

Evaluation of Historic Breeding Habitats with a View to the Potential for Reintroduction of the Oriental White Stork (*Ciconia boyciana*) and Crested Ibis (*Nipponia nippon*) in Korea

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ABSTRACT

The Oriental White Stork (*Ciconia boyciana*) and the Crested Ibis (*Nipponia nippon*) are wetland species listed as “Endangered” on the IUCN Red List of Threatened Species. The two species were once common on the Korean peninsula, but have experienced a severe population reduction in the past decades. Currently, they are officially extinct in Korea. At present, reintroduction programs to release the birds to the wild are in progress in Korea as well as in Japan. In this study, we surveyed the historic breeding sites of the two species using the literature and face-to-face interviews with local people as a step toward determining appropriate breeding habitats for reintroduction. We found 26 historic breeding sites for the Oriental White Stork in Chungcheong-do and Gyeonggi-do, but did not find any breeding sites for the Crested Ibis. These findings suggest that the Oriental White Stork was resident, while the Crested Ibis was a winter visitor to Korea. Based on these results, we discuss the possibilities for successful reintroduction of the two species in Korea.

Keywords: *Ciconia boyciana*, *Nipponia nippon*, historic breeding sites, interviews, reintroduction

INTRODUCTION

The Oriental White Stork (*Ciconia boyciana*, family Ciconiidae) and the Crested Ibis (*Nipponia nippon*, family Threskiornithidae) both have typical characters of a long bill, neck, and legs, and are in the order Ciconiiformes. They are representative wetland species, foraging in rice fields (artificial but well-developed wetlands), riparian areas, and various types of wetlands. However, the two species have experienced severe population declines in the wild during the past decades, primarily due to hunting, but also to habitat loss and decreasing food resources due to the use of insecticides (Hancock et al., 1992; Park and Cheong, 2002). Thus, they are now listed as “Endangered” on the IUCN Red List of Threatened Species, and there is great concern over their protection and conservation (Birdlife International, 2001). At present, the two species are both considered extinct in Korea, although the Oriental White Stork can be seen in the winter on migration.

Reintroduction programs for the Oriental White Stork and

Crested Ibis are in progress in Korea; the number of storks in captivity has increased to 97 individuals, while one pair of ibis was recently imported from China for captive breeding. Once there are enough captive individuals in Korea, it is still uncertain whether the two species can persist successfully in appropriate habitats after release into the wild.

In general, the success rates for survival and persistence of reintroduced species in the wild are quite low. Estimates of success rates have ranged from 11% (Beck et al., 1994) to 38% (Griffith et al., 1989) among the programs reviewed. Low success rates have been due to lack of systematic preparation for the reintroduction, as well as technical problems during the actual reintroduction process (Snyder et al., 1996; IUCN, 1998).

Thorough studies on the historic sites of the subject species are a prerequisite for success in reintroduction programs. The following must be considered before initiating a reintroduction program: 1) whether the species inhabited the particular area in the past, 2) whether habitat restoration is possible, and 3) whether the species can avoid predators at the release site (Kleiman et al., 1994).

Reintroduction programs with incomplete preparation may cost time, energy, and money and be unsuccessful. Thus,

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in this study, we investigated the historic breeding habitats of the Oriental White Stork and Crested Ibis through a literature review and conducted face-to-face interviews with local people from focal areas. We also compared what is known about the breeding behaviors of the two species, and reviewed the possibilities for and appropriateness of reintroduction programs in Korea for each of the species. Finally, we suggest an alternative plan for reintroduction efforts and values in accordance with academic and biological principles.

MATERIALS AND METHODS

We first reviewed historic sites recorded in the literature and selected 421 potential breeding sites in 138 *myeons* or towns (subdivisions of *guns* or cities by administrative district) from 27 *guns* or cities in three (Gyeonggi-do, Chungcheongbuk-do, and South Chungcheongnam-do) provinces. As the average size of a *myeon* is 50.3-72.2 km² (n=416) and Oriental White Storks inhabited 19.6-63.6 km² (Kwak, 1981), we organized the interviews of local residents based on *myeon* district. We visited the sites in winter 2008 and spring 2009 to verify and identify additional historic breeding sites through face-to-face interviews with local people from each focal area using prepared questionnaires. We interviewed a total of 1,270 local residents at least 60 years of age, because the two species were present until the 1970s. Each interview was 30-60 min. The questionnaires included five questions presented in a step-wise fashion to the respondents as follows:

- Step 1: Have you ever seen Oriental White Storks or Crested Ibises breeding at your village? If the respondent says "yes," go to the next step.
- Step 2: Do you know the birds' size, bill shape, and feather coloration? If the respondent answers correctly, go to the next step.
- Step 3: Do you know the vocalization of the birds? If the explanation of the vocalization is correct, go to the next step.
- Step 4: How many birds bred in one nest tree? If the respondent answers two birds only, go to the next step.
- Step 5: Could you show us the tree where the birds had nests?

We confirmed nest locations by visiting the breeding tree as part of step 5 and asking the interviewee to describe the breeding behavior of the target species. Guesses by the respondents were addressed through validation methods such as asking them to point out the appropriate target species from a picture (20 × 15 cm, 300 dpi resolution) showing various types and sizes of wetland species (e.g., Great Egret, *Ardea alba*; Red-crowned Crane, *Grus japonensis*; Gray He-

ron, *Ardea cinerea*).

RESULTS

About 57% (727 of 1,270) of the respondents had seen Oriental White Storks in their villages; however, only 4% (47) respondents correctly answered the final question of step 5 (Table 1). About 9% (97 of 1,109) of the respondents, by contrast, claimed to have seen Crested Ibises; however, no one correctly answered the final question. Only three respondents from Yeongyeom-ri, Goduck-myeon, and Pyeongtaek-si responded that they had seen several ibises at the beginning of winter in the 1960s.

Several sources of information on the historic habitats of the Oriental White Stork and Crested Ibis were identified during the literature surveys and the interviews (Table 2). There were four historic breeding sites of the storks in South Korea listed in the literature, including two at Eumseong-gun, one at Jincheon-gun, and one at Yesan-gun, and we identified 22 new breeding sites from the 47 respondents who answered the final question: seven at Yeosu-gun, five at Icheon-si, four at Anseong-si, two at Eumseong-gun, and one each at Pyeongtaek-si, Cheonan-si, Yesan-gun, and Yeonggi-gun (Fig. 1, Table 3).

The respondents stated that breeding at the historic sites discontinued between 1920 and the mid-1970s, and that habitat destruction during the Korean War (1950-1953) and poaching were the main factors causing local extinctions. The nest trees were seven ginkgoes (*Ginkgo biloba*), seven pines (*Pinus densiflora*), four poplars (*Populus deltoides*), two oaks (*Quercus* sp.), two firs (*Abies holophylla*), one persimmon (*Diospyros kaki*), one ash (*Fraxinus rhynchophylla*), one acacia (*Robinia pseudoacacia*), and one willow (*Salix glandulosa*). The 26 sites were frequently located near flood plains.

DISCUSSION

During the present study, we found 26 historic breeding

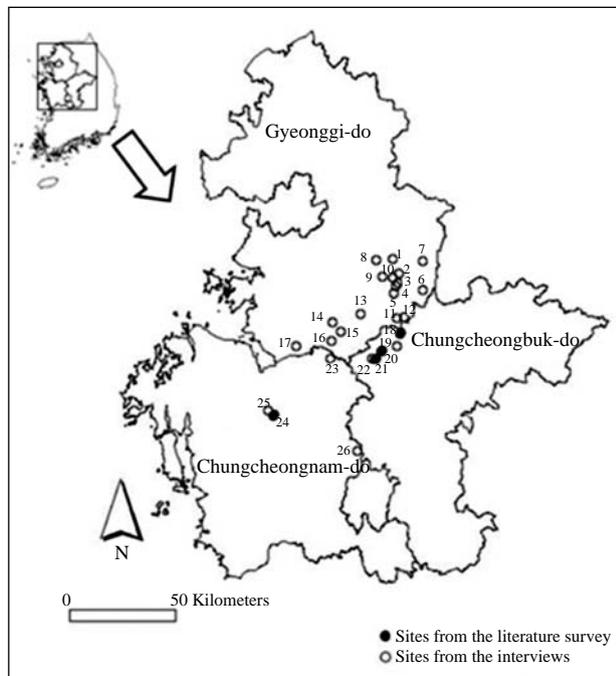
Table 1. Correct responses to each question during the five-step interviews concerning historical breeding sites for the Crested Ibis and Oriental White Stork

Question	Oriental White Stork (%)	Crested Ibis (%)
Step 1	727 (57)	97 (9)
Step 2	266 (21)	3 (0.2)
Step 3	145 (12)	0
Step 4	79 (6)	0
Step 5	47 (4)	0
Total	1,270	1,109

Table 2. Historic habitats of the Oriental White Stork and Crested Ibis in Korea (1883-1970)

Province	Oriental White Stork	Crested Ibis
Hamgyeongbuk-do	Nasun ³	Kumchack (Sungjin) ^{1,2,3}
Hamgyeongnam-do	Kimchack* ^{3,6} , Sinpo ³	Yonghung ¹ , Sinpo ¹ , Hamhung ^{2,3} , Wonsan ^{1,2,3}
Pyeonganbuk-do	Parkchun ³	Amnok (Yalu) river* ⁴
Pyeongannam-do	Pyongyang ³ , Anju ³	Sanchun ¹ , Anju ¹
Hwanghae-do	Ongjin ³ , Haeju ³ , Pyongsan* ⁶ , Onjungri ³ , Baecheon* ^{3,6}	Haeju ^{1,2,3}
Gyeonggi-do	Seoul ³ , Goyang ³ , Yeosu* ⁵ , Icheon* ⁵ , Yangpyeong ⁵ , Pyeongtaek* ⁵ , Anseong* ⁵ , Ilsan ⁵	Seoul ^{1,3} , Goyang ^{1,3} , Pungduck ¹ , Suwon ¹ , Goran ¹ , Palmido ¹ , Gaepung ^{1,3} , Yeoncheon ¹ , Panmunjom ¹ , Pyeongtaek ⁵
Chungcheongbuk-do	Eumseong* ⁶ , Jincheon* ⁶ , Chungju ³	Eumseong ^{2,3}
Chungcheongnam-do	Yesan* ⁷ , Cheonan* ⁵ , Yeongi* ⁵	Seosan ² , Hongseong ^{1,2} , Gongju ^{1,3} , Asan ¹ , Daejeon ²
Gyeongsangbuk-do		Yecheon ^{1,3}
Gyeongsangnam-do	Busan ³	Busan ^{1,3}
Jeollabuk-do		Gunsan ¹ , Gimje ^{1,2,3}
Jeollanam-do		Mokpo ^{1,2,3}

*Breeding sites

¹Goto (2005), ²Shi and Cao (2001), ³Kang (1962), ⁴Sowerby (1923), ⁵Kim (2009), ⁶Park (2004), ⁷So (2007)**Fig. 1.** Breeding sites of the Oriental White Stork in Gyeonggi-do, Chungcheongbuk-do, and Chungcheongnam-do, Korea. Filled dots indicate historic breeding sites in the literature, while open dots are sites identified through the interview surveys. Information on these locations is shown in numerical order in Table 3.

sites for the Oriental White Stork in three provinces, while finding none for the Crested Ibis. These results are in agreement with the previous breeding literature indicating that the Oriental White Stork was resident, while the Crested Ibis was a winter visitor to Korea.

Historic breeding habitats

Until the early 1970s, the Oriental White Stork bred at Gyeonggi-do, Chungcheong-do, and Hwanghae-do, Korea (Hancock et al., 1992; Park and Cheong, 2002; Kim et al., 2008). In particular, Campbell (1892) reported that he frequently observed breeding individuals in the central districts of the Korean Peninsula. In addition, these birds also breed in northwestern China, Japan, and Russia (Fig. 2A). At present, wild breeding populations are found in the wetlands of the Amur and Ussuri Rivers located near the national border between China and Russia, and in the extreme northeastern area of Heilongjiang, Jilin Province, China (Smirrenski, 1991). After the breeding season, they migrate to southern China, Japan, and the Korean Peninsula for the winter (Wang, 1991). According to Kuroda (1918), the storks bred on the Korean peninsula while the ibises did not. In fact, the storks bred at various locations, while the Crested Ibises bred only in the vicinity of the Amnok (Yalu) River; neither breeding records nor the interview surveys suggest that they bred in south-central Korea (Tables 1 and 2).

Many Crested Ibises once inhabited the Korean Peninsula, mainly as winter visitors in southern Korea before the Korean War of the 1950s. This has been confirmed from specimens collected in the winter (Austin, 1948; Nam, 1950; Fennell and King, 1964; Won, 1969). Kang (1962) reported that some ibises also visited the Korean Peninsula in the summer and migrated to Taiwan in the autumn, while a few ibises wintered in Korea. Shi and Cao (2001) similarly reported that many ibises were observed in the winter, but rarely in the summer, on the Korean peninsula. Summer visitors may have been vagrants or juveniles that were not able to return to their breeding sites. In addition, Sowerby (1923) reported: "It is possible that it breeds in South Manchuria. I

Table 3. Information on four historic and 22 new breeding sites of the Oriental White Stork

No.		Location	Nest coordinates
1	Gyeonggi -do	Daedaeri Heungcheonmyon, Yeosu-gun	N 37° 19' 58" E 127° 31' 52"
2		Maeryuri Neungseomyon, Yeosu-gun	N 37° 16' 19" E 127° 33' 48"
3		Osanri Ganammyon, Yeosu-gun	N 37° 14' 10" E 127° 33' 30"
4		Shinhaeri Ganammyon, Yeosu-gun	N 37° 13' 21" E 127° 33' 02"
5		Daeshinri Ganammyon, Yeosu-gun	N 37° 11' 32" E 127° 32' 18"
6		Sagokri Jeomdongmyon, Yeosu-gun	N 37° 12' 01" E 127° 41' 24"
7		Shinjeopri Buknaemyon, Yeosu-gun	N 37° 19' 20" E 127° 41' 21"
8		Jangdongri Shindunmyon, Icheon-si	N 37° 19' 55" E 127° 26' 48"
9		Shinhari Bubaleup, Icheon-si	N 37° 15' 43" E 127° 28' 42"
10		Sujeongri Bubaleup, Icheon-si	N 37° 15' 13" E 127° 31' 50"
11		Godangri Eulmyon, Icheon-si	N 37° 05' 16" E 127° 33' 18"
12		Eoseokri Janghowoneup, Icheon-si	N 37° 05' 22" E 127° 35' 27"
13		Eulgokri Samjukmyon, Anseong-si	N 37° 06' 09" E 127° 21' 43"
14		Chugokri Yangseungmyon, Anseong-si	N 37° 04' 16" E 127° 13' 02"
15	Sohyunri Daedukmyon, Anseong-si	N 37° 01' 45" E 127° 15' 36"	
16	Shinduri Gongdoeup, Anseong-si	N 36° 59' 27" E 127° 12' 36"	
17	Naeri Pangseungeup, Pyeongtaek-si	N 36° 58' 16" E 127° 01' 31"	
18	Chungcheongbuk-do	Gwanseongri Sanggeukmyon, Eumseong-gun	N 37° 01' 18" E 127° 34' 11"
19		Yupori Geumwangeup, Eumseong-gun	N 36° 58' 06" E 127° 33' 04"
20		Samhori Daesomyon, Eumseong-gun	N 36° 56' 45" E 127° 28' 08"
21		Jungsanri Iwolmyon, Jincheon-gun	N 36° 54' 51" E 127° 26' 19"
22		Nowonri Iwolmyon, Jincheon-gun	N 36° 54' 58" E 127° 25' 17"
23	Chungcheongnam-do	Shinduri Ipjangmyon, Cheonan-si	N 36° 54' 51" E 127° 12' 14"
24		Gwolgokri Daesulmyon, Yesan-gun	N 36° 40' 47" E 126° 54' 30"
25		Sucheolri Yesaneup, Yesan-gun	N 36° 41' 54" E 126° 52' 45"
26		Myunghakri Dongmyon, Yeongi-gun	N 36° 31' 48" E 127° 20' 46"

saw birds in the distance on the Yalu that I took to belong to this species. It is more likely that, as in South Shensi, where the bird is very plentiful, it breeds as well as winters in South Korea, and that only a few stragglers find their way up to the Yalu to breed. It builds its nest in a tree, much after the fashion of the herons and egrets".

This is the first record of possible breeding of the Crested Ibis on the northern Korean Peninsula near the Amnok (Yalu) River. As the ibises were summer visitors to north-western China (e.g., Liaoning, Gilin, and Heilongjiang), resident in central China (e.g., Zhejiang, Gansu, Shaanxi, and Hunan), and winter visitors to southern China (Shi and Chao, 2001), if the record of Sowerby (1923) is correct, appropriate breeding habitats for the ibises as summer visitors may have been present in the Amnok (Yalu) River area, from which they possibly migrated to the southern parts of Korea in the winter. On the other hand, the ibises in Japan were resident, with a short migration to Sado Island and the Noto Peninsula of the Ishikawa prefecture in central Honshū, the main island of Japan (Fig. 2B).

Potential for breeding on the Korean peninsula

In recent years, Oriental White Stork and Crested Ibis individuals have been reintroduced in Japan, where the wild birds became extinct in the 1970s. Five Oriental White Storks were released to the wild at Toyooka City, Hyogo prefec-

ture in 2005. Since then, annual reintroductions have continued and the first hatchling from one pair of the released individuals was reported in 2007. At present, 44 storks, including 25 fledged juveniles from the reintroduced storks and one wild stork, survive in the wild. Ten Crested Ibises were released to the wild to breed at Sado Island in 2008; however, more time is needed to determine whether the birds have adapted to the wild.

In contrast to reintroduction efforts in Japan, no attempt or preparation for reintroduction has yet occurred in Korea. Based on geographic information system analysis, Kim (2009) suggested that more than 60% of the 26 historic breeding sites of the Oriental White Stork described in the present study are no longer available for breeding due to habitat loss from urbanization and industrialization. Furthermore, the remaining sites are unprotected from further habitat loss and modification. Using these 26 breeding sites, Kim (2009) developed a habitat suitability model considering land-use changes and several other habitat factors to select potential nesting sites for reintroduction of the Oriental White Stork. Recently, the authors selected Yesan-gun, one of the 26 breeding sites, for reintroduction based on the above model, where we plan to create suitable habitat, such as establishing fishways, organic farming, and biotope restoration of rice fields. Because the breeding sites of the storks are typically located close to villages in Korea, coo-

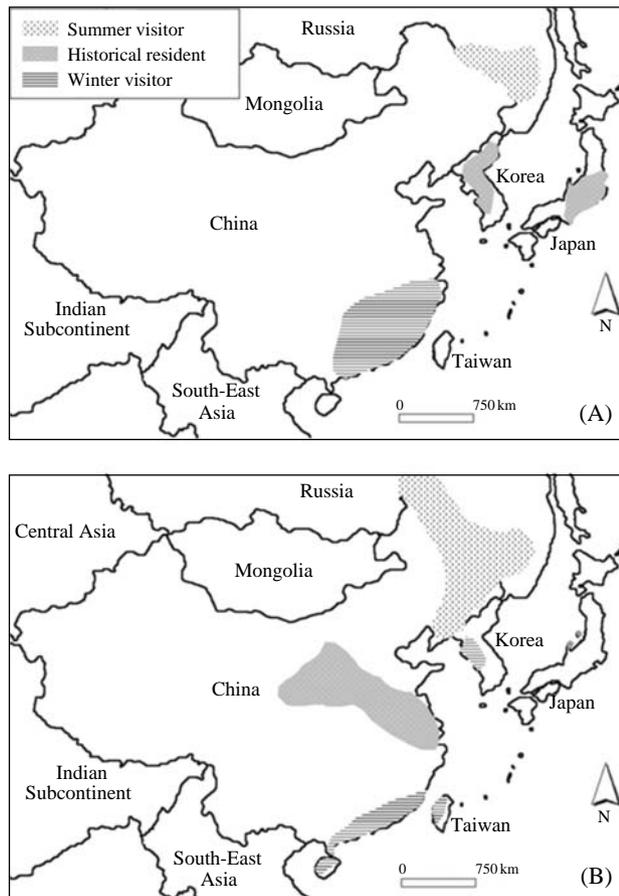


Fig. 2. Distributions of the Oriental White Stork (A) and Crested Ibis (B).

peration of the local people and support from related administrative agencies is necessary for successful reintroduction of this species (Naito and Ikeda, 2007).

Most conservation biologists support reintroduction guidelines recommending that release sites be within the historic range of the species (Brambell, 1977; Griffith et al., 1989; Kleiman, 1989; Stanley Price, 1989). The IUCN Guidelines for Reintroduction (1998) suggest that benign introduction should be a last resort when the original reintroduction site or range no longer exists. Thus, for the Crested Ibis, if there are no historic breeding records for the Korean Peninsula, we must seriously consider whether it would be appropriate to release and breed the Crested Ibis in the wild.

Many factors threaten the survival and reproductive success of wild populations of the Crested Ibis. Since conservation efforts have been devoted to the species, the overall breeding success of the wild Crested Ibis population has been 65.6% over 24 years, which is much higher than that of many nidicolous birds (Yu et al., 2006). Yu et al. (2006) suggested that the two main factors causing egg loss, chick death, and

relatively high rates of unsuccessful nests at various altitudes are predation and human disturbance. Birds of prey (which mainly attack adults), crows, snakes, martens, and weasels are all natural predators of eggs and chicks (Xi et al., 1997; Yu et al., 2006).

In Korea, the fact that the Crested Ibis has only been a winter visitor and apparently never nested may be the result of natural processes. There is evidence that some ibises may have tried to breed in Korea historically; judging by an adult specimen collected with grayish nuptial feathers and remnant nest traces (Taczanowski, 1888). Unlike in China or Japan, the ability to breed may have suffered from a lack of suitable habitat for breeding and rearing young, due to predation pressure in Korea. In addition to crows and other mammals mentioned above, Black-billed Magpies (*Pica pica*; Birkhead, 1991), Eurasian Jays (*Garrulus glandarius*), and Korean Red Squirrels (*Sciurus vulgaris coreae*) are very common in forested areas, and they prey on eggs and small chicks. If the Crested Ibis were to be reintroduced into the wild in Korea, the above predators would inhabit the same areas, which could negatively influence the breeding success of the ibises. Furthermore, they may wander from their release sites and migrate as winter visitors.

In short, the success of a reintroduction program for the Oriental White Stork depends on establishing natural habitats. It is necessary, however, to find and use historical breeding sites as current and future habitats, and to develop conservation and management efforts with local residents and government employees (Kleiman et al., 1994). On the other hand, reintroduction of the Crested Ibis to the wild in Korea may be problematic, because the Korean Peninsula is not part of its former breeding range. For successful Crested Ibis reintroduction, we suggest first protecting their typical wintering sites by establishing appropriate ecosystems. To do this, we should begin with setting up a reintroduction program for the Crested Ibis in northeastern China, and then conduct research on winter migration patterns and potential breeding possibilities for further ecological adaptation in Korea.

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