) of the Reserve was also examined in 1984, 1992 and 2000 to map landuse conditions in the Reserve. The area of developed land and the location of developments on the tidelands were also determined then; the area of developed tidelands was calculated using Arcview GIS version 3.2 (ESRI 1999).

3 Results

3.1 Changes in numbers of red-crowned cranes

In the early 1980s, only about 400 red-crowned cranes were recorded in the Reserve. In the two decades since then, their numbers have, despite fluctuations, increased gradually. In the winter of 1996, their numbers reached 1 020, the largest number yet recorded. Since then, numbers have remained stable at about 800–1 000.

3.2 Changes in distribution of red-crowned cranes

Significant changes have occurred in the distribution of the cranes over the past two decades. In the early 1980s, cranes could be found in most parts of the Reserve, although their numbers were low. From then on, they began to become concentrated in southern sectors. In the early 1990s, most cranes occurred in central and southern parts which, from 1985 to 1996, held 40% of the population; cranes in the north occurred only at saltworks. By the late 1990s, all had become concentrated in the central part of the Reserve, that is, the Reserve's core area. In the winter of 2000 and 2001, more than 70% of cranes were present in the core and surrounding regions, within an area of about 200 km^2 and covering about 4% of the total area of the Reserve.

3.3 Changes in habitat use by red-crowned cranes

In the early 1980s, the main habitats used by cranes were grassy tidelands and beaches with salt-living wormwood. Nearly 80% of cranes were recorded in these two types of habitats. The number of cranes on beaches with salt-living wormwood decreased in the 1990s, and those on grassy tidelands decreased similarly after 1996. In the winter of 1995, three cranes were recorded in wheat fields. This was the first time that cranes were found selecting farmland as habitat. In the winter of 1996, the number of cranes recorded there increased to 95, to about 10% of the total crane population. In the winter of 1999 and 2000, wheat/paddy fields finally became important habitats for cranes. In these two years, 37.2% and 38.1% of the total crane population, respectively, was recorded there. Some cranes searched for wheat seeds and malts in wheat fields, while others foraged by gleaning in harvested paddy fields.

In 1982, natural wetlands were the major habitats of red-crowned cranes, with 61% of cranes recorded there. In the late 1980s, this changed to artificial and semi-artificial wetlands. Thus, in 1988, about 47% of cranes were recorded on natural wetlands while the remainder, more than half, selected artificial and semi-artificial wetlands. In the winter

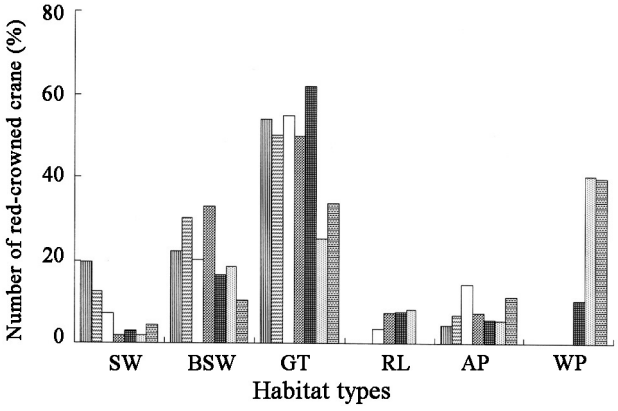

Fig. 1 Habitat use by red-crowned cranes in Yancheng Nature Reserve, showing % of total crane population in each habitat type in different years

SW = saltworks, BSW = beaches with salt-living wormwood, GT = grassy tidelands, RL = reed lands, AP = aquacultural ponds, WP = wheat/paddy fields. Column legend for different years: vertical lines = 1982, diagonal dashes = 1985, open bars = 1988, shaded bars = 1993, cross-hatched bars = 1996, stippled bars = 1999, horizontal lines = 2000.

of 1995, 564 cranes were recorded on artificial and semi-artificial wetlands, about 71% of the total crane population in that year. Since 1999, artificial wetlands, semi-artificial wetlands and wheat/paddy fields have become the major habitats for cranes; only about 10% of cranes are now recorded in natural wetlands. These shifts in habitat use are shown in Fig. 1.

3.4 Changes in land use in the Reserve

Tidelands in the Reserve have been reclaimed and developed over the past two decades. In the early 1980s, development was concentrated in the north, where more than 50% of the tidelands were converted to saltworks and farmlands in Xiangshui and Binhai counties (Fig. 2). At that time, most of the tidelands in the central and southern parts of the Reserve remained in natural condition. From the mid 1980s, however, large-scale development began in central sectors, particularly in reed beds and aquacultural ponds.

Then, the southern parts of the Reserve became subject to development, and by 2000, about 75% of the tidelands had been reclaimed for exploitative development. Currently, the natural wetlands in the Reserve remain as beaches with salt-living wormwood, exposed tidelands and other areas with little human disturbance. Due to harvesting, most of the reed beds and grassy tidelands have become semi-artificial. The percentage of Yancheng Nature Reserve that has been subjected to development is shown in Fig. 2.

4 Discussion

Due to the deposition of silt and human activities on the tidelands, the environmental conditions of Yancheng Nature Reserve have continued to change during the past two decades. The distribution of red-crowned cranes in the Reserve follows these changes. In the 1980s, the natural wetlands in the northern part of the Reserve gradually disappeared due to development. Because of the sedimentation of silt on tidelands in the southern sector, large areas of new tidelands formed there rapidly. Though some development began there as well, large areas still remained to provide natural wetlands for cranes; and the cranes moved there accordingly. After the mid-1990s, large-scale development in the southern sector reclaimed large areas of natural wetlands, changing them into farm lands. The loss of natural wetlands and intensive human disturbance then caused the cranes to move to the central parts of the Reserve.

Although development has now begun in this core area, its relatively low intensity has not disturbed the cranes much. Moreover, most development there is concerned with establishing artificial wetlands, such as aquacultural ponds and waterfowl lakes, which provide habitat for cranes. Human-provided foods may also be important to the cranes there (Lu, 1998). More than 100 cranes are now commonly recorded foraging for food provided to them daily at artificial feeding sites. Artificial feeding is important for maintaining a stable population of red-crowned cranes in the core area of the Reserve, especially later in the winter, when natural food resources become depleted. Due to large scale of tideland reclamation and development elsewhere, human-provided foods help to maintain stable populations of cranes over the rest of the Reserve as well.

This study shows that artificial wetlands, semi-artificial wetlands and wheat/paddy fields have now become the major wintering habitats of red-crowned cranes, and that human-provided foods are an important resource supplement. This situation is similar to that in Japan, where red-crowned cranes depend on artificial wetlands and human-provided foods (Ohsako, 1994). Nevertheless, we conclude that the habitat changes for red-crowned cranes in Yancheng Nature Reserve reveal that development has had serious effects on their feeding ecology, and that their natural wetland wintering habitat has been largely lost in the past two decades.

By foraging in wheat fields, red-crowned cranes are

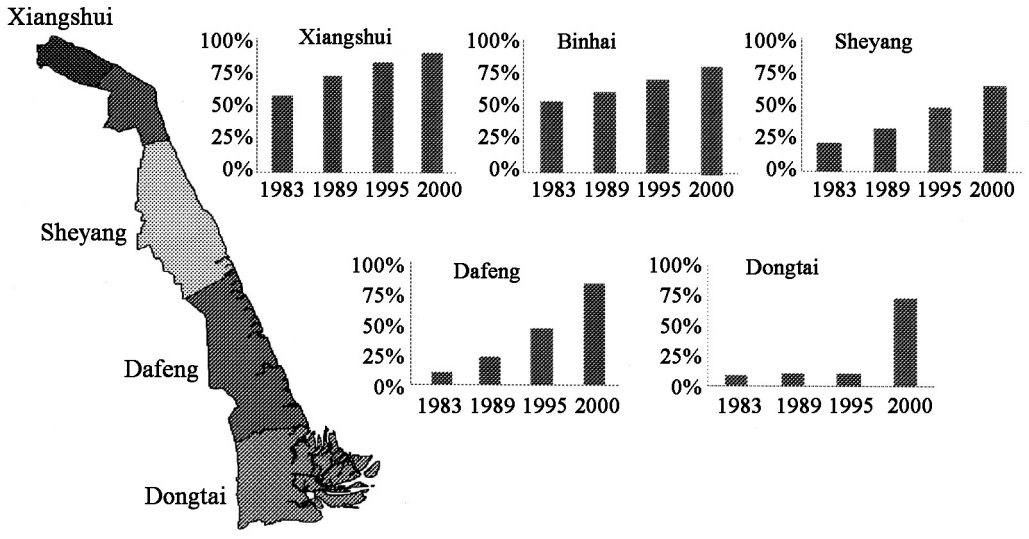

Fig. 2 Developed area (%) of tidelands in Yancheng Nature Reserve

further threatened by agrochemicals and pesticides. Every year from 1996 onwards, cranes have been found poisoned from eating treated seeds or malts in wheat fields. Poisoned cranes have also been found frequently at other wintering grounds and stopover sites (Ma et al., 2000). Conservation measures should be taken by the Reserve and local government to allay these threats.

Although the development of tidelands has had serious effects on the red-crowned crane and its habitats, it has also brought enormous economic benefit to the local communities (Ma, unpubl.). How to manage the relationship between economic development and the conservation of red-crowned cranes is an important issue facing Reserve managers and local government (Ma et al., 1998). In the interim, we conclude that artificial wetlands, such as aquacultural ponds, should be considered as having significant potential in the Reserve, economically and for the cranes. Scientific management should also be undertaken to limit disturbance to artificial wetlands coincident with human activities, and to provide abundant food resources for red-crowned cranes.

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