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Bird Use of Rice Fields in Korea and Japan

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Abstract.—Rice (*Oryza sativa*) is the main cereal grown in the Republic of Korea and Japan and is planted on 54% and 36% of agricultural lands, respectively. Information on the status of birds that use rice fields in these nations was reviewed. More than 30%, or 135 species of 430 native avian species, excluding 152 accidental visitors, use rice fields. The fields serve primarily as foraging habitat, providing aquatic prey for passage, summer and resident species and residual grains for winter visitors. Some species, such as the Grey-faced Buzzard (*Butastur indicus*), require a mosaic of rice fields and forests for successful breeding. However, most waterbirds prefer rice fields in wide, open plains rather than narrow rice fields surrounded by forest. At least 32 (24%) of 135 species that use rice fields are designated threatened at the global or national scale, and eleven (22%) of 49 globally threatened species found in Korea and Japan use rice fields. Populations of most granivorous and piscivorous waterbirds such as geese, cranes and herons tend to be stable or increasing. The Baikal Teal (*Anas formosa*) is an exception. The breeding ranges or populations of some carnivorous and insectivorous birds, such as the Ruddy-breasted Crake (*Porzana fusca*), Greater Painted Snipe (*Rostratula benghalensis*) and many shorebirds have shrunk in recent decades. Some agricultural and conservation sectors have succeeded in attracting many waterbirds by flooding fallow fields in the rice-growing season and post-harvest rice fields. Further research on the direct and indirect effects of agricultural practices and conservation measures is needed in Korea and Japan. *Received 19 October 2007, accepted 7 July 2009.*

Key words.—foraging habitat, Japan, Korea, population trends, rice fields, threatened species.

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Today, rice (*Oryza sativa*) fields represent 15% of the world's wetlands (Lawler 2001), and in many places they are the only lasting habitats for waterbirds (Fasola and Ruíz 1997; Elphick 2000). The situation is also found in Korea and Japan, where many natural wetlands such as floodplains and estuaries have been converted into rice fields and other types of lands for human use by the combination of draining, reclamation, dams and banks. For example, 61% of Japanese wetlands, or 1,290 km^2, have been lost during the last 75 years (Geographical Survey Institute Japan 2000). As a result, many, although not all, waterbirds that originally used temporary wetlands such as floodplains now depend on rice fields in this region.

Rice is the main cereal in Korea and Japan. Large areas of both countries are covered by forests (64% in the Republic of Korea, ROK; 67% in Japan), but rice fields comprise 54% and 36% of agricultural lands in ROK and Japan, respectively (Table 1). In the countries' agricultural statistics, "paddy fields" can mean croplands where rice is planted for food production, as in western countries, or it can refer to any agricultural lands that are designed for flooding, irrespective of the crop produced or water management. Rice is also planted in upland fields, but the areas are negligible: 176 km^2 in ROK and 47 km^2 in Japan. We do not have up-to-date, reliable data on rice production in the Democratic People's Republic of Korea (DPRK), but Food and Agriculture Organization (FAO) statistics show that about 28% of cultivated lands there are used for rice (Table 1).

Rice fields are flooded in spring to prepare for transplantation. Transplantation of rice seedlings is more prevalent than direct-seeding, which is used in less than 10% of

Table 1. Statistics on rice fields in the Democratic People's Republic of Korea (DPRK; FAO 1998), Republic of Korea (Ministry of Agriculture and Forestry, ROK 2005) and Japan (Ministry of Agriculture, Forestry and Fisheries of Japan 2006). "Paddy fields" refer to cultivated land designed for flooding, but not necessarily used for rice production. Paddy rice refers to areas where rice was produced under flooded conditions.

	DPRK (1998)	ROK (2004)	Japan (2004)
Total lands (km^2)	120,410	99,617	377,915
Cultivated lands (km^2)	20,490	18,356	47,140
% of total lands	17%	18%	12%
Paddy fields (km^2)		11,150	25,750
% of cultivated lands		61%	55%
Paddy rice (km^2)	5,800	9,836	17,010
% of total lands	5%	10%	5%
% of cultivated lands	28%	54%	36%

paddies in ROK and 1% in Japan. Field size is very small, around 0.25 ha on average and sometimes less than 0.1 ha, although it has gradually increased and thousands of contiguous rice fields may occupy large plains such as the western coast of the Korean Peninsula and the Kanto Plain, Japan. In typical rice fields, shallow water is retained during the early half of the rice-growing period (typically from May to early July). Rice fields are drained in mid-summer and flooded intermittently thereafter. Water depth is usually less than 10 cm. The monsoon climate in East Asia brings plenty of rain during the period from spring to summer, coinciding with the flooding regimes in rice fields. During winter, rice fields may be dry and plowed, dry with stubble, wet with stubble, or flooded, depending on rainfall, field structure and management. Many farmers plow fields during autumn and winter to promote decomposition of organic matter, but the extent and timing vary with the location and weather conditions. Winter rice fields tend to be wet or partially flooded on the northwest side of the largest island (Honshu) of Japan due to plenty of snow, while in other areas precipitation is much less during winter than during summer and rice fields are usually dry. In some paddy fields winter crops such as wheat or barley (*Hordeum vulgare*) are planted, usually after harvesting rice or other summer crops such as soybean (*Glycine max*).

Although rice fields often provide food resources (Stafford *et al.* 2010), they are not necessarily ideal habitats for birds (Richardson and Taylor 2003). Natural marshes support more waterbirds than neighboring rice fields in southern France (Tourenq *et al.* 2001). Agricultural practices and/or the area of rice fields may change drastically due to economic conditions (Czech and Parsons 2002). For example, more than one-third of the potential paddy fields in Japan are now managed as dry arable lands or abandoned (Table 1) due to overproduction of rice since the 1970s. Appropriate management of rice fields thus is very important for waterbird conservation. In this paper, we review available information on the status of birds that use rice fields in Korea and Japan. We show that 1) more than 30% of avian species occurring in the region use rice fields, 2) rice fields serve primarily as foraging habitat, providing aquatic prey for passage, summer and resident species and residual grains for winter visitors, 3) both intensification and abandonment of rice fields are likely to cause population declines of some waterbirds, and 4) appropriate management of rice fields such as keeping non-crop flooded fields in summer and winter can greatly improve the value of rice fields as habitat for waterbirds. See also another review on farmland birds in Japan, Amano (2009), which has been simultaneously and cooperatively prepared.

BIRD USE OF FIELDS

Excluding introduced species, 543 and 451 species of birds have been recorded in

Japan (Ornithological Society of Japan 2000) and Korea (Lee *et al.* 2000), respectively. Four hundred and twelve species are shared by both countries (91% of Korean birds). To compile the list of birds that use rice fields in this region (Appendix), we first excluded 152 species of accidental visitors (vagrants) from 582 native species. We then identified species that are likely to use rice fields based on information in checklists and field guides (Won *et al.* 1968; Brazil 1991; Nakamaura and Nakamura 1995; Kanouchi *et al.* 1998; Kirihara *et al.* 2000; Lee *et al.* 2000; Maki and Ohnishi 2000; Ornithological Society of Japan 2000; Iozawa *et al.* 2004; Birds Korea 2007; Shimba 2007; Takano 2007) as well as our own experiences. For this assessment rice fields were defined only as agricultural paddies and levees, however, we also included birds that rarely use rice fields per se but are often found in irrigation ditches or reservoirs, which are tightly associated with rice farming. Such birds include Little Grebe (*Tachybaptus ruficollis*), Northern Shoveler (*Anas clypeata*) and Common Kingfisher (*Alcedo atthis*). We did not consider some other types of habitats such as set-aside fields (or fallow fields) and farmers' houses, although some of the listed birds may use, or even prefer, these habitats. Species abundance and seasonality in our region are mostly based on descriptions in the checklists and field guides. The dependency of each species on rice fields and the season of their use relative to rice phenology were based on our experiences and knowledge. We defined dependency as follows: "Heavy" means that rice fields are the most important habitat for the population at least during a certain period of year, "Moderate" means that rice fields are used regularly and about 10-50% of the population are dependent upon rice fields in some way, and "Light" means that rice fields are used infrequently or by a small fraction of the population. Dependency may differ between Korea and Japan. For example, the Red-crowned Crane (*Grus japonensis*) is a resident breeder in eastern Hokkaido, northern Japan, where few rice fields exist and thus it does not use rice fields there. However, the species is a winter visitor in Korea, where it uses rice fields intensively for feeding (Lee *et al.* 2007a). In such cases, we adopted the dependency category of the country where the species seems to depend more heavily on rice fields. Scientific and English names follow Gill *et al.* (2009).

A total of 135 species were recognized as rice field users (Appendix). Anseriformes, Ciconiiformes and Gruiformes tend to depend on rice fields heavily, while most species of Falconiformes, Charadriiformes and Passeriformes use other types of habitat at least as often as rice fields (Fig. 1a). The season when these birds use rice fields relative to the crop phenology varies with the taxonomic group (Fig. 1b). Ciconiiformes (herons, ibises and storks) and smaller Gruiformes (rails) are mostly summer or resident breeders and use rice fields during the growing season, when fields are flooded. Also, they may use rice fields during winter if fields are wet or flooded. Most species of Charadriiformes (shorebirds) are spring and autumn migrants in our region, using rice fields early in the growing season (Watanabe 2001, 2006) and, less frequently, just after harvest in autumn. Anseriformes (swans, geese and ducks) and larger Gruiformes (cranes) are winter visitors with a few exceptions. These species are basically vegetarian, looking for residual grains in rice fields in winter. Rice fields are used by several terrestrial birds belonging to the Falconiformes (hawks, falcons) and Passeriformes (songbirds) as feeding habitat mostly in winter. Exceptions include the Eurasian Tree Sparrow (*Passer montanus*), which feeds on rice seeds before harvest and is a major pest

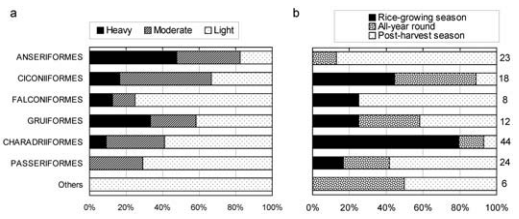

Figure 1. (a) Number of species in relation to the dependency on rice fields and (b) the timing of rice production. See text or the Appendix for the definition of dependency. Numerals on the right side are numbers of species. Species belonging to orders that have five or fewer species of rice-field users were combined into "Others."

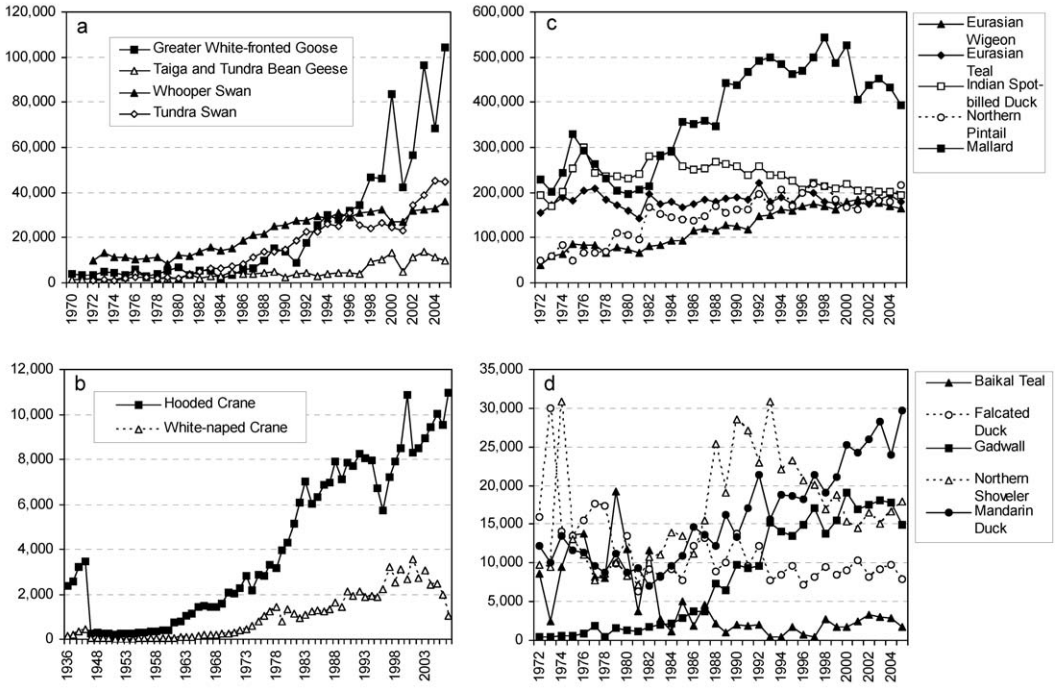

Figure 2. Population fluctuations of wintering waterbirds in rice fields in Japan: (a) swans and geese; (b) cranes at Izumi City; (c) abundant duck species; (d) uncommon duck species. Data from annual census of Anatidae in January by the Ministry of the Environment, Japan (a, c, d) and Izumi City (b).

bird and the Zitting Cisticola (*Cisticola juncidis*), which sometimes breeds in rice fields. Two species of *Falconiformes*, the Chinese Sparrowhawk (*Accipiter soloensis*) and the Grey-faced Buzzard (*Butastur indicus*), breed in mosaic landscapes consisting of rice fields and forests (see below).

Although about 31% of birds recorded in Korea and Japan can be seen in rice fields (135 of 430 species evaluated), the number of species at a site is usually limited to ten or so, depending on the season and location. In a rural area mostly comprised of rice fields in a central area of Japan, 31 terrestrial bird species and 19 waterbird species were recorded in a year (Maeda 2001). In northeast Taiwan, which is close to southwestern Japan, 37 species of waterbirds were recorded in winter rice fields, but species richness per 15 ha plot ranged from 5 to 23 (Chan *et al.* 2007).

In rice fields, activities other than feeding can be seen for only a few species. Seven species (three geese, two swans and two cranes) use rice fields for roosting in winter (Appendix). These birds usually roost on lakes or rivers with shallow water, but flooded fields may function as roosts, as in California (Ackerman *et al.* 2006). Another seven species nest in rice fields. The Grey-headed Lapwing (*Vanellus cinereus*) often nests in fields in early spring before they are flooded (Takahashi and Ohkawara 2007). The other six species, the Indian Spot-billed Duck (*Anas poecilorhyncha*), Ruddy-breasted Crake (*Porzana fusca*), Common Moorhen (*Gallinula chloropus*), Greater Painted Snipe (*Rostratula benghalensis*), Zitting Cisticola and the Siberian Stonechat (*Saxicola maurus*), usually prefer other habitats such as natural marshes and fallow wet fields for nesting. In all, 121 of the 135 species use rice fields for feeding only (Appendix), implying that they require other habitat elements in the surrounding landscape for nesting or roosting.

FORAGING HABITAT

Rice fields typically serve as foraging habitat for birds. It is important to distinguish two groups of farmland birds, herbivorous

birds and carnivorous birds (Fujioka and Yoshida 2001). These groups differ in their role within the food chain, in the interaction between birds and farming, and in the conservation measures to be considered. Protecting carnivorous birds is generally more difficult than herbivorous birds because food supplementation is harder to accomplish.

Rice fields can support abundant aquatic prey animals for carnivorous waterbirds during the rice-growing season (Fasola and Ruiz 1996; González-Solís *et al.* 1996; Fujioka and Lane 1997; Marques and Vicente 1999; Iwata and Fujioka 2006). In spring and summer, rails, plovers, sandpipers, ibises and herons use agricultural paddies for food; these species seek small aquatic animals such as earthworms, aquatic insects, frogs and fish. They prefer open, newly planted and flooded fields to densely vegetated fields. In midsummer, rice plants become so dense that few birds go into the fields and most waterbirds move to other croplands or fallow fields (Sato and Maruyama 1996; Li *et al.* 2002). More waterbirds can be seen in fallow fields that are managed as open wetlands (Fujioka *et al.* 2001). Herons and shorebirds visit rice fields again to take prey such as grasshoppers during and after harvest. Rice fields are generally associated with grassy areas managed by farmers, which provide hunting habitat for Chinese Sparrowhawks and Grey-faced Buzzards, especially during spring.

Modernization of rice farming can influence the conditions for birds. For example, effective draining systems can eliminate wet winter fields, which have been proven important for some aquatic birds (Day and Colwell 1998; Elphick and Oring 1998, 2003). Changes in water levels, straw management and paddy size can also impact the use of rice paddies by birds (Day and Colwell 1998; Elphick and Oring 1998; Maeda 2005). Recent changes in the structure of paddy fields in Japan have led to concerns that rice fields have declined in value as foraging habitat for Ardeidae, especially for the Intermediate Egret (*Egretta intermedia*), which is designated "Near Threatened" by the Japanese government, through the decline in aquatic prey animals (Lane and Fujioka 1998). This prey decline happens due to the installation of deep, concrete-sided drainage ditches, which prevent freshwater fish and other aquatic animals from moving into fields (Fujioka and Lane 1997; Lane and Fujioka 1998).

In winter, geese, ducks and cranes exploit rice grains after harvest as well as weeds and small animals. Remaining rice grain is also an important food resource for terrestrial birds such as Eurasian Collared Doves (*Streptopelia decaocto*), Oriental Turtle Doves (*Streptopelia orientalis*) and Carrion Crows (*Corvus corone*). Some predatory birds such as the Common Buzzard (*Buteo buteo*), Common Kestrel (*Falco tinnunculus*), Merlin (*Falco columbarius*), and Short-eared Owl (*Asio flammeus*) are relatively common in dry fields during the post-harvest season. Most carnivorous waterbirds are summer breeders or passage migrants, but a few species, for example, the Grey Heron (*Ardea cinerea*), Little Egret (*Egretta garzetta*) and Greater Painted Snipe, spend winter in our region. These species generally do not use rice fields in winter, instead feeding in adjacent ditches or in natural habitats with open water such as rivers and tidal flats (Maeda 2001; Chan *et al.* 2007; Amano *et al.* 2008). They may, however, forage in post-harvest fields if the fields are flooded or wet, as in Europe and North America (Czech and Parsons 2002; Elphick *et al.* 2010a).

Some herbivorous farmland birds, especially those living year-round in rural areas, have been considered pests by farmers. Wintering birds that eat rice grain residues do not affect yield and may even be beneficial by removing weed seeds, promoting straw decomposition, and leaving feces that act as fertilizer (e.g. Yamamoto *et al.* 1999; Bird *et al.* 2000). Large amounts of rice grain are spilled in the fields after harvest (Stafford *et al.* 2010). Shimada (1999) and Amano *et al.* (2004) counted 858 and 1,330 grains/m^2, respectively, in Japanese rice fields; equivalent to about 220 kg/ha. In the USA, 140 kg (Hobaugh 1984) or 388 kg (Miller *et al.* 1989) of rice per hectare remain in the fields. Such a large amount of food can con-

tribute directly to bird populations. Residual rice grain supports some threatened geese (Shimada 2002; Shimada *et al.* 2002) and cranes (Lee *et al.* 2007b) wintering in Japan and Korea, respectively. Similarly, Snow Geese (*Chen caerulescens*) have increased since rice cultivation began in Texas, USA (Robertson and Slack 1995) and the number of Common Cranes (*Grus grus*) wintering in southwestern Spain is correlated with the area of rice cultivation (Guzman *et al.* 1999). The amount of residual grain available to birds is decreased dramatically by plowing (Miller *et al.* 1989; Shimada 1999; Shimada 2002; Lee *et al.* 2007a). Geese feed on weeds in rice fields and levees as well as rice stubble and roots after grains have been exhausted (Hobaugh 1984; Shimada *et al.* 2002).

Landscape features such as composition of habitat elements and their configuration can greatly influence some species (Benton *et al.* 2003; Bennett *et al.* 2006; Amano *et al.* 2008; King *et al.* 2010). Some rice fields in Korea and Japan are located on relatively steep terraced slopes or valley bottoms. These fields differ in their function as bird habitat from those in the plains. The Grey-faced Buzzard is a summer breeder in central Japan and nests in trees in forests near to rice fields. These raptors take frogs and other small animals in and around rice fields during the early half of the breeding season, and feed on insects in the forest during the later half (Azuma *et al.* 1998). They therefore require rice fields and forest in close proximity (Azuma *et al.* 1999; Momose *et al.* 2005). An increase in the abandonment of rice fields in such environments has led to the decline of this species, and the Ministry of Environment in Japan listed it as Vulnerable on their Red List in 2006. The Chinese Sparrowhawk shows a similar habitat preference, although no published studies are available.

Although habitat heterogeneity in agricultural landscapes generally contributes to higher biodiversity (Benton *et al.* 2003), rice fields in wide, open plains or areas where paddies occupy a large proportion of the land are used by more species at higher densities than those on narrow, valley bottoms or areas with fewer paddies in summer (Maeda 2005; Amano *et al.* 2008). Many species of geese, ducks, wading birds and shorebirds move widely between their nesting colonies or roosts and feeding sites. Herons are colonial breeders, flying up to about 30 km from the colony to forage on small animals (Smith 1995; Custer and Galli 2002; Nemeth *et al.* 2005). Geese roosting in Izu-numa Lake, Japan, forage mainly in rice fields within 12 km of the lake (Shimada 2003). These facts suggest that maintaining both rice fields as feeding habitats and other types of habitat for roosting and nesting is critical for waterbird conservation.

CONSERVATION CONCERNS

At least eleven (22%) of 49 globally-threatened species (Red List categories: Critically Endangered, Endangered and Vulnerable; IUCN 2009) found in Korea and Japan use rice fields at some extent (Table 2). Including species recognized as threatened by the ROK and Japanese governments, 32 (24%) of 135 species that use rice fields are designated threatened at the global or national scale (Table 2).

Among these species, the most seriously threatened is the Crested Ibis (*Nipponia nippon*). This species was historically widespread in Japan, China, Korea, Taiwan and Russia, but is now extinct in most of its former range including Korea and Japan. The only remaining wild population is in Shaanxi Province in China, where the major foraging habitat is rice paddies during the breeding season (Li *et al.* 2002; Wood *et al.* 2010). In Japan, several fledglings have been produced in captivity from pairs derived from China since 1999. Ten of these birds were released into the wild in September 2008 on Sado Island off the north shore of central Japan. Sado Island is where the last five wild birds were captured for captive breeding in 1981, but all died by 2003 without leaving descendants. Similarly, a reintroduction program is running in Japan for the Oriental Stork (*Ciconia boyciana*), which was a resident breeder in some rural areas of Japan before 1950 but is now a rare winter migrant in Korea and Japan. Nineteen captive birds have

Table 2. Threatened species that use rice fields in Korea and Japan. Listed species are considered Critically Endangered (CR), Endangered (EN) or Vulnerable (VU) by the IUCN or the Japanese government, or EN-I (equivalent to CR + EN) and EN-II (VU) by the Korean government. Crested Ibis is extinct (EX) or extinct in the wild (EW). Terms for rice field dependency are defined in the text. Note that taxonomy used here differs slightly from that used on the Red Lists.

Latin name	Common name	IUCN	Korea	Japan	Dependency on rice fields
ANSERIFORMES					
Anser cygnoides	Swan Goose	VU	EN-II		Heavy
Anser fabalis	Taiga Bean Goose		EN-II	NT	Moderate
Anser serrirostris	Tundra Bean Goose			VU	Heavy
Anser erythropus	Lesser White-fronted Goose	VU	EN-II		Heavy
Branta hutchinsii leucopareia	Cackling Goose			CR	Heavy
Cygnus columbianus	Tundra Swan		EN-II		Moderate
Cygnus cygnus	Whooper Swan		EN-II		Light
Tadorna tadorna	Common Shelduck			EN	Light
Anas formosa	Baikal Teal	VU	EN-II	VU	Heavy
CICONIIFORMES					
Ciconia boyciana	Oriental Stork	EN	EN-I	CR	Moderate
Nipponia nippon	Crested Ibis	EN	EX	EW	Heavy
Platalea leucorodia	Eurasian Spoonbill		EN-I		Light
Platalea minor	Black-faced Spoonbill	EN	EN-I	CR	Light
Ixobrychus eurhythmus	Von Schrenck's Bittern			EN	Light
Egretta eulophotes	Chinese Egret	VU			Light
FALCONIFORMES					
Falco columbarius	Merlin		EN-II		Light
Circus spilonotus	Eastern Marsh Harrier			EN	Light
Circus cyaneus	Northern Harrier		EN-II		Light
Butastur indicus	Grey-faced Buzzard			VU	Heavy
Buteo buteo	Common Buzzard		EN-II		Light
GRUIFORMES					
Coturnicops exquisitus	Swinhoe's Rail	VU		EN	Light
Porzana fusca	Ruddy-breasted Crake			VU	Moderate
Gallicrex cinerea	Watercock		EN-II		Moderate
Grus vipio	White-naped Crane	VU	EN-II	VU	Heavy
Grus monacha	Hooded Crane	VU	EN-II	VU	Heavy
Grus japonensis	Red-crowned Crane	EN	EN-I	VU	Heavy

Table 2. (Continued) Threatened species that use rice fields in Korea and Japan. Listed species are considered Critically Endangered (CR), Endangered (EN) or Vulnerable (VU) by the IUCN or the Japanese government, or EN-I (equivalent to CR + EN) and EN-II (VU) by the Korean government. Crested Ibis is extinct (EX) or extinct in the wild (EW). Terms for rice field dependency are defined in the text. Note that taxonomy used here differs slightly from that used on the Red Lists.

Latin name	Common name	IUCN	Korea	Japan	Dependency on rice fields
CHARADRIIFORMES					
Himantopus himantopus	Black-winged Stilt			VU	Light
Charadrius placidus	Long-billed Plover		EN-II		Light
Numenius minutus	Little Curlew			EN	Light
Numenius madagascariensis	Eastern Curlew			VU	Light
Tringa totanus	Common Redshank			VU	Light
COLUMBIFORMES					
Streptopelia decaocto	Eurasian Collared Dove			VU	Light
Total number of threatened species:		11	18	21	

been released in the wild since September 2005 and, with a wild individual, they fledged 13 juveniles between 2007 and July 2009.

Large granivorous waterbirds such as geese and cranes decreased to near extinction in Japan during the period between the Meiji Restoration (1868) and the 1970s, primarily due to over-hunting and poaching. Populations of goose and swan species have been recovering since the 1970s through enforced protection (Fig. 2a). More than 10,000 cranes, mainly Hooded Cranes (*Grus monacha*) and White-naped Cranes (*Grus vipio*), stay in Izumi, Kagoshima, Japan during the winter and their numbers have been increasing gradually (Fig. 2b). These cranes and swans, in many locations, depend partly on food provisioning by local people. On the other hand, most duck species are currently hunted in Japan, but their populations have also been stable or increasing in the last two to three decades (Figs. 2c and 2d). The Baikal Teal *Anas formosa* is an exception (Fig. 2d) and had declined to only 2,000 birds throughout Japan by the late 1980s (del Hoyo *et al.* 1992); it is now categorized as Vulnerable globally (IUCN 2009). Over 20,000 Baikal Teals winter in the western part of Korea, where they heavily depend on agricultural paddies.

In Korea, waterbird population trends are available for the Han River estuary near Seoul, which consists of rice paddies and natural marshes (Table 3). Anseriformes was the most abundant order, comprising over 92% of the birds seen. Populations of some important species of ducks and geese were monitored during 1999-2007 and Mallards (*Anas platyrhynchos*), bean geese (Taiga Bean Goose *Anser fabalis* and Tundra Bean Goose *Anser serrirostris*) and Greater White-fronted Geese (*Anser albifrons*) have increased recently (Fig. 3). During the same period the area of agricultural paddies declined from 870 km^2 (25.7% of the estuary) to 782 km^2 (23.1%) (Kim 2008). Previous rice paddies have been converted rapidly to housing and industrial parks so that the wintering habitat is reduced. This change might have led to population concentration of Anseriformes,

Table 3. Population trends of bird species at the Han River estuary near Seoul during 1999-2007. Data from the Ministry of Environment, ROK (2007).

	1999	2000	2001	2002	2003	2004	2005	2006	2007	Total	% of all birds
Podicipediformes	0	0	0	0	0	0	10	21	20	51	0.02
Pelecaniiformes	0	13	3	0	0	30	37	30	184	297	0.14
Ciconiiformes	10	4	0	1	0	16	9	12	25	77	0.04
Anseriformes	20,922	5,957	4,383	17,833	4,018	7,642	51,546	32,349	52,121	196,771	92.76
Falconiiformes	3	0	9	1	1	7	17	9	16	63	0.03
Gruiformes	68	7	0	0	0	56	85	130	129	475	0.22
Chadriiformes	145	324	374	345	221	17	110	1,384	3,302	6,222	2.93
Columbiformes	0	0	0	0	0	45	27	9	261	342	0.16
Passeriformes	32	210	47	100	1,071	1,130	2,636	1,826	780	7,832	3.69
Total	21,180	6,515	4,816	18,280	5,311	8,943	54,477	35,770	56,838	212,130	100.00

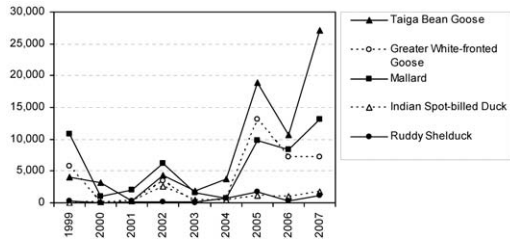

Figure 3. Population trends of common geese and ducks at the Han River estuary, Republic of Korea, during winter migration. Data source: Ministry of Environment, ROK (2007).

but the population has also grown from approximately 21,000 in 1999 to 52,000 in 2007. The Han River estuary probably provides good wintering habitat for ducks and geese because the area has limited access for humans, making it possible for the area to remain an ecological reserve.

For waterbirds that use rice fields and breed in Japan, we determined the number of cells on a grid of c. 20 km squares where each species was recorded during extensive surveys carried out in 1978 and 1998 (Table 4). The breeding range was similar in the two periods for 17 of 21 species. Two ardeids, the Eastern Great Egret (*Ardea modesta*) and the Grey Heron (*Ardea cinerea*), expanded their breeding range more than double (3.3 and 5.9 times, respectively; Table 4). This tendency coincides with the increase of another piscivorous bird, the Great Cormorant (*Phalacrocorax carbo*), in Japan, suggesting that increased fish in inland water bodies after the banning of certain insecticides and other pollutants such as dichloro-diphenyl-trichloroethane (DDT) may be the explanation (Iseki *et al.* 2002). On the other hand, the breeding ranges of the Ruddy-breasted Crake and the Greater Painted Snipe shrank by more than half between 1978 and 1998. The snipes are frequently associated with wet vegetated habitat, where they prey on worms and aquatic insects (Maeda 2000; Fujioka *et al.* 2001). The Ruddy-breasted Crake has been decreasing in Tochigi Prefecture, Kanto, Japan, even in places where habitat has not apparently changed (Hirano *et al.* 1997, 2003).

It is difficult to monitor shorebirds in rice fields because they scatter over large areas

Table 4. Changes in the breeding range of waterbirds that used rice fields between 1978 and 1998 in Japan. Numerals are numbers of grid cells (c. 20 km × 20 km; N = 1,291) in which breeding was confirmed (A), presumed (B), or where species were just observed during the breeding season (C). Species recorded in more than 20 cells in either year are listed. Trends are the ratio of the total number of cells where the species was recorded in 1998 to that in 1978. Bold face indicates species for which the population at least doubled or halved. Source: Biodiversity Center of Japan, Ministry of the Environment (2004).

Species		1978			1998			
Latin name	Common name	A	B	C	A	B	C	Trend
ANSERIFORMES								
Aix galericulata	Mandarin Duck	19	16	45	14	25	82	1.51
Anas platyrhynchos	Mallard	21	21	37	18	15	81	1.44
Anas poecilorhyncha	Indian Spot-billed Duck	141	86	135	64	67	267	1.10
CICONIIFORMES								
Ixobrychus sinensis	Yellow Bittern	31	17	14	13	15	17	0.73
Nycticorax nycticorax	Black-crowned Night Heron	83	33	80	89	29	126	1.24
Butorides striata	Striated Heron	31	16	45	25	9	51	0.92
Bubulcus coromandus	Eastern Cattle Egret	40	6	37	46	6	71	1.48
Ardea cinerea	**Grey Heron**	15	12	42	114	13	279	**5.88**
Ardea modesta	**Eastern Great Egret**	23	0	22	50	3	94	**3.27**
Egretta intermedia	Intermediate Egret	39	3	24	40	3	48	1.38
Egretta garzetta	Little Egret	71	7	111	66	11	126	1.07
GRUIFORMES								
Porzana fusca	**Ruddy-breasted Crake**	59	76	24	12	23	12	**0.30**
Gallinula chloropus	Common Moorhen	111	48	52	56	34	72	0.77
Fulica atra	Eurasian Coot	19	7	8	8	13	12	0.97
Grus japonensis	Red-crowned Crane	8	1	4	24	0	0	1.85
CHARADRIIFORMES								
Vanellus cinereus	Grey-headed Lapwing	35	18	7	44	31	15	1.50
Charadrius placidus	Long-billed Plover	35	51	27	25	33	36	0.83
Charadrius dubius	Little Ringed Plover	92	65	45	68	50	79	0.98
Rostratula benghalensis	**Greater Painted Snipe**	45	24	10	12	18	7	**0.47**
Scolopax rusticola	Eurasian Woodcock	14	13	19	2	10	22	0.74
Actitis hypoleucos	Common Sandpiper	38	95	113	13	49	115	0.72

and are only present for a short time. Amano (2006) compiled population trends for shorebirds counted at major mud flats in Japan, however, and the species that used rice fields had generally declined (Table 5). Only three of 20 species showed evidence of increases between the 1974-1985 and 2000-2003 surveys. In contrast, eight of 20 species declined by more than half during the same period, based on both spring and autumn counts. These shorebird declines may have been caused largely by degradation of sea shore environments, but changes in rice fields might also have been involved.

MANAGEMENT IMPLICATIONS

Rice fields are not perfect habitats for all waterbirds primarily because they are more uniform in time and space than natural wetlands and lack some elements found in natural wetlands (Fujioka and Yoshida 2001). For example, rice fields become unsuitable as foraging habitat for the Crested Ibis in the post-breeding season because of dense and tall rice plants (Li *et al.* 2002). However, fallow or set-aside paddy fields can add conservation benefits by increasing habitat heterogeneity. In Japan, local non-governmental organizations succeeded in making set-aside fields into good foraging habitat for migratory shorebirds by flooding fields during summer in cooperation with farmers (Ikezawa 1996; Kanagawa Chapter of the Wild Bird Society of Japan 1998). Fujioka *et al.* (2001) compared the use of farmland habitat by birds in summer among four types of fallow fields plus rice fields in 26 survey plots, and found that flooded fallow fields without much vegetation supported the largest number of species and the highest density of birds, while rice fields supported the fewest birds. In another successful example, 50 ha of rice fields were restored to a wetland that quickly became a large roost site for geese and ducks (Kurechi 2007).

There is a risk that the increase in fallow fields could result in further declines of already threatened birds, as has happened in Europe (Sotherton 1998), if correct management of fallow fields is not carried out. Although no evidence is available for bird population declines due to the increase of fallow fields in our region, abandoned rice fields with tall, dense grass were used by many fewer species and individuals than managed set-aside fields during summer (Fujioka *et al.* 2001). Grey-faced Buzzards also perched and foraged in cultivated rice fields at much higher frequency than in fallow fields (Kadowaki *et al.* 2007), suggesting that increased field abandonment may eventually cause population declines.

Using rice fields during the non-growing season is another way for them to contribute to bird conservation (Elphick *et al.* 2010a). Because many birds that use rice fields in the post-harvest season feed on rice grain residues, unplowed fields can provide geese and cranes with much more food than do plowed fields (Shimada 2002). Winter flooding of rice fields is a popular form of bird conservation. For example, Elphick and Oring (1998) compared the abundance of wintering birds between flooded and unflooded rice stubble fields in California and concluded that flooding fields after harvest offered better habitat for most, but not all, waterbirds. Waterfowl foraging in flooded fields also promotes rice straw decomposition, thus benefiting farmers (Bird *et al.* 2000). Similarly, rice fields flooded during winter in Japan attracted more waterfowl than non-flooded fields (Yamamoto *et al.* 1999, 2003). A combination of organic rice production and winter flooding brought an increase of both ducks in winter and egrets in late summer (Kurechi 2007). Swans, geese and cranes look for rice grains visually during the day, while ducks take rice by filtering water mostly at night. Flooding fields in winter should be carried out in areas where using water does not cause other environmental problems, but some fields should be kept dry because several landbirds prefer dry fields for foraging in winter (Maeda 2001; see Appendix). As most of these conservation actions in rice fields are not profitable for farmers, financial support from governments may be key to the promotion of bird-friendly rice production.

There is a serious problem in that few studies on bird-agriculture interactions in Asia have been published (Czech and Par-

Table 5. Trends in the numbers of shorebirds dependent on rice fields in Japan. Modified from Table 2 in Amano (2006), which reviews results of bird counts carried out mostly on mud flats. 1974-85 data are average counts carried out at 115-507 sites per year (mean = 351) by the Wildbird Society of Japan and other nongovernmental organizations. 2000-03 data are average counts carried out at 84-104 sites per year (mean = 95) by the WWF Japan with support from the Ministry of Environment, Japan. The 2000-03 numbers are 1.4 times the counted numbers to compensate for differences in the number of survey sites (Amano 2006). Trends are the ratio of the number in 2000-03 to that in 1974-1985 and are emboldened for species that decreased to less than half in both spring and autumn.

		Spring			Autumn		
Latin name	Common name	1974-85	2000-03	Trends	1974-85	2000-03	Trends
Himantopus himantopus	Black-winged Stilt	7	73	11.106	12	98	7.927
Pluvialis fulva	Pacific Golden Plover	3,974	3,176	0.799	1,853	953	0.514
Charadrius dubius	Little Ringed Plover	803	298	0.371	901	734	0.814
Gallinago gallinago	**Common Snipe**	1,454	432	**0.297**	1,123	133	**0.118**
Limosa limosa	**Black-tailed Godwit**	185	6	**0.031**	531	76	**0.144**
Limosa lapponica	Bar-tailed Godwit	2,411	2,184	0.906	497	379	0.763
Numenius phaeopus	Whimbrel	6,028	6,673	1.107	932	662	0.710
Numenius madagascariensis	Eastern Curlew	268	148	0.553	152	141	0.932
Tringa erythropus	**Spotted Redshank**	2,555	91	**0.036**	155	8	**0.054**
Tringa nebularia	Common Greenshank	659	380	0.577	1,188	1,093	0.920
Tringa ochropus	**Green Sandpiper**	48	22	**0.460**	105	40	**0.382**
Tringa glareola	**Wood Sandpiper**	2,325	105	**0.045**	2,611	310	**0.119**
Xenus cinereus	Terek Sandpiper	607	221	0.363	1,714	1,696	0.989
Actitis hypoleucos	**Common Sandpiper**	628	178	**0.284**	955	355	**0.371**
Tringa brevipes	Grey-tailed Tattler	1,945	674	0.347	2,092	1,998	0.955
Arenaria interpres	Ruddy Turnstone	2,859	1,479	0.517	401	724	1.806
Calidris ruficollis	Red-necked Stint	3,517	1,109	0.315	5,306	4,013	0.756
Calidris acuminata	**Sharp-tailed Sandpiper**	528	99	**0.188**	56	23	**0.417**
Calidris alpina	Dunlin	50,925	32,836	0.645	2,860	928	0.324
Limicola falcinellus	**Broad-billed Sandpiper**	7	2	**0.211**	123	28	**0.226**

sons 2002; Elphick *et al.* 2010b), especially in English-language journals (Amano 2009). Fujioka and Yoshida (2001) pointed out three research priorities in the field of bird-agriculture interactions: 1) the relationships between birds and habitat heterogeneity at different spatial scales, 2) the development of environmental indicators using birds, and 3) the benefits and problems of new agricultural practices and agri-environmental actions for birds. We believe these three topics remain important. Regarding habitat heterogeneity, rice fields are usually more homogeneous than natural wetlands, but there are large variations in the distribution of rice fields and nearby habitats. Effects of such landscape patterns are likely to vary among species and have recently attracted much attention (Benton *et al.* 2003; Bennett *et al.* 2006; Amano *et al.* 2008; King *et al.* 2010). Studies should account not only for rice fields per se but also other types of habitat nearby because many birds require natural marshes, rivers, mud flats or forests as nesting, roosting and alternative foraging sites. These requirements may complicate the use of birds as environmental indicators.

Last, but not least, scientific research on the direct and indirect effects of agricultural practices and conservation measures is much needed in Korea and Japan. Agricultural intensification has accelerated and abandoned rice fields have increased since the 1980s. Some sectors, on the other hand, have tried to enhance rice fields as bird habitats. Unfortunately, their effects remain largely unexplored by scientists probably because little financial support is available. The effects of changes in agriculture may be slow and subtle as in the case of the Common Reed Bunting (*Emberiza schoeniclus*) in Europe, for which the loss of waste grains in winter following a change from spring-sown to autumn-sown cereals caused lower over-winter survival and population decline (Peach *et al.* 1999). Such studies are often labor-intensive and involve difficulties in manipulation of study sites. We believe, however, that studies of bird-agriculture interactions can contribute not only to the conservation of farmland birds but also to a better understanding of ecological phenomena in general.

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Appendix. Bird species that use rice fields (including associated irrigation ditches and reservoirs) in Korea (KR) and Japan (JP). Bird names and species order follow the IOC world bird list, ver. 2.1, as of 12 May 2009 (Gill *et al.* 2009). Abundance codes: CM = common, UC = uncommon, LC = locally common, RR = rare, n/a = not found (includes species that are extinct in the wild). Season codes: R = resident breeders (including migrants within the nation), S = summer breeders, W = winter visitors, P = passage migrants, I = irregular visitors (mostly in winter). Use: HV = heavy (rice fields are the most important habitat for the population at least during a certain period of year), MD = moderate (rice fields are used regularly; 10-50% of the population are found in rice fields), LT = light (rice fields are used infrequently or by a small fraction of the population); note that abundant species may be commonly observed in rice fields even if their dependency is light, and vice versa. Season codes: GR = rice growing season (spring-summer), during which rice fields are usually flooded, PH = post-harvest season (autumn-winter), irrespective of dry, wet, or flooded, AL = all year round.

		Abundance		Season		Use of Rice Fields		
Latin name	Common name	KR	JP	KR	JP	Use	Season	Activity other than foraging
GALLIFORMES								
Phasianidae								
Phasianus colchicus	Common Pheasant	CM	CM	R	R	LT	AL	
ANSERIFORMES								
Anatidae								
Anser cygnoides	Swan Goose	RR	RR	I	I	HV	PH	
Anser fabalis	Taiga Bean Goose	RR	CM	W	W	MD	PH	Roosting
Anser serrirostris	Tundra Bean Goose	CM	RR	W	W	HV	PH	Roosting
Anser anser	Greylag Goose	RR	RR	I	I	HV	PH	
Anser albifrons	Greater White-fronted Goose	CM	CM	W	W	HV	PH	Roosting
Anser erythropus	Lesser White-fronted Goose	RR	RR	W	I	HV	PH	
Anser caerulescens	Snow Goose	RR	RR	I	I	HV	PH	
Branta hutchinsii	Cackling Goose	RR	RR	I	I	HV	PH	
Cygnus columbianus	Tundra Swan	CM	CM	W	W	MD	PH	Roosting
Cygnus cygnus	Whooper Swan	CM	CM	W	W	LT	PH	Roosting
Tadorna tadorna	Common Shelduck	UC	UC	W	W	LT	PH	
Tadorna ferruginea	Ruddy Shelduck	RR	RR	I	I	MD	PH	
Aix galericulata	Mandarin Duck	CM	CM	R	R	LT	AL	
Anas strepera	Gadwall	CM	CM	W	W	MD	PH	
Anas falcata	Falcated Duck	CM	CM	W	W	MD	PH	
Anas penelope	Eurasian Wigeon	CM	CM	W	W	MD	PH	
Anas platyrhynchos	Mallard	CM	CM	W	R	HV	AL	
Anas poecilorhyncha	Indian Spot-billed Duck	CM	CM	R	R	HV	AL	Nesting
Anas clypeata	Northern Shoveler	CM	CM	W	W	LT	PH	
Anas acuta	Northern Pintail	CM	CM	W	W	MD	PH	
Anas querquedula	Garganey	UC	UC	W	W	MD	PH	
Anas formosa	Baikal Teal	CM	UC	W	W	HV	PH	
Anas crecca	Eurasian Teal	CM	CM	W	W	HV	PH	

Appendix. (Continued) Bird species that use rice fields (including associated irrigation ditches and reservoirs) in Korea (KR) and Japan (JP). Bird names and species order follow the IOC world bird list, ver. 2.1, as of 12 May 2009 (Gill *et al.* 2009). Abundance codes: CM = common, UC = uncommon, LC = locally common, RR = rare, n/a = not found (includes species that are extinct in the wild). Season codes: R = resident breeders (including migrants within the nation), S = summer breeders, W = winter visitors, P = passage migrants, I = irregular visitors (mostly in winter). Use: HV = heavy (rice fields are the most important habitat for the population at least during a certain period of year), MD = moderate (rice fields are used regularly; 10-50% of the population are found in rice fields), LT = light (rice fields are used infrequently or by a small fraction of the population); note that abundant species may be commonly observed in rice fields even if their dependency is light, and vice versa. Season codes: GR = rice growing season (spring-summer), during which rice fields are usually flooded, PH = post-harvest season (autumn-winter), irrespective of dry, wet, or flooded, AL = all year round.

		Abundance		Season		Use of Rice Fields		
Latin name	Common name	KR	JP	KR	JP	Use	Season	Activity other than foraging
PODICIPEDIFORMES								
Podicipedidae								
Tachybaptus ruficollis	Little Grebe	CM	CM	R	R	LT	AL	
CICONIIFORMES								
Ciconiidae								
Ciconia boyciana	Oriental Stork	RR	RR	I	I	MD	GR	
Threskiornithidae								
Threskiornis melanocephalus	Black-headed Ibis	RR	RR	I	I	MD	PH	
Nipponia nippon	Crested Ibis	EX	EW	R	R	HV	AL	
Platalea leucorodia	Eurasian Spoonbill	RR	RR	I	I	LT	PH	
Platalea minor	Black-faced Spoonbill	RR	RR	R	I	LT	AL	
Ardeidae								
Ixobrychus sinensis	Yellow Bittern	CM	CM	S	S	LT	GR	
Ixobrychus eurhythmus	Von Schrenck's Bittern	UC	UC	S	S	LT	GR	
Ixobrychus cinnamomeus	Cinnamon Bittern	RR	LC	I	R	MD	AL	
Nycticorax nycticorax	Black-crowned Night Heron	CM	CM	R	R	MD	AL	
Butorides striata	Striated Heron	CM	CM	S	S	MD	GR	
Ardeola bacchus	Chinese Pond Heron	RR	RR	I	I	MD	GR	
Bubulcus coromandus	Eastern Cattle Egret	CM	CM	S	S	HV	GR	
Ardea cinerea	Grey Heron	CM	CM	R	R	MD	AL	
Ardea purpurea	Purple Heron	RR	LC	I	R	LT	AL	
Ardea modesta	Eastern Great Egret	CM	CM	R	R	MD	AL	
Egretta intermedia	Intermediate Egret	CM	CM	S	S	HV	GR	
Egretta garzetta	Little Egret	CM	CM	R	R	MD	AL	
Egretta eulophotes	Chinese Egret	UC	RR	S	I	LT	GR	

Appendix. (Continued) Bird species that use rice fields (including associated irrigation ditches and reservoirs) in Korea (KR) and Japan (JP). Bird names and species order follow the IOC world bird list, ver. 2.1, as of 12 May 2009 (Gill *et al.* 2009). Abundance codes: CM = common, UC = uncommon, LC = locally common, RR = rare, n/a = not found (includes species that are extinct in the wild). Season codes: R = resident breeders (including migrants within the nation), S = summer breeders, W = winter visitors, P = passage migrants, I = irregular visitors (mostly in winter). Use: HV = heavy (rice fields are the most important habitat for the population at least during a certain period of year), MD = moderate (rice fields are used regularly; 10-50% of the population are found in rice fields), LT = light (rice fields are used infrequently or by a small fraction of the population); note that abundant species may be commonly observed in rice fields even if their dependency is light, and vice versa. Season codes: GR = rice growing season (spring-summer), during which rice fields are usually flooded, PH = post-harvest season (autumn-winter), irrespective of dry, wet, or flooded, AL = all year round.

		Abundance		Season		Use of Rice Fields		
Latin name	Common name	KR	JP	KR	JP	Use	Season	Activity other than foraging
FALCONIFORMES								
Falconidae								
Falco tinnunculus	Common Kestrel	CM	CM	R	R	LT	PH	
Falco columbarius	Merlin	UC	UC	W	W	LT	PH	
Accipitridae								
Circus spilonotus	Eastern Marsh Harrier	UC	CM	W	R	LT	PH	
Circus cyaneus	Northern Harrier	CM	UC	W	W	LT	PH	
Accipiter soloensis	Chinese Sparrowhawk	CM	LC	S	P	MD	GR	
Butastur indicus	Grey-faced Buzzard	RR	CM	I	S	HV	GR	
Buteo buteo	Common Buzzard	CM	CM	W	R	LT	PH	
Buteo lagopus	Rough-legged Buzzard	UC	RR	W	W	LT	PH	
GRUIFORMES								
Rallidae								
Coturnicops exquisitus	Swinhoe's Rail	n/a	UC	n/a	W	LT	PH	
Rallus aquaticus	Water Rail	UC	CM	S	R	LT	AL	
Amaurornis phoenicurus	White-breasted Waterhen	RR	LC	I	R	MD	AL	
Porzana pusilla	Baillon's Crake	UC	UC	S	S	LT	GR	
Porzana fusca	Ruddy-breasted Crake	UC	UC	S	S	MD	GR	Nesting
Gallicrex cinerea	Watercock	RR	RR	S	I	MD	GR	
Gallinula chloropus	Common Moorhen	CM	CM	R	R	LT	AL	Nesting
Fulica atra	Eurasian Coot	CM	CM	R	R	LT	AL	
Gruidae								
Grus vipio	White-naped Crane	RR	LC	I	W	HV	PH	Roosting
Grus grus	Common Crane	RR	RR	W	W	HV	PH	
Grus monacha	Hooded Crane	RR	LC	I	W	HV	PH	Roosting
Grus japonensis	Red-crowned Crane	RR	LC	W	R	HV	PH	

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		Abundance		Season		Use of Rice Fields		
Latin name	Common name	KR	JP	KR	JP	Use	Season	Activity other than foraging
CHARADRIIFORMES								
Recurvirostridae								
Himantopus himantopus	Black-winged Stilt	UC	CM	I	R	LT	AL	
Charadriidae								
Vanellus vanellus	Northern Lapwing	CM	CM	W	W	HV	PH	
Vanellus cinereus	Grey-headed Lapwing	RR	CM	I	R	HV	AL	Nesting
Pluvialis fulva	Pacific Golden Plover	UC	CM	P	P	MD	GR	
Charadrius placidus	Long-billed Plover	UC	CM	R	R	LT	AL	
Charadrius dubius	Little Ringed Plover	CM	CM	S	S	LT	GR	
Rostratulidae								
Rostratula benghalensis	Greater Painted Snipe	RR	UC	I	R	HV	AL	Nesting
Scolopacidae								
Scolopax rusticola	Eurasian Woodcock	UC	CM	I	R	LT	AL	
Lymnocryptes minimus	Jack Snipe	UC	RR	P	P	MD	GR	
Gallinago hardwickii	Latham's Snipe	UC	UC	I	S	MD	GR	
Gallinago stenura	Pin-tailed Snipe	UC	UC	P	P	MD	GR	
Gallinago megala	Swinhoe's Snipe	UC	UC	P	P	MD	GR	
Gallinago gallinago	Common Snipe	CM	CM	W	W	HV	PH	
Limnodromus scolopaceus	Long-billed Dowitcher	RR	UC	P	P	MD	GR	
Limnodromus semipalmatus	Asian Dowitcher	n/a	RR	n/a	P	LT	GR	
Limosa limosa	Black-tailed Godwit	UC	CM	P	P	MD	GR	
Limosa lapponica	Bar-tailed Godwit	UC	CM	P	P	LT	GR	
Numenius minutus	Little Curlew	UC	RR	P	P	LT	GR	
Numenius phaeopus	Whimbrel	CM	CM	P	P	LT	GR	
Numenius madagascariensis	Eastern Curlew	n/a	UC	n/a	P	LT	GR	
Tringa erythropus	Spotted Redshank	UC	UC	P	P	MD	GR	
Tringa totanus	Common Redshank	UC	UC	P	P	LT	GR	
Tringa stagnatilis	Marsh Sandpiper	UC	UC	P	P	MD	GR	

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		Abundance		Season		Use of Rice Fields		
Latin name	Common name	KR	JP	KR	JP	Use	Season	Activity other than foraging
Tringa nebularia	Common Greenshank	CM	CM	P	P	LT	GR	
Tringa ochropus	Green Sandpiper	CM	CM	W	W	LT	PH	
Tringa glareola	Wood Sandpiper	CM	CM	P	P	MD	GR	
Tringa brevipes	Grey-tailed Tattler	RR	CM	P	P	LT	GR	
Xenus cinereus	Terek Sandpiper	CM	CM	P	P	LT	GR	
Actitis hypoleucos	Common Sandpiper	CM	CM	R	R	LT	AL	
Arenaria interpres	Ruddy Turnstone	RR	CM	P	P	LT	GR	
Calidris tenuirostris	Great Knot	CM	CM	P	P	LT	GR	
Calidris canutus	Red Knot	UC	UC	P	P	LT	GR	
Calidris ruficollis	Red-necked Stint	UC	CM	P	P	LT	GR	
Calidris temminckii	Temminck's Stint	RR	UC	P	P	MD	GR	
Calidris subminuta	Long-toed Stint	UC	UC	P	P	MD	GR	
Calidris melanotos	Pectoral Sandpiper	RR	RR	P	P	LT	GR	
Calidris acuminata	Sharp-tailed Sandpiper	RR	UC	P	P	MD	GR	
Calidris ferruginea	Curlew Sandpiper	RR	RR	P	P	LT	GR	
Calidris alpina	Dunlin	CM	CM	P	P	LT	GR	
Limicola falcinellus	Broad-billed Sandpiper	UC	UC	P	P	LT	GR	
Philomachus pugnax	Ruff	UC	UC	P	P	MD	GR	
Phalaropus lobatus	Red-necked Phalarope	UC	UC	P	P	LT	GR	
Laridae								
Chlidonias hybrida	Whiskered Tern	RR	RR	I	I	LT	GR	
Chlidonias leucopterus	White-winged Tern	RR	RR	P	P	LT	GR	
COLUMBIFORMES								
Columbidae								
Streptopelia orientalis	Oriental Turtle Dove	CM	CM	R	R	LT	PH	
Streptopelia decaocto	Eurasian Collared Dove	CM	LC	R	R	LT	PH	

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		Abundance		Season		Use of Rice Fields		
Latin name	Common name	KR	JP	KR	JP	Use	Season	Activity other than foraging
STRIGIFORMES								
Strigidae								
Asio flammeus	Short-eared Owl	RR	CM	W	W	LT	PH	
CORACIIFORMES								
Alcedinidae								
Alcedo atthis	Common Kingfisher	CM	CM	S	R	LT	AL	
PASSERIFORMES								
Laniidae								
Lanius bucephalus	Bull-headed Shrike	CM	CM	R	R	LT	PH	
Corvidae								
Pica pica	Eurasian Magpie	CM	LC	R	R	LT	PH	
Coloeus dauuricus	Daurian Jackdaw	CM	UC	W	W	MD	PH	
Corvus frugilegus	Rook	CM	CM	W	W	MD	PH	
Corvus corone	Carrion Crow	CM	CM	R	R	MD	AL	
Hirundinidae								
Hirundo rustica	Barn Swallow	CM	CM	S	S	LT	GR	
Alaudidae								
Alauda arvensis	Eurasian Skylark	CM	CM	R	R	LT	AL	
Cisticolidae								
Cisticola juncidis	Zitting Cisticola	CM	CM	R	R	MD	GR	Nesting
Sylviidae								
Acrocephalus arundinaceus	Great Reed Warbler	n/a	CM	n/a	S	LT	GR	
Sturnidae								
Spodiopsar cineraceus	White-cheeked Starling	CM	CM	R	R	LT	AL	

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		Abundance		Season		Use of Rice Fields		
Latin name	Common name	KR	JP	KR	JP	Use	Season	Activity other than foraging
Turdidae								
Turdus naumanni	Naumann's Thrush	CM	CM	W	W	LT	PH	
Muscicapidae								
Saxicola maurus	Siberian Stonechat	CM	CM	S	S	LT	GR	Nesting
Passeridae								
Passer rutilans	Russet Sparrow	CM	CM	R	R	MD	PH	
Passer montanus	Eurasian Tree Sparrow	CM	CM	R	R	MD	AL	
Motacillidae								
Motacilla alba	White Wagtail	CM	CM	R	R	LT	AL	
Motacilla grandis	Japanese Wagtail	CM	CM	R	R	LT	AL	
Anthus cervinus	Red-throated Pipit	UC	UC	P	P	LT	PH	
Anthus spinoletta	Water Pipit	n/a	CM	n/a	W	MD	PH	
Fringillidae								
Fringilla montifringilla	Brambling	CM	CM	W	W	LT	PH	
Carduelis sinica	Grey-capped Greenfinch	CM	CM	R	R	LT	PH	
Emberizidae								
Emberiza cioides	Meadow Bunting	CM	CM	R	R	LT	PH	
Emberiza fucata	Chestnut-eared Bunting	UC	CM	R	R	LT	PH	
Emberiza pusilla	Little Bunting	CM	CM	W	W	LT	PH	
Emberiza rustica	Rustic Bunting	CM	CM	W	R	LT	PH	
Emberiza schoeniclus	Common Reed Bunting	CM	CM	R	R	LT	PH	