

# Habitat Restoration for the Reintroduction of Oriental White Storks

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## Abstract

Oriental white storks (*Ciconia boyciana*) became extinct in Japan in 1971. After successful breeding in captivity, a pilot release program was started as the first step toward reintroduction in 2005 in the Toyooka Basin, the last region this bird inhabited in Japan. As the oriental white stork is carnivorous and uses a variety of animals in its diet, restoration of its foraging habitat is an important part of the reintroduction project. Although this bird chooses good foraging sites seasonally in response to shifting habitat conditions and the amount of prey available, paddy field systems, including ditches and shallow rivers are relatively important to its foraging. At present, several restoration projects have been established in the Toyooka Basin. To ameliorate the habitat quality of paddy fields, a new farming scheme, including installation of "fishways" connecting paddy fields and ditches, prolongation of the period of paddy field flooding and application of reduced amounts of agricultural chemicals, was introduced to local areas in 2002. In addition, a project to create a shallow riverbed along the side of the Maruyama River in the Toyooka Basin was begun in order to improve the river channel to prevent flooding and to restore wetland habitat. These projects are being performed with the collaboration of local stakeholders.

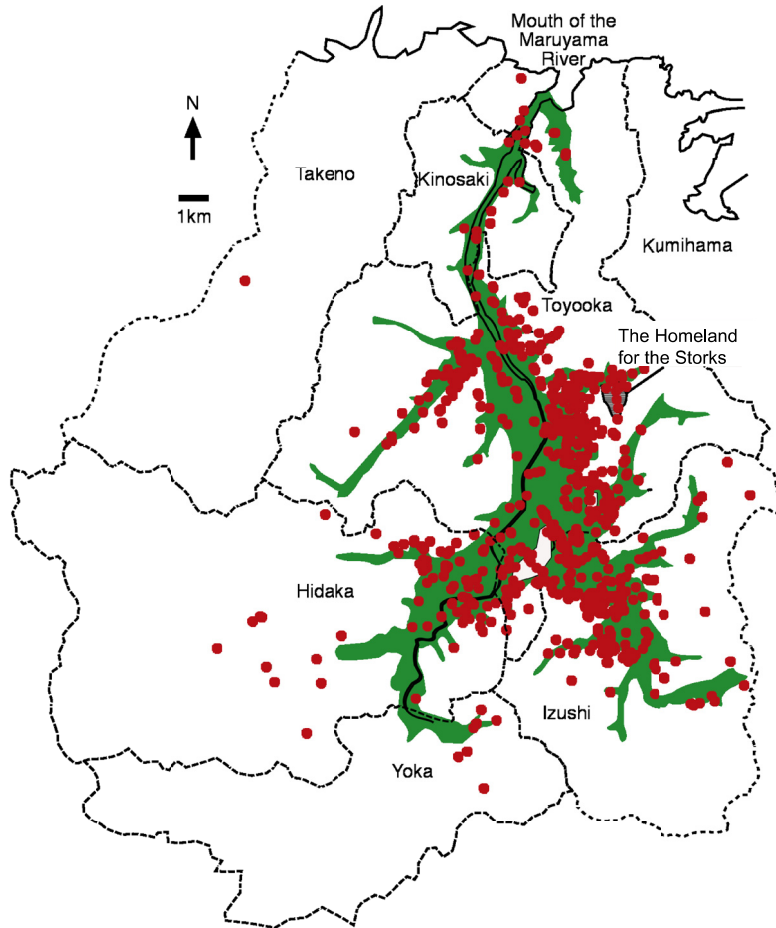
**Key words:** *Ciconia boyciana*, habitat restoration, oriental white stork, paddy field, reintroduction

## 1. Introduction

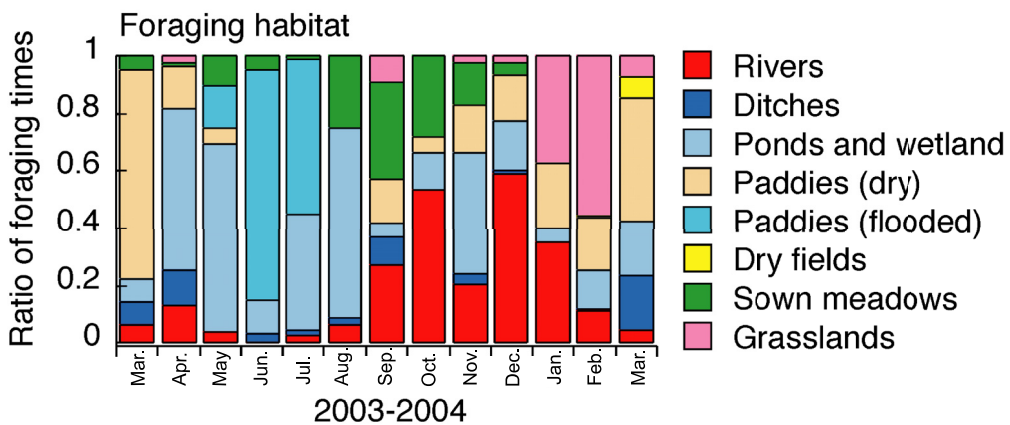
The oriental white stork (*Ciconia boyciana*) is one of the largest birds in Japan, with a wing span of up to two meters. Its breeding territory extends from the Amur to the Ussuri River in east Siberia, and an estimated 3,000 individuals still exist worldwide (Litvinenko, 2000). According to the IUCN (International Union for Conservation of Nature and Natural Resources) red list, however, the survival of this species is still in peril. Although it was once found throughout Japan, during the Second World War it gradually decreased, until a reproducing population survived only in the Toyooka Basin. The surviving individuals continued to decrease after the war, consequently becoming extinct in 1971. A captive breeding project was started for the conservation of oriental white storks in 1965. After the first breeding success in 1989, the captive population reached nearly 100 individuals in 2002. A pilot release as a step toward reintroduction was started in 2005. Conservation of oriental white storks began with a focus on breeding techniques in order to increase the number of individuals and maintain genetic diversity in the population through establishment of different breeding pairs. With the start of the reintroduction project, habitat restoration emerged as a big problem and, at present, several restoration programs have been established in the Toyooka Basin.

## 2. Foraging Sites and Prey Animals of Oriental White Storks

The oriental white stork is carnivorous and preys on a variety of animals. According to our study, the oriental white stork used to occur throughout the entire Toyooka Basin (Fig. 1) before its extinction and its foraging sites seemed to include paddy fields, ditches and rivers in rural areas. Until the test release of the oriental white stork, little was known on where and how the storks would use rural areas as foraging sites, because the wild population had been extinct for so long. Fortunately, a wild individual of this species flew into the basin in August 2002, revealing that the relative importance of foraging sites changed seasonally (Fig. 2). Namely, it mainly used paddy fields during May to July, when the paddy fields were flooded. The ratio of foraging time in paddy fields was about 80% in June, the maximum for the year. The foraging sites shifted to sown grasslands along the Maruyama River around September, then to shallow areas of the river during winter. This indicates that oriental white storks choose good foraging sites seasonally in response to shifting habitat conditions and amounts of prey animals. According to our observations, the prey animals of wild and released oriental white storks included loaches, *Carassius* species, frogs (including tadpoles) and red swamp crayfishes



**Fig. 1** Sites where the oriental white storks were observed (Naito *et al.*, 2002). This information was collected through a questionnaire distributed among retirees in the local population.



**Fig. 2** Seasonal changes in foraging sites of a wild oriental white stork that come to Toyooka Basin in 2002.

(*Procambarus clarkii*) in flooded paddy fields and ditches. They also ate insects such as grasshoppers and dragonflies in dry paddy fields and sown grasslands along the Maruyama River and freshwater fish in shallow areas of the river. They also occasionally caught snakes.

### 3. Habitat Restoration for Oriental White Storks

#### 3.1 Reconstruction of the ecological pyramid

Large, long-lived, top-predator birds such as the oriental white stork require a large amount of prey animals to survive. An ecological pyramid had been

presumably formed up with the oriental white stork as a tertiary consumer (Fig. 3). The bird requires various habitats, since it uses different types of foraging sites seasonally. Re-establishing a wild population of oriental white storks means reconstructing a biological community comprising an ecological pyramid which has the stork as the top predator. As this ecological pyramid once collapsed due to the heavy use of toxic agricultural chemicals and deterioration of habitat, it must be reconstructed through habitat restoration prior to the reintroduction of the oriental white stork.

### 3.2 Current status of the paddy field ecosystem and its restoration

What is the current status of the Toyooka Basin from the view of the oriental white stork's prey animals? A study of the density of the prey animals in paddy fields and ditches in the Toyooka Basin found that the density was lower in the paddy fields than in the ditches (Naito & Ikeda, 2004, Fig. 4).

The main reason for the difference in densities was the irrigation and drainage system actively implemented in almost all of the paddy fields in the Toyooka Basin since the 1960s as part of land consolidation projects, which led to the deterioration and loss of habitat of aquatic animals. Nevertheless, paddy fields are still

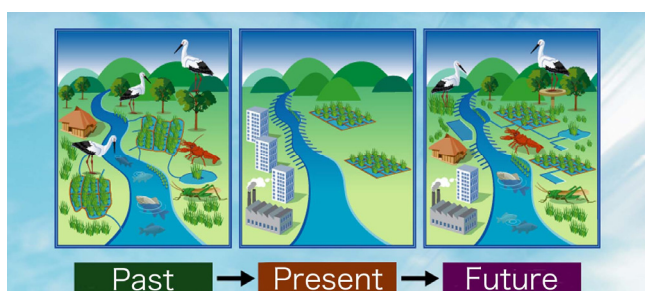


Fig. 3 Ecological pyramid indicating former, current and future habitat situations.

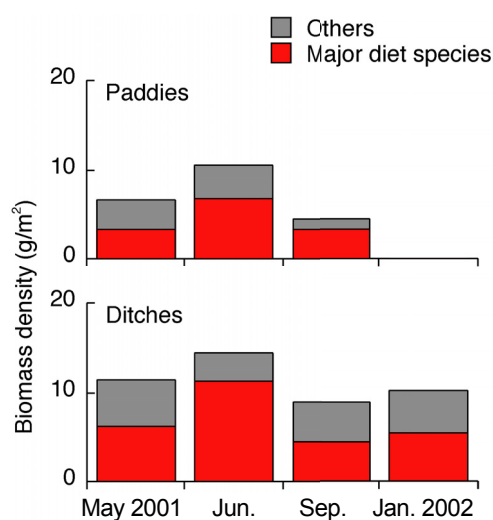


Fig. 4 Seasonal changes in prey animals in paddy fields and ditches.

important as foraging sites because they cover most of the area of the basin, thus restoration would presumably have a big effect. In consideration of the reintroduction of the storks, at several sites duck farming has been carried out as an alternative rice farming method that uses ducks in place of agricultural chemicals to control weeds and pests. Because duck farming is more labor-intensive, its employment has been limited in scope; therefore a more practical rice farming scheme is needed in order to cover a broader area.

### 3.3 A new rice farming scheme for the oriental white stork

To ameliorate the habitat quality of the paddy fields, a new rice farming scheme was introduced to certain areas in 2002. The Toyooka Agricultural Extension Center developed the scheme, using either reduced or no agricultural chemicals and alternative water management, i.e., flooding the paddies more deeply with water, keeping the water in them longer than in conventional rice farming methods and using compost and other natural resources (Nishimura, 2006). It is considered a method of producing rice while raising aquatic animals that could share the paddy fields. This scheme was adopted at 157 ha of paddy fields in the basin in 2007, and the product has been recognized by consumers as a healthy and safe value-added rice. Key to this scheme from the view of restoring habitats is installation of fishways connecting paddy fields and ditches, extension of the flooding period of the paddy fields and application of reduced amounts of agricultural chemicals. Among these measures, the fishways have proven indispensable and since a synergistic effect may be expected, they have been adopted in many areas where the new rice farming scheme was introduced.

### 3.4 Continuous watering and biological communities of paddy fields

In conventional rice farming, the paddy fields hold water for only a short period of time, from several days prior to planting to several weeks afterwards, and then are drained off. Some regions of Japan, however, have recently adopted a method in which the fields are flooded for a longer period of time with the aim of restraining weed growth, softening the soil for non-plowing cultivation and creating habitats for waterfowl. The scheme adopted in the Toyooka Basin requires flooding after harvesting, and holding the water in the fields until the next rice planting season, with the extra-farming aim of creating habitat for aquatic animals. This water management scheme increased the benthos biomass particularly of red worms (tubificids) and chironomids (Toyooka City, 2006), as has been found in other regions where the same management has been carried out. This increase in benthos biomass probably contributes to the survival of other animals that use benthos species as food resources, which in turn may increase the prey biomass for the oriental white stork.

### 3.5 Agricultural chemical reduction and its effect on biodiversity

The Toyooka Agricultural Extension Center and local farmers made a brief investigation of the fauna of several paddy fields with differing amounts of applied agricultural chemicals. This investigation revealed that natural enemies of pest insects, such as praying mantises, spiders and dragonflies, were more abundant in paddy fields in which no agricultural chemicals had been applied (Fig. 5). These results indicate that no or reduced application of agricultural chemicals may enrich the biological diversity of paddy fields, thus providing more prey animals for oriental white storks. There was no way we could easily estimate the effects of non-use of agricultural chemicals, as there were other factors involved, including water management and use of different fertilizers in addition to application of agricultural chemicals.

### 3.6 Flooding of paddy fields and its effect on frogs

The new paddy farming scheme adopted in Toyooka includes postponement of the draining of paddy fields for about two weeks, allowing tadpoles to metamorphose into frogs during this specific season. In Shounji, the village adopted this method the soonest, and the density of black-spotted pond frogs (*Rana nigromaculata*) increased during 2002 to 2005 (Toyooka City, 2006). In this village, certain paddy fields were set aside and filled with water throughout the year in 2001 to be restored as biotopes for aquatic animals. In addition to these biotopes, the number of constantly flooded paddy fields increased considerably in 2004. This probably reflects the result of habitat restoration projects. Such trends, however, did not occur in neighboring areas, indicating that the density of frogs was also influenced by other factors on the landscape scale, such as distance from forest edges, distribution of residential areas and dry fields, habitat fragmentation by roads, etc.

### 3.7 Restoration of temporally flooded areas

The greater part of the Toyooka Basin was originally a floodplain of the Maruyama River and consisted of a

network of wetland habitat. The plain, however, was fragmented when most of it was turned into paddy fields, and has undergone further land consolidation projects since the 1960s. The Maruyama River has also been modified by construction of shortcut river channels, banks and high-water channels as part of river improvement projects, resulting in a decrease in temporally flooded areas. As many freshwater aquatic animals reproduce in temporally flooded areas, which are predator-free and rich in food resources, the habitat deterioration and destruction of temporally flooded areas had a considerable impact on such aquatic animals.

Two projects to reconstruct ecological networks in the floodplain have been underway. One involves creating small-scale fishways connecting paddy fields with ditches. As a result of land consolidation projects, the ditches were located more than one meter lower than the surface of the paddy fields. This makes it hard for aquatic animals, especially fish, to move between the ditches and the paddy fields, even when the paddy fields are filled with water, so they cannot reproduce in paddy fields. The fishway project started in 2003, and a total of 94 fishways had been built as of March 2007. An investigation to monitor the results revealed that several kinds of freshwater fishes, such as loaches (*Misgurnus anguillicaudatus*), catfish (*Silurus asotus*) and *Carassius* sp., entered paddy fields via fishways and reproduced there (Naito *et al.*, 2005). The lone wild stork and some released oriental white storks have been observed in paddy fields in the Akaishi area, where fishways were intensively installed, implying that they recognized these paddy fields as richer than the other paddy fields without fishways.

The second project involves creating a shallow riverbed alongside the Maruyama River. The lower reaches of the Maruyama River are extremely flat, so the Toyooka Basin suffered from repeated flooding. Intensive river drainage improvement construction has been ongoing since 2004, when a typhoon caused extraordinary flooding. River channel improvement includes dredging the riverbed so that water not exceeding the design limits can be discharged and excavating a dry riverbed, called a "high-water channel," which is higher than the river channel and is usually not filled with water, so that flooding will inundate this particular channel when waters have risen above the design limits of the former channel. Because this high-water channel can become adequate wetland for reproduction of aquatic animals and for foraging by oriental white storks, this excavated riverbed can serve as both flood prevention and habitat restoration. According to our investigation, the density of prey animals in the river was lower than that in the paddy fields or ditches. The wild oriental stork fed in the shallows, usually 20-50 cm in depth, in the river mainly during winter. Prior to the project, there were few such shallow areas in the river, and the total area was also limited. The shallows created under the project will ultimately reach three times the area of the original. Monitoring will be needed to ascertain

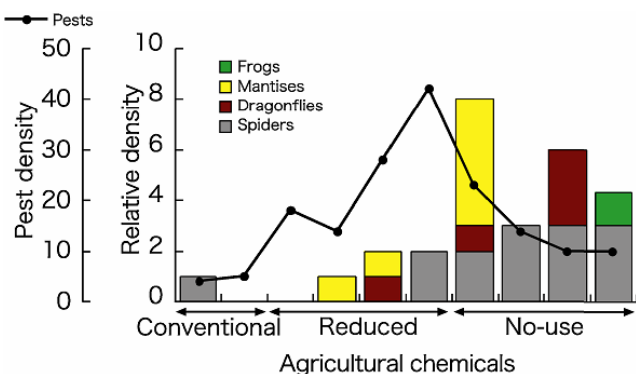


Fig. 5 Density of major animal species in paddy fields with differing amounts of agricultural chemicals. Data from the Toyooka Agricultural Extension Center.

persistence of the shallows created, the dynamics of the aquatic community and the functionality as a foraging site for the oriental white stork.

#### 4. Social Framework of Restoration

Recently, some laws of Japan have been changed, including the River Law (1997), the Basic Law on Food, Agriculture and Rural Areas (1999) and the Land Improvement Act (2001), to indicate the necessity of attention to the condition of the environment in executing public projects. Further, the Law for the Promotion of Nature Restoration was established in 2003 to authorize restoration projects as part of public works. As this law promotes participation of the stakeholders, including local people, in restoration projects, public involvement has become a common trend in such projects. These social changes have encouraged restoration activities for the reintroduction of oriental white storks. In addition, constitutional frameworks have also been established in local administrations. In 2002, both Toyooka City and a local branch of Hyogo Prefecture created sections that handle restoration activities and reintroduction projects in each organization.

The oriental white stork needs a habitat range containing rural landscapes covering various kinds of land, whose land use, owners and/or management schemes differ. Therefore, reintroduction of oriental white storks cannot be considered separately from sociological aspects such as our lifestyles and restoration of local society (Kikuchi, 2003; Naito *et al.*, 2004). From this point of view, in 2003 the various stakeholders in regional management, which included such entities as administrations, researchers, companies, local parties, residents and NPOs, organized a promotion committee for the reintroduction of the storks in order to discuss reintroduction plans and form public consensus and to perform restoration activities as participants (Committee for the Reintroduction of the Oriental White Stork, 2003). The restoration activities mentioned above are an outcome of the discussions of the committee.

#### 5. Conclusion

In the test release, a total of 19 individuals were released in 2005-2007. According to our monitoring, the released individuals have often foraged in paddy areas where the new rice-farming scheme was introduced. On the other hand, many individuals visited the roofless pens in the breeding facilities (Homeland) for the oriental white stork and ate the fish provided for the captive individuals, mingling with them. Some individuals depended on additional food in their activity range, because we fed them in order to have some individuals stay in particular areas or to have them eat supplemental food during nesting season. An individual released in 2006 and two done in 2007 did not depend at all on food handouts. It foraged for loaches, crayfish and small insects in paddies and ditches during the winter of the

year it was released. The reintroduction project is now in the first stage of establishing a wild population of the oriental white stork. Restoration in different areas as well as in different types of habitat should be encouraged in order to create more stable foraging sites.

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