Restoring Rice Paddy Wetland Environments and the Local Sustainable Society – Project for Achieving Co-existence of Rice Paddy Agriculture with Waterbirds at Kabukuri-numa, Miyagi Prefecture, Japan –

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Abstract

Over the past century, Japan's wetlands have been greatly impoverished, and 61% completely lost. Miyagi Prefecture, in particular, lost 92%, most of which were converted to rice paddies. Ibaraki, Chiba and other prefectures have similar histories. Better productivity and efficiency have further fueled construction of paddies so as to eliminate their remaining wetland value by keeping them dry in winter, particularly on Japan's drier Pacific coast. This has seriously impacted many wetland-dependent species, driving some close to extinction. This paper takes a 100-year perspective in discussing enhancement of rice paddies' value as wetlands as a way of restoring wetland environments and sustainable local communities. It presents the case of the Ramsar site, "Kabukuri-numa and the surrounding rice paddies," where co-existence of rice agriculture with over-wintering geese is being sought through restoration of some paddies back to wetland and winter-flooding of others still under cultivation.

A proposal to dredge the Kabukuri-numa wetland became an opportunity for stakeholders to initiate a movement towards wetland protection and co-existence of wildlife with agriculture. Landholders agreed to re-convert of 50 hectares (ha) of paddy fields back to wetlands in 1998. The number of geese using Kabukuri- numa as a roosting site increased, illustrating that the restoration augmented the site's wildlife carrying capacity. Farmers and others cooperated to implement a winter-flooding regime for nearby cultivated paddies. The project was examined from various standpoints, including as an application of the Ramsar Convention, and achievements and issues were identified.

Normally, once a wetland is destroyed, restoration requires huge commitments of time and money, but restoration through the managing of rice paddies under cultivation as "agricultural wetlands" can be a realistic and effective method for restoring natural wetland environments in Asia.

Key words: Kabukuri-numa, Ramsar Convention, wetland restoration, White-fronted Goose, winter-flooded rice paddy

1. Introduction

The Senpoku alluvial plain is located in the catchment of the Hasama River, a tributary of the Kitakami River in northern Miyagi prefecture. According to Togashi and Kato (1994), 100 years ago it was a large, low-lying wetland dotted with about 40 lakes and ponds, of which 37 were reclaimed, 31 completely and six, including the Izunuma and Kabukuri-numa Ramsar sites, reduced by about half. Thus, over the last 100 years the wetland environment of north Miyagi was devastatingly impoverished (Fig.1).

According to a Geographical Survey Institute (2000), 61% of Japan's wetlands disappeared during the last century. In the early 20th century, Miyagi Prefecture ranked 3rd in wetland area, but lost 92%, Japan's top rate of loss. Thus, Miyagi experienced the most extreme change in wetlands in the nation. In that era of increasing demand for food, most reclaimed wetlands were converted into rice paddies and low-lying alluvial plains were actively targeted. Chiba and Ibaraki Prefectures, which also have alluvial plains, lost about 90% of their wetlands (Figs. 2-1, 2-2).

The rice paddies that replaced the natural wetlands have also been changing. Those reclaimed earlier on are mostly "wet" paddies, but those reclaimed in the last

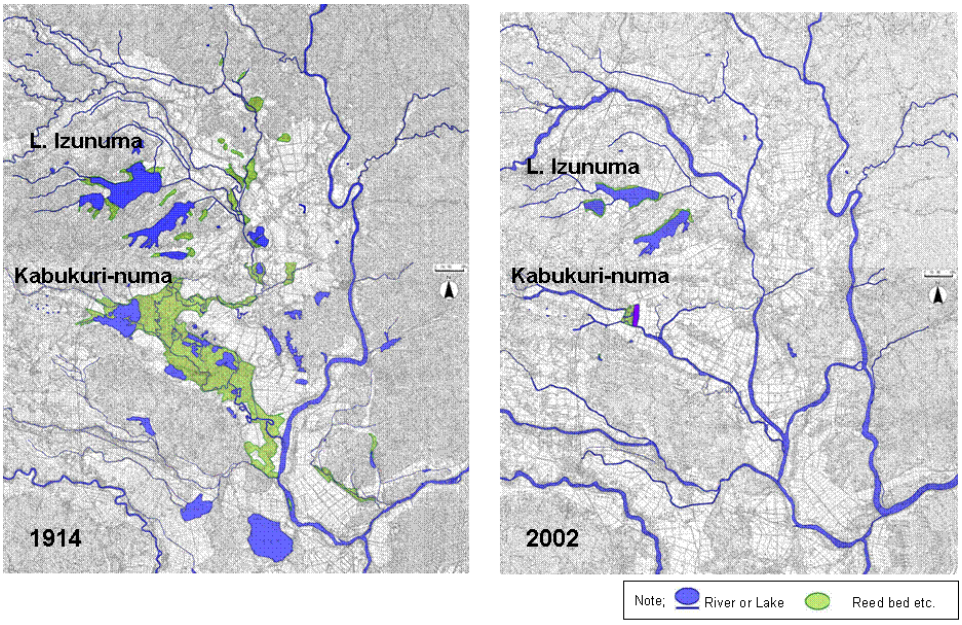


Fig. 1 Changes in wetland habitat in the northern plains of Miyagi Prefecture (1914-2002). (modified from Geographical Survey Institute data)

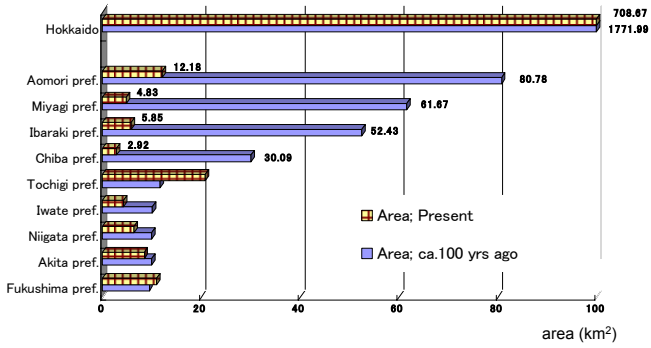


Fig. 2-1 Changes in wetland area over the past 100 years in Japan (ten prefectures most abundant in wetlands 100 years ago). (modified from Geographical Survey Institute data)

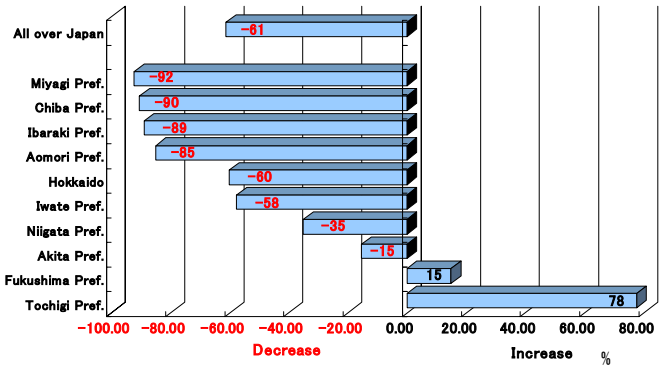


Fig. 2-2 Ratio of Wetlands lost over the past 100 years in Japan (ten prefectures most abundant in wetlands 100 years ago). (modified from Geographical Survey Institute data)

quarter of the 20th century are qualitatively different. Civil engineering technology development and agricultural policies favoring efficiency and productivity resulted in paddies built or re-built with excellent drainage, to allow use of large-scale machinery and conversion to dry fields for non-rice crops. This trend continues today. For example, in Miyagi in 2000, 77.5% of a total of 21,883 hectares (ha) undergoing agricultural improvement at 104 sites were transformed into dry-field convertible paddies (Chiba K., unpublished data). The area of abandoned fields is also growing. According to the Ministry of Agriculture, Forestry and Fisheries (2005), there were 384,800 ha of abandoned fields in Japan, about double the 2000 figure and equal to 10.1% of all arable land, making abandoned fields a serious national issue. These losses of natural wetlands and qualitative changes in rice paddy environments have had major negative impacts on wetland-dependant species groups. Most paddies were created by destroying natural wetlands to feed humans. However, they differ significantly from other agricultural fields in that they are flooded to grow the wetland plant, rice, and thus function as wetlands; they can also be continuously cultivated for a long time without impoverishing the soil.

Appropriate water management is required to activate the wetland functions of rice paddies. Traditionally, water was retained in paddies during winter, so they functioned as semi-natural but still important habitat for wetland-dependent wildlife. However, in modern times the practice of letting fields dry out completely during winter has spread rapidly, robbing paddies of wetland functions and helping drive many wetland species towards extinction, for example the Japanese Crested Ibis and the White Stork, both extinct in the wild in Japan.

Waterbirds such as geese, swans and ducks use these wetlands in winter and feel these impacts most strongly. Yamamoto *et al.* (2002) found a significant correlation

between numbers of mallards visiting the Katano-Kamoike Ramsar site (Kaga City, Ishikawa Prefecture) and the cumulative area of rice paddies in Kaga kept dry in winter. Dry paddies are almost useless to wetland wildlife, particularly in Miyagi and other prefectures along Japan's Pacific coast, which receive less precipitation in winter than the Japan Sea coast.

The loss of almost all wetlands over the past 100 years and the loss of rice paddy wetland functions useful to wildlife threw these environments rapidly off balance, seriously impacting wetland species. This was recognized by the Ministry of the Environment (MOE) (2002) in the "National Strategy for the Conservation and Sustainable Use of Biological Diversity" as an example of one of the categories of threat involving changes in production methods in rural areas affecting species formerly supported by human activities. Restoration of the biological diversity of impoverished wetlands will be a major, unavoidable challenge in creating a sustainable society.

This paper introduces efforts at Kabukuri-numa to restore the wetland value of rice paddies as agricultural wetlands and achieve co-existence with environmentally-sensitive geese, consciously referring to the wetland environment of 100 years ago. It discusses ways, including application of the Ramsar Convention (2006), to restore wetlands and sustainable local societies.

2. Action for Co-existence of Waterbirds and Wet Rice Cultivation at Kabukuri-numa and the Surrounding Rice Paddies

The Ramsar site "Kabukuri-numa and the Surrounding Rice Paddies," in northern Miyagi Prefecture, is the 1,545th wetland on the "List of Wetlands of International Importance" of the international Ramsar Convention dedicated to the conservation and wise use of wetlands. Added to the list in November 2005, it was the first Ramsar site to expressly include surrounding rice paddies as an agro-wetland buffer zone to an open-water wetland. Paddy fields can help maintain a wetland ecosystem, although normally they impose an environmental burden due to intensive agricultural methods, indifference to wetlands, etc. To reduce or eliminate this burden, the first requirement is awareness and agreement among the local community that rice paddies are valuable buffer zones for wetlands. At Kabukuri-numa, incentives for meeting this requirement have included discussions and agricultural/environmental policies designed to reduce environmental burdens and activate the wetland functions of paddies. A consensus reached by local farmers to apply the Ramsar Convention as a framework for allowing wildlife to share wetland benefits led to the area's designation and addition to the list.

2.1 Birds of Kabukuri-numa

Kabukuri-numa has a diverse environment of marshes and open water and is high in biodiversity; it is particularly important as one of Japan's foremost wintering sites for wild geese (Miyabayashi, 1994). So far, birds of 219 species, 43 families and 16 orders have been recorded at Kabukuri-numa (Tohoku regional nature protection center (TRNPC) for MOE, 2005; TRNPC for MOE & Kabukuri Wetlands Club, 2003). The *Anatidae*, including geese, are dominant (Tojima, 1999) but many other species groups are present. In all, there are 126 species of wetland-dependent birds (58%) and 93 "terrestrial" species (42%) attesting to the site's diversity (Nakashio, 1998) (Table 1). Many of these birds are endangered, including six "Natural Treasure" species (one "special" and five "national"), and (as of December 2006), 42 species included in the "Red List of Japan" (TRNPC for MOE, 2005: TRNPC for MOE & Kabukuri Wetlands Club, 2003). In all, 85 *Passeriformes*, 42 *Charadiiformes*, 27 *Anseriformes*, 18 *Falconiformes* and 14 *Ciconiformes* were observed: this includes over half of all species seen in Japan of *Anatidae* of the *Anseriformes*, *Accipitridae* of the *Falconiformes* (64%) and *Ardeidae* of the *Ciconiformes* (63%). The presence of so many top predators attests to its rich biodiversity and variety of supporting habitats.

Table 1 Checklist of the birds of Kabukuri-numa. (modified from TRNPC for MOE, 2005)

Order	Number of Species			Family	Number of Species		
	Kabu-kuri-numa (Nk)	All over Japan (Nj)	Nk/Nj (%)		Kabu-kuri-numa (Nk)	All over Japan (Nj)	Nk/Nj (%)
Podicipendiformes	2	5	40%	*Podicipedidae*	2	5	40%
Pelecaniformes	1	13	8%	*Phalacrocoracidae*	1	4	25%
Ciconiiformes	14	25	56%	***Ardeidae***	**12**	**19**	**63%**
				Ciconiidae	1	2	50%
				Threskiornithidae	1	4	25%
Anseriformes	27	52	52%	***Anatidae***	**27**	**52**	**52%**
Falconiformes	18	29	62%	***Accipitridae***	**14**	**22**	**64%**
				Falconidae	**4**	**7**	**57%**
Galliformes	4	6	67%	***Phasianidae***	**4**	**6**	**67%**
Gruiformes	8	22	36%	*Gruidae*	2	7	29%
				Rallidae	**6**	**12**	**50%**
Charadriiformes	42	125	34%	*Rostratulidae*	1	1	100%
				Scolopodidae	24	52	46%
				Charadriidae	**7**	**12**	**58%**
				Recurvirostridae	1	2	50%
				Phalaropodidae	1	3	33%
				Glareolidae	1	1	100%
				Laridae	7	34	21%
Columbiformes	1	10	10%	*Columbidae*	1	9	11%
Cuculiformes	3	6	50%	***Cuculidae***	**3**	**6**	**50%**
Strigiformes	5	11	45%	*Strigidae*	5	11	45%
Caprimulgiformes	1	1	100%	*Caprimulgidae*	1	1	100%
Apodiformes	2	3	67%	***Apodidae***	**2**	**3**	**67%**
Coraciiformes	2	9	22%	*Alcedinidae*	2	6	33%
Piciformes	4	11	36%	*Picidae*	4	11	36%
Passeriformes	85	183	46%	*Alaudidae*	1	5	20%
				Hirundinidae	**4**	**5**	**80%**
				Motacillidae	5	13	38%
				Campephagidae	1	2	50%
				Pycnonotidae	1	2	50%
				Laniidae	**4**	**6**	**67%**
				Bombycillidae	2	2	100%
				Troglodytidae	1	1	100%
				Turdidae	13	31	42%
				Sylviidae	**13**	**24**	**54%**
				Aegithalidae	1	1	100%
				Paridae	**4**	**6**	**67%**
				Zosteropidae	1	1	100%
				Emberizidae	**14**	**24**	**58%**
				Fringillidae	**10**	**18**	**56%**
				Ploceidae	**2**	**3**	**67%**
				Sturnidae	2	6	33%
				Corvidae	**6**	**10**	**60%**
Total	219	511	43%	Total	219	452	48%

2.2 Wetland transitions around Kabukuri-numa and the 100-year Restoration Plan

A rich natural environment remains at Kabukuri-numa, but it formerly had a larger area of open water when it was a natural reservoir for the Kitakami River's floodwaters. When the Kitakami was canalized, Kabukuri-numa became part of the catchment of its tributary, the Hasama River, which was also canalized, placing Kabukuri-numa in the catchment of the former Hasama River. A parallel development was reclamation of much of the wetland area, leaving only 100 ha of open water, a major reason for the present intensive concentration of natural habitat, for example, of geese (Figs. 3-1, 3-2).

The "Hundred-Year Open-Water Restoration Plan" was designed to restore balance to these wetland environments.

Over the last 100 years, many of Japan's lakes, ponds, marshes and other wetlands were reclaimed as paddy land, and much of that was further transformed into paddies that are completely dried out in winter. The Hundred-Year Plan's main purpose is to take the next 100 years to restore these wetlands to an approximation of their former status through water management and rice cultivation that allows paddies to function as wetlands. Specifically, the project educates local stakeholders and proposes a flooding regime to keep water in paddies as long as possible to activate their wetland functions. Its fundamental principles are:

1) Abandoned rice paddies should be amalgamated and restored as natural wetlands;

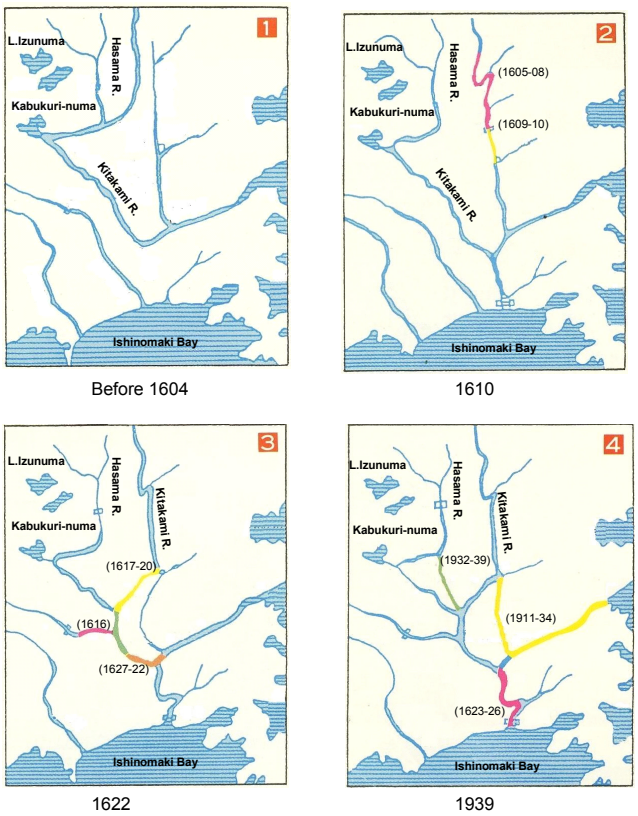


Fig. 3-1 Changes in the course of the Kitakami River system to which Kabukuri-numa belongs (since 1604, modified from Hasama Town History).
[Numbers in parentheses indicate years of new river course construction]

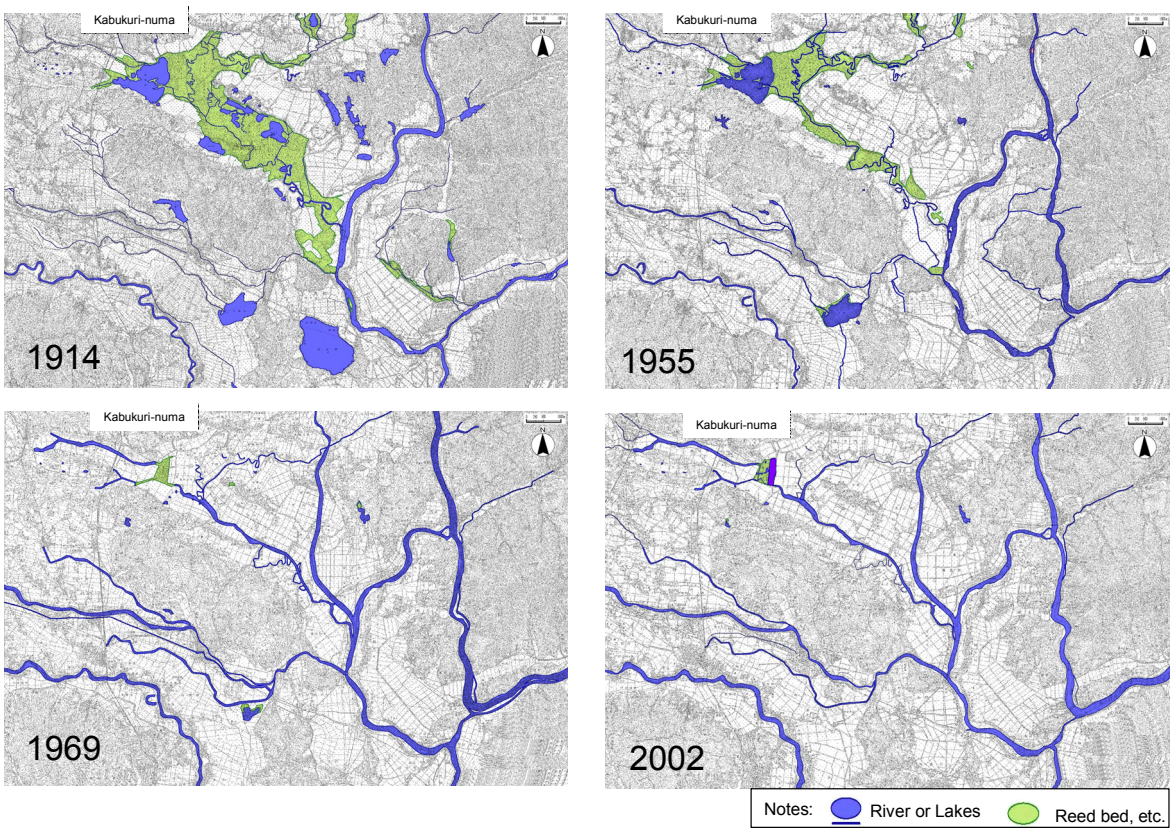


Fig. 3-2 Changes in wetland habitat around Kabukuri-numa Marsh (1914-2002).
(modified from Geographical Survey Institute data)

2) Fallow paddies should be flooded year-round and managed as wetlands;
3) Paddies with good water retention should be managed under a "winter-flooding" regime;
4) These activities should be undertaken with the support of all stakeholders in agriculture, environmental protection, water management, etc.

Implementing these principles required a revolution in the consciousness of farming families, and the establishment of a system of incentives and guidance by government authorities.

Actions that anticipated this project were already under way. The "Kabukuri-numa Retarding Basin Project" was a flood control measure first undertaken by Miyagi prefecture in 1970 that targeted 582 ha of Kabukuri-numa and its vicinity for retaining floodwater overflows. In 1996, a plan was revealed that called for the entire area to be dredged by one meter; it had supposedly become shallower from sediment accumulation. This proposal ended up providing an opportunity to protect Kabukuri-numa – environmental studies preceding its implementation led to a complete reconsideration of the project. Lessons were learned about considering only flood-control factors and not releasing information regarding retarding-basin construction plans. How to conserve a rich natural environment while maintaining flood control functions was discussed by an informal deliberative council, the Kabukuri-numa Round Table Meeting, set up by Miyagi Prefecture's Rivers Department at the request of environmental conservation groups and others (Matsugane, 1997; Kurechi, 1998). The Round Table pursued constructive discussions and actions to carry out the consensuses reached by stakeholders, including fundamental changes in the overflow embankment plan to include environmental concerns. These concepts were included in the "Kabukuri-numa Basic Environmental Management Plan," based on the Round Table's discussions and summarized below (Miyagi prefecture, 2000):

1) Maintain Kabukuri-numa's function as a floodwater-retarding basin in a way that allows it to fulfill its other roles and functions;
2) Protect the river environment as habitat for its diverse, precious wildlife;
3) Create and use the area as a place for humans to relate with the natural environment;
4) Manage Kabukuri-numa with residents and authorities acting as a single entity.

2.3 Effects of the Shiratori restoration on Kabukuri-numa's environmental carrying capacity

One of the most important developments was returning paddies in the Shiratori area within the Kabukuri-numa retarding basin to wetland status, as this increased the carrying capacity of the wetland overall. In a context of various actions for revitalizing natural wetland functions, in 1997, farmers cultivating the 50 ha Shiratori reclaimed-rice-paddy area on the eastern border of Kabukuri-numa proper agreed with local and prefectural authorities to withdraw it from cultivation. Based on an agreement between conservation groups and the river management authority, a regime for normally keeping this area under water (up to 81 cm deep) in such a way as to prevent impairment of its floodwater retarding function was adopted in the spring of 1998. Thus, Shiratori was restored as a natural wetland and became an integral part of Kabukuri-numa, increasing its area by 1.5 times to 150 ha (Fig. 4-1). At first the river authority perceived the constant flooding regime as a threat to the area's floodwater retention capacity and withheld their agreement. With expert assistance, volunteers took simple ground height measurements at 171 points. Although the cross-sectional map used to plan the retarding basin put the entire area's ground height at 3.0 m above sea level (Takada, 1999), the measurements revealed that the great majority of points were actually lower (Fig. 4-2).

The total number of White-fronted Geese wintering in Japan has been trending upwards, more markedly in the 1990s. This is reflected in numbers overwintering in northern Miyagi, which accounts for about 80% of the national total, as it has several overnight roosting sites such as Izunuma (including Uchinuma) and Kabukuri-numa. The greatest number used to roost at Izunuma, but this began to change after restoration started at Kabukuri-numa. Figure 5-1 summarizes use of Kabukuri-numa by White-fronted Geese before and after the restoration project. Before a voluntary ban on gun hunting in Kabukuri-numa was adopted in the winter of 1994/95, a relatively low proportion of geese roosted there, but afterwards their numbers started to rise, and in the second winter after the Shiratori restoration (1999/2000), rose higher than at the previous top site, Izunuma, a trend that has been sustained. Figure 5-2 shows this trend in relation to the status of the Shiratori area. The peak number roosting at Kabukuri-numa the winter before the restoration (1997/98) was 32,000. The first winter after the restoration (1998/99) it rose to 35,000, with 25% using Shiratori. The second winter after restoration, the peak number rose to 41,275, with about 50% using Shiratori, topping the number at Izunuma (Kurechi *et al*., 2007; Miyagi Prefecture, 2001).

Most importantly, the increase in geese roosting at Shiratori to a maximum of 29,643 was not accompanied by an increased maximum for Kabukuri-numa proper (the Original Kabukuri-numa), where numbers actually declined, indicating that the increase was due not to enhanced carrying capacity in the Original Kabukuri-numa, but to the Shiratori restoration and the creation of more open water (Kurechi *et al*., 2007) (Figs. 5-1, 5-2, Tables 2-1, 2-2). A series of surveys showed no significant change after the proportion of geese roosting at Shiratori reached about 50%. A stand of reeds divides Shiratori into two open water sections, north (20 ha) and south (30 ha). White-fronted Geese use both, but a difference

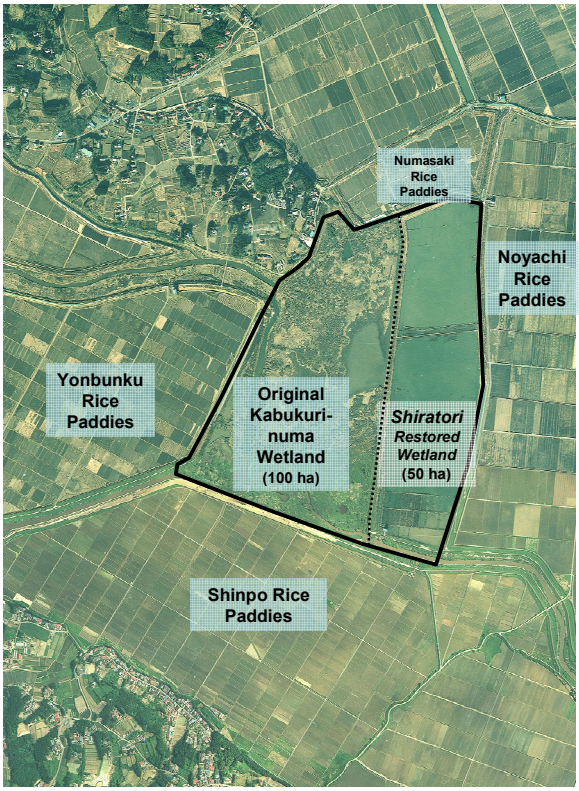


Fig. 4-1 Shiratori rice paddies restored to wetlands in 1998.

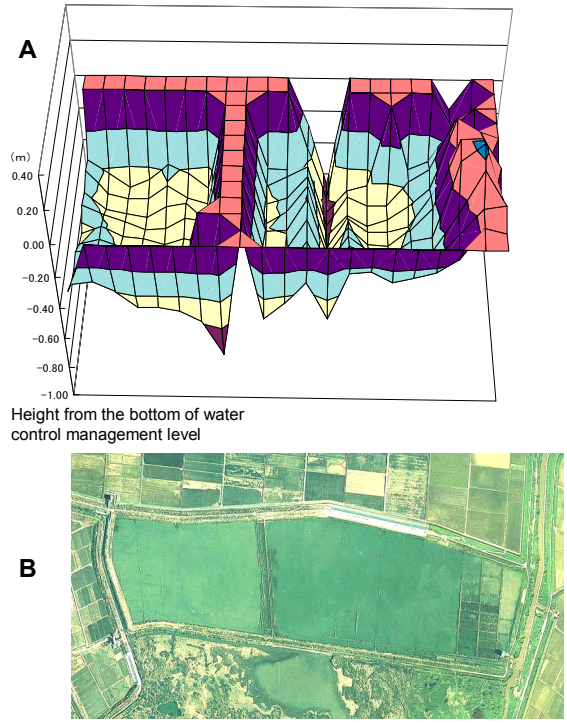


Fig. 4-2 Height of the ground in the Shiratori area (A) and Shiratori area after being flooded up to the level stipulated by water control management authorities (B).

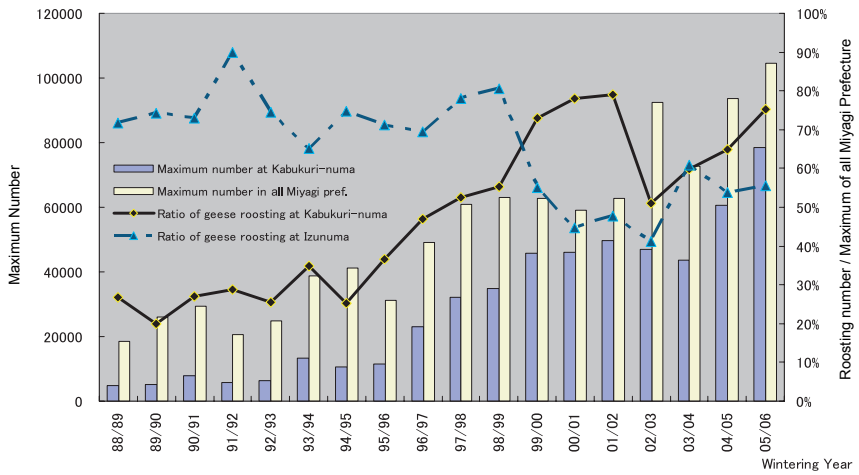


Fig. 5-1 Trends in Maximum Number of White-fronted Geese (*Anser albifrons*) in Miyagi Pref. and the roosting ratio at Kabukuri-numa and Izunuma. (88/89-99/00: JAWGP data, 00/01-02/03: Miyagi Pref. data, 03/04-05/06: WfG Joint Res. Data)

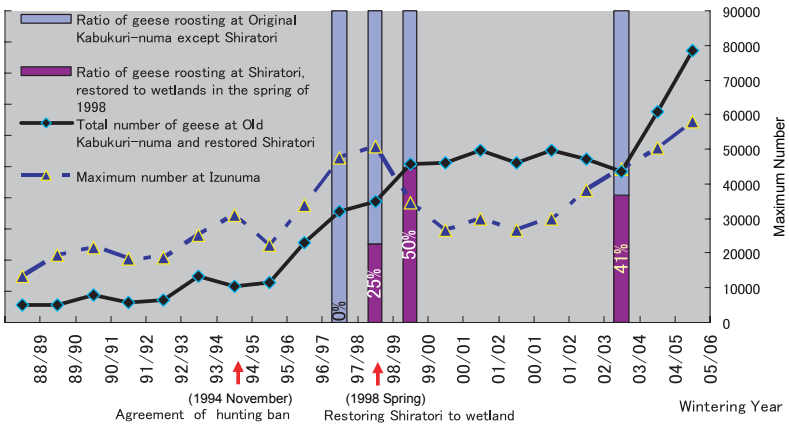


Fig. 5-2 Trends in ratio of roosting White-fronted Geese at Original Kabukuri-numa or the Shiratori Restored Wetland. (88/89-99/00: JAWGP data, 00/01-02/03: Miyagi Pref. data, 03/04-05/06: WfG Joint Res. Data)

Table 2-1 Trends in the maximum roosting number of White-fronted Geese (*Anser albifrons*) at the Original Kabukuri-numa and Shiratori Restored Wetlands.

* = data of Shiratori Monitoring Research by Japanese Association for Wild Geese Protection were used.
* = data of 1997/98 and 2000/01were from the Annual Census of Waterfowl by Miyagi Prefecture.
* = data of 2003/04 was from the Fundamental Research Report on the Environment of Kabukuri-numa (TRNPC for MOE & Kabukuri Wetlands Club, 2004).

	Original Kabukuri-numa (a)		Shiratori Restored Wetlands (b) (restored in the spring of 1998)		Whole area of Kabukuri-numa (a)+(b)	
Wintering year	Maximum number	Rise or fall (comparison with 97/98)	Maximum number	Rise or fall (comparison with 97/98)	Maximum number*	Rise or fall (comparison with 97/98)
1997/98	32,000	-	0	-	32,000	-
1998/99	25,000	▲7,000	13,770	13,770	35,000	3,000
1999/00	30,190	▲1,810	29,643	29,643	41,275	9,275
2000/01	-	-	-	-	46,096	14,096
2003/04	35,710	3,710	20,864	20,864	43,600	11,600

Table 2-2 Roosting density of White-fronted Geese (*Anser albifrons*) at the Original Kabukuri-numa and Shiratori Restored Wetlands.

* = data of 98/99, 99/00 were from Shiratori Monitoring Research by the Japanese Association for Wild Geese Protection.
* = data of 2003/04 were from the Fundamental Research Report on the Environment of Kabukuri-numa (TRNPC for MOE & Kabukuri Wetlands Club, 2004).

		a) Original Kabukuri-numa	b) Shiratori Restored Wetlands			Whole area of Kabukuri-numa (a)+(b)	d) Frequency of research
			b-1 North open water	b-2 South open water	Total of Shiratori b-1)+b-2)		
	e) area (ha)	100	20	30	50	150	
f) Total number of recorded geese	1998/99	250,030	9,788	62,266	106,154	356,184	35
	1999/00	110,340	50,115	58,356	108,471	218,811	8
	2003/04	112,925	20,835	58,438	79,273	192,198	10
	Total	473,295	80,738	179,060	293,898	767,193	53
Average density (bird/ha) 〔f/(e×d)〕		89	76	113	111	97	

emerged in their use as overnight roosts. As shown in Table 2-2, the largest number use Shiratori south overnight, followed by the Original Kabukuri-numa and Shiratori north. We can conclude that a group of White-fronted Geese takes at least two years to get used to a new roosting site, and that they will use a 20 ha area of open water, but to a lesser extent than a 30 ha area, suggesting they may feel insecure in a 20 ha area.

One problem is managing water level and quality. An embankment surrounds the restored area and no natural streams flow in or out; a pumping station installed for irrigation and flood management is used. Water management authorities and other stakeholders agreed to commission the local environmental non-profit organization to manage pumping and draining of the area.

2.4 The Winter-flooded Rice Paddy Project

Monitoring the Shiratori area during and after restoration suggested that, given the appropriate circumstances, shallowly flooding rice paddies in winter could create new goose roosting sites. This led to the Winter-flooded Rice Paddy Project, started in the winter of 1998/99 in Tajiri Township (now Ohsaki City), where Kabukuri-numa is located. With the cooperation of farmers owning and cultivating rice paddies within the habitat range of geese roosting at Kabukuri-numa, the paddies were flooded during winter to create new roosting sites and disperse over-concentrated waterbird populations (Iwabuchi *et al.*, 2001; Kurechi, 2005; Iwabuchi, 2006). In flooded paddies, mostly surrounded by dried-out paddies, swans by day and ducks at night were frequently seen, and in time even extremely shy

White-fronted Geese were occasionally seen. This showed that winter-flooded rice paddies could attract White-fronted Geese and other birds, offering an efficient way to extend habitat (Kurechi *et al*., 2007; Iwabuchi *et al*., 2001) and alleviate over-concentration, a serious issue for geese. The geese do not feed, but rest, drink and preen in these paddies: given an absence of disturbances, they will stay the entire day in an area with winter-flooded paddies (Fig. 6), though normally not at night. Stronger efforts by farmers, better national networking and support systems and an increase in the scale of projects could create many new goose roosting sites (Fig. 7). Specifically, each site would need an amalgamated area of winter-flooded rice paddies of at least 20 ha and the removal of disturbances to geese roosting behavior, such as the presence of natural predators and especially human activities such as hunting, road traffic, etc.

Winter-flooded rice paddies benefit not only over-wintering waterbirds, but also those using the paddies in summer. Rice paddies in the Shimpo area next to Kabukuri-numa where farmers flood a concentrated group of rice paddies in winter were monitored over two years (2005, 2006) for benefits to waterbirds, with the assistance of a Ministry of the Environment subsidy for promoting the development of environmental technology (Kurechi *et al*., 2007; Kagawa & Saito, 2007). These surveys showed benefits to over-wintering geese and other waterbirds, and also clear and significant benefits to herons, *Ardeidae,* in summer, when the paddies were cultivated as usual. The main *Ardeidae* visiting the area are Intermediate Egret, Great Egret, Cattle Egret, and Gray Heron, which use it mainly to feed. Depending on the water level, they catch loaches, frogs, or red swamp crayfish (*Procambus clarkii*) (Kurechi *et al*., 2007). The concentration of *Ardeidae* in winter-flooded paddies was 3.6-3.8 times more than in other paddies; Great Egret (2.7-5.0 X) and Intermediate Egret (3.0-4.0 X) clearly and consistently selected winter-flooded paddies (Fig. 8) (Kurechi *et al*., 2007), where the concentration of loaches and tubificid worms, eaten by loaches, were about five times greater than in

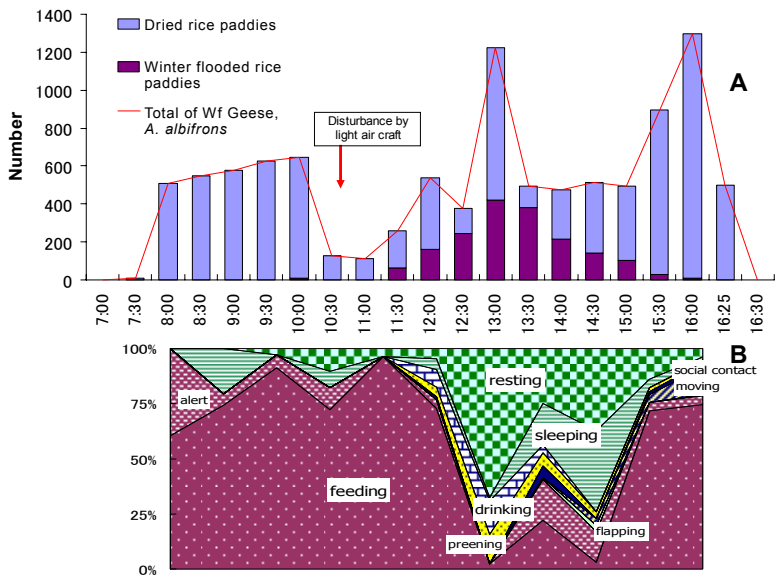


Fig. 6 Selection of winter-flooded or dried rice paddies (A) and time budget at rice paddies (B) of White-fronted Geese, (*A. albifrons*). (Dec. 22, 1999)

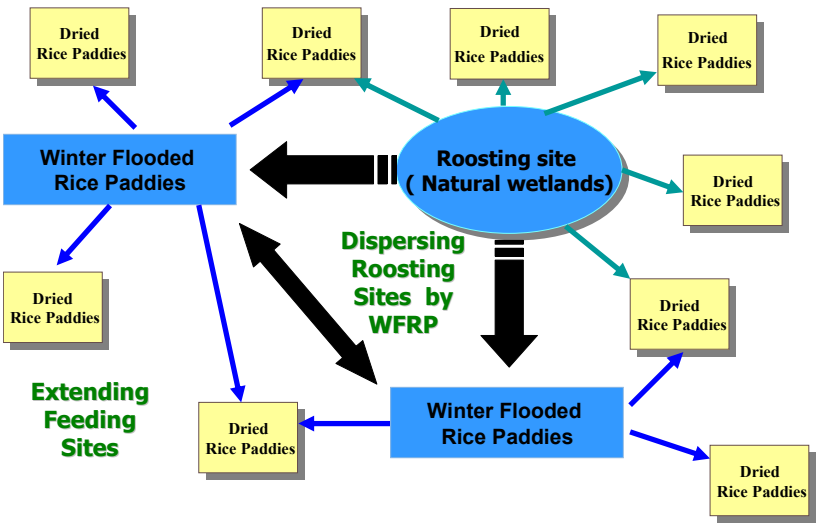
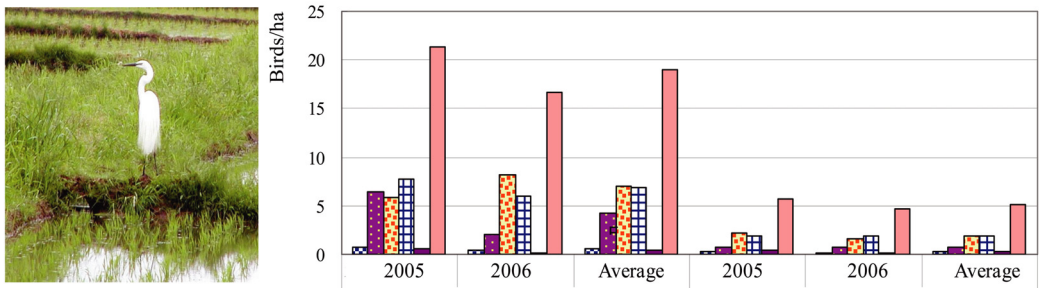


Fig. 7 Dispersing goose roosting sites by creating winter flooded rice paddies to extend habitat.



	Winter flooded RP 2005	Winter flooded RP 2006	Winter flooded RP Average	Non winter flooded RP 2005	Non winter flooded RP 2006	Non winter flooded RP Average
Grey Heron, *Ardea cinerea*	0.73	0.45	0.59	0.35	0.20	0.28
Cattle Egret, *Bubulcus ibis*	6.50	1.98	4.24	0.78	0.77	0.77
Great Egret, *Egretta alba*	5.85	8.16	7.01	2.19	1.62	1.91
Intermediate Egret, *E. intermedia*	7.70	5.94	6.82	1.91	1.97	1.94
Little Egret, *E. garzetta*	0.58	0.20	0.39	0.39	0.14	0.27
Total	21.35	16.73	19.04	5.63	4.70	5.16

Fig. 8 Winter-flooded rice farming and heron density in summer. (Average of summers of 2005 and 2006, n=1,980)

Table 3 Condition of winter-flooded rice paddies based on a questionaire survey of farmers involved. (modified from Ishida *et al*., 2004)

Prefecture	Area (a)	Prefecture	Area (a)
Miyagi	2,046	Nagano	20
Akita	340	Gifu	5
Yamagata	288	Mie	56
Fukushima	416	Shiga	320
Ibaraki	693	Hyogo	46
Tochigi	145	Nara	25
Chiba	807	Shimane	1,000
Niigata (Sado I.)	440	Hiroshima	98
		Saga	17
Ishikawa	1,670	Kumamoto	4
Fukui	4,154	Kagoshima	275
Yamanashi	10		
		Total	12,875

* data of December 2003

other paddies (Hirai *et al*., 2006). These results indicate that winter-flooded paddies have higher biodiversity and greater biomass in both winter and summer, leading to higher concentrations of top predators such as *Ardeidae*.

Winter-flooding is attracting attention as a new agricultural method that brings the rice-paddy ecosystem to life (Iwabuchi, 2006; Ito, 2006), and more farmers are applying it or showing an interest (Ishida *et al*., 2004) (Table 3). Also, Kobayashi *et al*. (2003) suggest that White-fronted Geese shuttling between rice paddies and open water may contribute to the local material cycle.

We can summarize winter-flooded rice paddy functions as follows:

1) They restore habitat for biota that naturally inhabit wet rice fields, enhancing biodiversity from microorganisms to waterbirds, and could help restore the migratory flyway of geese.

2) Proliferation of tubificid worms from winter flooding creates a soil layer composed of worm feces, etc., that controls weeds. Waterbirds fertilize the paddy, helping decompose rice straw. Higher concentrations of insectivorous spiders, frogs, etc., employ the paddy's ecosystem power to assist agriculture.

3) They help create a sustainable, recycling local society based on co-existence/symbiosis between nature and agriculture.

3. Wise Use of Rice Paddies as Agricultural Wetlands

3.1 Co-existence between waterbirds and rice agriculture

Both waterbirds and humans inhabit most sites on the Ramsar List, and so it is worthwhile to highlight co-existence/symbiosis between them. Kabukuri-numa is one of the most important wintering sites for geese in Japan, making it an attractive and interesting spot. However, local farmers were hostile to geese, considering them pests harmful to their rice crop. This hostility doomed several past attempts to have Kabukuri-numa designated a Wildlife Protection Area, but in 2005 it attained Special National Wildlife Protection Area status.

The first step towards this rapprochement was in 1996 when the dredging plan surfaced. Conservationists and farmers joined to oppose this plan and it was cancelled, averting a major threat and creating an opportunity to reconsider the meaning of the geese's presence at the site. This was when farmers' ideas about the geese started to change. Geese are extremely sensitive to environmental change and require a large area of undisturbed, shallow open water to roost and an extensive area of rice paddy land on which to feed (Shimada, 2002; Takekawa *et al*., 2000; Yokota *et al*., 1980). Farmers came to appreciate that about 80% of wild geese over-wintering in Japan choose Kabukuri-numa

and other northern Miyagi sites, in the sense that geese choose the richest paddies, which can therefore produce safe, premium-priced rice. Farmers stopped trying to drive out the geese, and instead started devising ways to use the geese's presence as an advantage. These farmers achieved a change of attitude, but this was significantly supported by the Winter-Flooded Rice Paddy project and by a change in the approach towards agriculture taken by the Ramsar Convention itself.

3.2 The Ramsar Convention as a tool for activating rice paddies as wetlands

The Ramsar Convention has never drawn distinctions between natural and artificial or permanent and temporary wetlands, but defined all watery areas, including rice paddies, as "wetlands." Thus, the Kabukuri-numa Ramsar site can include rice paddies as well as ponds and marshes. Most rice paddies have been created by humans reclaiming natural wetlands for agriculture, but unlike many other types of agricultural fields, rice paddies can be used sustainably for thousands of years and function as valuable agricultural wetlands providing habitat for wildlife. Rice paddies also account for the greatest area of wetlands in the rice-growing countries of Asia; in Japan alone they cover about 2.6 million ha (2002). Rice paddies have been valued exclusively as rice production units, but their wetland functions have recently attracted more attention. Even Japan's Ministry of Agriculture, Forestry and Fisheries has included (still rather inadequate) provisions in its basic plan for food and agriculture to support "reduction of environmental burdens on rice paddies in areas particularly requiring environmental protection."

In addition, the 8th Conference of the Parties (COP) to the Ramsar Convention (Valencia, 2002) adopted Resolution VIII.34 "Agriculture, wetlands and water resource management," its first resolution dealing directly with agriculture. This resolution calls upon Parties to "ensure that management plans for Ramsar sites and other wetlands … duly acknowledge the need for appropriate implementation of agricultural practices and policies that are compatible with wetland conservation and sustainable use goals…" and urges them to identify and enhance positive incentives and replace negative incentives with ones that contribute to wetland conservation.

This resolution significantly influenced the opinions of farmers in the Kabukuri-numa area regarding the Ramsar Convention. Farmers that formerly perceived it as "regulatory," and consequently refused to allow their land to be included in the Ramsar site, changed their minds and actively sought designation and application of the Convention as the framework for drawing up environmental policy for agriculture. This change of heart initiated a movement towards making Japan the first country to intentionally designate rice paddy land.

"Kabukuri-numa and the surrounding rice paddies" was included on the List during the 9th COP (Uganda, 2005), when Japan designated 20 new Ramsar sites, bringing Japan's total to 33. Eleven of these are located among or near rice paddies (Table 4), but only at Kabukuri-numa are stakeholders using the Convention to add environmental value to agriculture to create a site comprised of open water and rice paddies.

Developments at Kabukuri-numa attracted attention at the COP; at Japan's ceremony to officially designate its new sites, Peter Bridgewater, then Secretary-General, warmly welcomed the designation of a site including agricultural land. Rice paddies surrounding an open-water wetland can play an important role as a buffer zone that helps maintain its distinctive ecosystem, and managing the two as a unit can enhance total wetland functions. Only two of Japan's eleven sites located near paddy land include rice paddies, and only Kabukuri-numa expressly includes them. Extending existing Ramsar sites by including paddy land could be the next step. For example, rice paddies around Lake Biwa serve as spawning sites for *nigoro-buna* (*Carassius auratus grandoculis*), a carp relative endemic to Lake Biwa. This Ramsar site is presently limited to the lake surface; extending it to surrounding rice paddies upstream where this fish spawns could encourage use of the Convention to promote wise use of this fishery resource. The Izunuma Ramsar site is also limited to the lake area, but the area of surrounding rice paddies is an important feeding ground for geese and other species, and has already been designated a Special National Wildlife Protection Area. With a little more local initiative, this site could easily be extended.

3.3 International focus on Asia's largest wetland – rice paddies

Farmers cultivating rice paddies directly south of Kabukuri-numa agreed to flood an amalgamated area during winter to activate its wetland functions. Although some unsolved issues with this practice as an agricultural method remain, the biological diversity has definitely increased and the area's value as an agricultural wetland continues to grow. The main issue now how to stabilize the business side of producing rice with higher value due to the sustainability and lower environmental impact achieved by putting the natural powers of the rice paddy as wetlands to use, in the spirit of the Ramsar Convention. (Organic winter-flooded paddy rice is normally more than twice the price of ordinary rice.) This will help bring back wetland environments even more favorable to waterbirds and other wetland-dependent species groups.

Rice paddies are the representative agricultural land of Japan and the Asian monsoon region, and comprise its greatest area of wetland. This region has Earth's richest soils and high levels of precipitation, making it suitable for growing rice, a wetland plant. Because of their distinctive wetland characteristics, rice paddies can serve as habitat for a variety of wetland-dependent species, and designation of Kabukuri-numa to the Ramsar List has initiated a reconsideration of the values of Asia's rice paddies. Japanese and Korean non-govern-

Table 4 Ramsar sites and surrounding rice paddies in Japan.

	Ramsar site	Location	Aate of designation	Area (ha)	Surrounding rice paddies	Rice paddies inside Ramsar site
1	Miyajima-numa	Hokkaido	2002/11/18	41	○	×
2	Uryunuma-shitsugen	Hokkaido	2005/11/8	624	×	×
3	Sarobetsu-genya	Hokkaido	2005/11/8	2,560	×	×
4	Kutcharo-ko	Hokkaido	1989/7/6	1,607	×	×
5	Tofutsu-ko	Hokkaido	2005/11/8	900	×	×
6	Utonai-ko	Hokkaido	1991/12/12	510	×	×
7	Kushiro-shitsugen	Hokkaido	1980/6/17	7,863	×	×
8	Akkeshi-ko & Bekambeushi-shitsugen	Hokkaido	1993/6/10	5,277	×	×
9	Kiritappu-shitsugen	Hokkaido	1993/6/10	2,504	×	×
10	Akan-ko	Hokkaido	2005/11/8	1,318	×	×
11	Furen-ko and Shunkuni-tai	Hokkaido	2005/11/8	6,139	×	×
12	Notsuke-hanto and Notsuke-wan	Hokkaido	2005/11/8	6,053	×	×
13	Hotokenuma	Aomori	2005/11/8	222	○	×
14	Izu-numa & Uchi-numa	Miyagi	1985/9/13	559	○	×
15	Kabukuri-numa and the surrounding rice paddies	Miyagi	2005/11/8	423	○	○
16	Oze	Fukushima Gunma Niigata	2005/11/8	8,711	×	×
17	Oku-Nikko-shitsugen	Tochigi	2005/11/8	260	×	×
18	Yatsu-higata	Chiba	1993/6/10	40	×	×
19	Sakata	Niigata	1996/3/23	76	○	×
20	Katano-kamoike	Ishikawa	1993/6/10	10	○	○
21	Mikata-goko	Fukui	2005/11/8	1,110	○	×
22	Fujimae-Higata	Aichi	2002/11/18	323	○	×
23	Biwa-ko	Shiga	1993/6/10	65,602	○	×
24	Kushimoto Coral Communities	Wakayama	2005/11/8	574	×	×
25	Nakaumi	Tottori Shimane	2005/11/8	8,043	○	×
26	Shinji-ko	Shimane	2005/11/8	7,652	○	×
27	Akiyoshidai Groundwater System	Yamaguchi	2005/11/8	563	×	×
28	Kuju Bogatsuru and Tadewara-shitsugen	Ohita	2005/11/8	91	×	×
29	Imuta-ike	Kagoshima	2005/11/8	60	×	×
30	Yakushima Nagata-hama	Kagoshima	2005/11/8	10	×	×
31	Manko	Okinawa	1999/5/15	58	×	×
32	Kerama-shoto Coral Reef	Okinawa	2005/11/8	353	×	×
33	Nagura Ampuru	Okinawa	2005/11/8	157	×	×
					11	**2**

mental organizations held a meeting at the Ramsar COP 9 in Uganda in 2005 to focus attention on the biodiversity and wise use of rice paddies in the Asian monsoon region, entitled "Rice Paddies–Amazing Wetlands in Asia." This meeting strategically anticipated the 10th COP, to be held in Korea in 2008, where a further appeal will be made regarding the potential of Asia's rice paddies as agricultural wetlands. The 2005 NGO meeting recognized the following points:

1) Rice paddies are a characteristic Asian wetland type and important habitat for migratory birds and many other species;
2) Socio-economic changes have caused the rapid degradation and loss of rice paddies;
3) Winter-flooded Rice Paddy projects in Japan and Korea deserve attention as a method for restoring rice paddies' wetland functions;
4) A resolution recognizing the wetland value of rice paddies in the Asian monsoon region should be presented to the 10th Ramsar COP.

Future issues include extending the movement started at Kabukuri-numa further into the neighboring wet-rice culture of Korea, and using the 10th Ramsar COP as a foothold for identifying and following up on ways to extend it to other East Asian countries.

4. Conclusion

Wetlands were formerly considered wastelands, and people strove to convert them into useful land. Japan's wetlands were greatly reduced and impoverished during the last century. People later realized that wetlands are essential for a wide diversity of living things, including humans, and appreciation for wetland protection increased, as evidenced by the adoption of the Ramsar Convention. By that time, however, huge areas of wetland had been lost. The recent enactment of Japan's Law for the Promotion of Nature Restoration promoted a number of incipient wetland restoration projects. However, returning a destroyed wetland to its original state is extremely difficult and normally requires large amounts of time and money. From a variety of standpoints, reviving the wetland functions of rice paddies can be a practical restoration method. Though mostly created by destroying natural wetlands, rice paddies as agro-wetlands can help promote the journey back to a more natural wetland environment. By appropriately activating their wetland characteristics and taking sufficient account of local resources and circumstances, various routes towards wetland restoration can be identified.

Rice paddies originated in Asia and comprise its

greatest area of wetlands. Many wetland restoration methods now rely on knowhow developed by Western cultures. Asian-style wetland conservation could be developed focusing on rice paddy agricultural wetlands that allows continued sustainable use while activating wetland functions to achieve wetland restoration.

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