

Practices for conserving paddy field biodiversity in the basin of Lake Biwa, a Ramsar Wetland

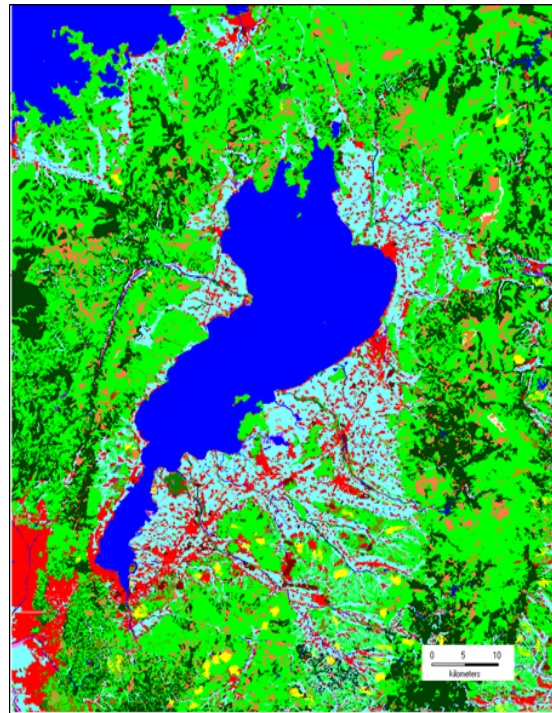
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Importance of paddy fields as the dominant marshy wetland in the Lake Biwa basin

Paddy fields around Lake Biwa are important as an alternative form of back marsh of the lake, and many of them have actually replaced satellite lakes or marshes. Conservation and restoration of the paddies around the lake are, therefore, also issues important in the management of these lakes. The lake itself is the largest and the oldest in Japan, inhabited by many endemic taxa. It was designated a UNESCO Ramsar Wetland in accordance with the Ramsar Convention in 1993. Nishino-ko, the largest extant satellite lake attached to Lake Biwa, was added to this designation in 2008.

More broadly, because paddy fields comprise a large part of Lake Biwa's catchment, wise use of the paddies is a key to conserving of the water system. The paddies occupy about 16% of the catchment, covering an area of 500 km², although about 30% of this area is now fallow or planted with other crops than rice. In the growing season for rice plants, the paddies clearly comprise the majority of the marshy wetland in this basin; the flooded area is equal to more than half the area of Lake Biwa's water surface (670 km²).

The paddy fields in Lake Biwa's basin have a history of more than 2,300 years, and the biodiversity of the paddies has consequently developed throughout this time. Coevolution of biodiversity and culture in the setting provided by Lake Biwa has been the source of a unique local culture. This is represented by "funazushi", lacto-fermented fish pickled with rice, which is made from the endemic crucian carp *Carassius auratus grandoculis*. Although the balance between the natural and cultural aspects of this coevolution has been altered, even damaged, by the modernization of rice farming, diverse organisms, including many threatened ones, and related aspects of the regional culture still persist.



A land use map of Lake Biwa's catchment (© Biodiversity Center of Japan & Yasuo Mukai). Whity aqua indicates paddy field areas.

In the present report, I will introduce some programs conducted in Shiga Prefecture to reveal, conserve, and restore paddy field biodiversity there, in an area largely corresponding to the Lake Biwa catchment.

Special cultivation practice to reduce the pollution load

Because effluent from paddy fields strongly affects the lakes' water quality, pollution load reduction from the paddies has been promoted by the government of Shiga Prefecture and the farmers themselves. Since 2001, Shiga Prefecture has been promoting and certifying specially cultivated rice, grown with reduced applica-

tion of agrochemicals, as “kankyo-kodawari-mai”, that is, rice grown through environmentally conscious farming. Direct payments to farmers taking part have also been carried out since 2004. In 2010, about 118 km² of paddies produced such certified rice, an area comprising more than one-third of the total rice acreage in Shiga.

Growing rice in this way markedly reduces the pollution load in runoff from the paddies. Hasukawa et al. (2009) demonstrated a clear reduction by restricting chemical fertilizer use to less than the half that of conventional farming accompanied with adequate water management. In experimental plots, the runoff reduction rates were 46-48% for total nitrogen, 14-28% for total phosphorus, 48-50% for suspended sediment, and 30-40% for chemical oxygen demand. Especially with respect to total nitrogen, the special rice farming practices enable substantial water purification in the paddy field; the outflow water usually being lower in nitrogen than the inflow water (Hasukawa et al. 2009, Shibahara 2010).

Expansion of this special rice farming program may improve the nitrogen/phosphorus balance of Lake Biwa, because it substantially removes nitrogen, but not phosphorus, from the irrigation water. Eutrophication of Lake Biwa has been improved in terms of phosphorus, the limiting factor of phytoplankton growth there. This is probably an achievement of the local ordinance on eutrophication prevention in Shiga Prefecture, enacted in 1980, which regulates phosphorus emission from household and factory effluents. Total nitrogen, however, has not decreased enough, and the nitrogen/phosphorus ratio becomes higher than before 1980. In the last decade, however, there has been an indication of nitrogen decrease, which may be due, at least in part, to the expansion of special rice farming in the basin.

Establishing fish passes to allow runs of lake fishes into paddies

In Lake Biwa’s basin, paddy fields also draw attention as a nursery for fishes. Many fishes of Lake Biwa can grow in paddy fields in their larva and juvenile stages (e.g., Kanao et al. 2009). In addition, some fish enter paddies for spawning if they can find an adequate pathway (e.g., Maehata 2007). Among these fish, *C. a. grandoculis* (“nigorobuna” in Japanese) is especially



Carassius auratus grandoculis in Lake Biwa come up to paddy field area for reproduction. (Photo: M. Maehata)

important because it is an endemic subspecies of Lake Biwa, and is designated as endangered in the Environment Ministry’s national red list, but is nonetheless a major fishery resource as principal ingredient in “funazushi”, the above mentioned specialty food of Shiga.

In 2001, Shiga Prefecture started its “Sakana-no-yurikago-suiden”, that is, Restoration of Fish Breeding Mechanism in Paddy Fields around Lake Biwa. This project aims at rural environmental improvement by encouraging the resumption of fish migration between paddies and Lake Biwa.

As a result of land improvement programs, most paddies around the lake sit much higher than the water level of the connecting drainage canal. Because this vertical disparity prevents fish runs into the paddies, establishing fish passes between the paddies and the adjacent drainage ditches is necessary. Participants of this project construct fish passes to enhance fish breeding in the paddies, and thus receive a subsidy. By 2011 this practice has expanded to 1.2 km² of paddy. In addition, about a half of the rice produced in such paddies is certified as “Sakana-no-yurikago-suiden-mai”, that is, fish-friendly rice, and commands a premium price.

Two main kind of fish pass are used in this area. One is fish-ladder that connects a drainage canal and an adjacent paddy directly. Another is also fish-ladder cascade, but it elevates the water level of the drainage canal through the installation of a series of successively higher flashboards; this sort of installation enables fish to enter the adjacent paddies by way of their drains. The latter kind of fish ladder is technically easier to install but socially more difficult to set up and manage

than the former, because it requires agreement among the all farmers sharing the drainage canal. In Shiga Prefecture, nevertheless, the latter method has been more frequently adopted. This indicates that rich social capital has been maintained in the rural areas. A detailed evaluation of the success of this project is provided in the accompanying factsheet.

Wildlife-friendly paddy fields in Takashima

“Takashima-ikimono-tanbo-mai”, a trade name for rice cultivated in wildlife-rich paddies in Takashima, is produced by the Study Group of Organic Farming in Takashima with advice from the Amita Institute for Sustainable Economies (Kyoto, Japan) and the Private Rice Research Institute (Kamimikawa, Tochigi, Japan). The members of the Study Group are all farmers concerning organic farming methodology in Takashima city, northwest of Lake Biwa. Their self-imposed stipulations are quite strict, including, for instance, no agrochemical use in the rice-growing season, no herbicide use on levees, delayed mid-season drainage, and no use of apple snails (*Pomacea canaliculata*), ducks (*Anas platyrhynchos*), or tadpole shrimps (*Triops* spp.) for weeding. These animals are prohibited because they are reputed to often degrade the rice quality and lower the species diversity in the paddies.



Principles of Study Group of Organic Farming in Takashima. <http://www.ikimontanbo.jp/approach/index.html>

Each member also “adopt” at least three organisms of their own choice, and takes various measures to protect them. For instance, a fish pass may be constructed to conserve fishes such as *C. a. grandoculis* or striped spined loach (*Cobitis* sp.). A ramp up from a drainage canal may be installed for the benefit of fallen frogs or turtles, especially daruma-frogs (*Rana porosa brevipoda*) and Japanese pond turtles (*Mauremys japonica*). A refuge biotope ditch may be dug deeply into one side of paddy in order to provide shelter for many animals during the mid-season drainage.

Consumers who buy this rice at a high price compensate the farmers for cost for conserving the environments. These consumers have been attracted by farmers’ efforts holding publicity events and by selling/marketing strategies devised together with the consultants. This is a rare successful case of organic-conscience rice branding without any prominent symbolic animals.

The Study Group of Organic Farming in Takashima seeks to establish a sustainable relationship between farmers, consumers, and wildlife. This brings farmers a degree of management stability, assures consumers of the safety of their food, and encourages biodiversity. This strategy may be more broadly applicable in effort to sustain or restore paddy fields as wetlands with high biodiversity. The detailed practices is shown in the accompanying factsheet.

In Shiga Prefecture, farmers or citizens are also engaged in other non-governmental approaches to conserve or enhance biodiversity in paddy fields. One such example is also shown in the accompanying factsheet.

Multifarious studies on organisms in paddy fields by a wide variety of people

In Japan, organisms in paddy fields other than the rice plants themselves, harmful weeds, pests, and their natural enemies had been paid little attention by researchers until the mid-1990’s, although some pioneer researchers demonstrated certain aspects of the biodiversity of paddy fields before then. This lack of interest, or even awareness, may be at least partly due to the decline in biodiversity in and around paddies as a result of land improvement and intensive pesticide use, accompanied by the abandonment of the use of wild an-

imals and plants for subsistence.

A comprehensive research program on paddy fields was started at the Lake Biwa Museum in 1996, just before the museum opened. With the collaboration of the pioneer researchers on the biodiversity of the “rice paddy belt”, this program focused on the interaction between humans and the rice paddy ecosystem. This program examined the ecology of fishes that inhabit paddy fields at some stage of their life history (e.g., Maehata 2007), and changes in the catch of these fishes for fun or a minor subsistence item by local residents (e.g., Makino et al. 2003). Yasumuro (2000), a member of the project, termed such fishes “Suiden-gyori”, namely rice-paddy fishes, and rice-paddy fishing for minor subsistence as “Suiden-gyori”. The program was canceled in 1998 and only parts of the results of this program have been published as academic papers. The stance of the research, however, impacted paddy field studies in many regions thereafter and also influenced the environmental policies of Shiga Prefecture leading, for example, to the Project for Fish Breeding Mechanism Restoration in Paddy Fields around Lake Biwa (“Sakana-no-yurikago-suiden”) Project. In addition, Dr. Yukiko Kada, the principal researcher of this research project, was elected governor of Shiga Prefecture in 2006.

Since the outset of the 21st century, participants in rice paddy studies in Shiga Prefecture have included a wide variety of people including amateurs. For instance, some local citizens gathering at the Lake Biwa Museum have investigated the distributions of large branchiopod crustaceans in paddy fields in the Lake Biwa basin, and found that at least one species tends to be absent in winter-wet paddies and in heavy-snow region (see the accompanying fact sheet).



Drawida hattamimizu (Photo: M. Taniguchi)

Concentrated study by researchers specializing on various groups of organisms has brought many new findings recently. To cite the case of earthworms, three new species have been described from paddy fields in Shiga (Blakemore 2007, 2010, Blakemore & Kupriyanova 2010). It is also now known that *Drawida hattamimizu*, the longest earthworm in Japan and an endemic species that was known from only restricted regions of Shiga, Ishikawa, and Fukui Prefectures, is in fact broadly distributed in paddy field berms around Lake Biwa in addition to some other lacustrine clay areas in the lake’s watershed. Some other new findings are shown in the fact sheets.



Study Meeting on Paddy Field Organisms in Lake Biwa Area (Photo: T. Ojika)

Since 2010, an open academic symposium on rice field biology has been held annually at the Lake Biwa Museum. The focus is on the organisms that live in or around paddy fields. Each year, about 20 talks have been given by a variety of researchers, including amateurs, to present findings on the paddy field organisms in this area. The attendees, totaling about 120 people each time, have consisted of a wider range of people, including farmers, governmental- and nongovernmental organization workers, environmental consultants, professional and amateur researchers, and other persons who are interested in paddy fields. This annual symposium thus promotes the sharing of understanding about rice paddy organisms among all persons concerned, which will eventually provide a base of social capital applicable to encouraging wise use of paddy fields in this area.

Concluding remarks

The above-mentioned cases, which represent only a small part of the whole picture, show how diverse actors are now engaged in conserving and restoring the biodiversity of paddy fields in the Lake Biwa basin. This will also intend to conserve ecosystem of Lake Biwa, an ancient lake designated as a Ramsar Wetland.

Conservation practices must be sustainable not only ecologically but also economically and socially. For this, more public or social support for rice farming is necessary. As is true throughout Japan, rice farmers around Lake Biwa suffer from a deficit of successors and a dropping price of rice. In Lake Biwa basin, though, even rice paddies farmed by conventional means still hold diverse organisms, with the species composition varying between districts (see factsheets). Maintaining paddy fields in production each district is therefore enormously important if the area's biodiversity is to be conserved.

Social capital is probably the most important resource as concerns sustainable rice farming. The OECD defined this as "the norms and social relations embedded in the social structures of societies that enable people to co-ordinate action to achieve desired goals". Among the practices summarized above, the "Sakana-no-yurikago-suiden" owes any hope of long-term success largely to accumulation of bonding social capital in the rural community, in as much as consensus and cooperation in the community reduce the cost and permit expansion on the scale of the operation. Both consent of the payers for local government subsidies and motivation of consumers to buy rice irrespective of any premium cost, depend at least partly on broadly-shared understanding of the agricultural practices that enhance biodiversity; these are examples of bridging social capital.

Diverse social events related to the paddy fields in Shiga Prefecture, such as hands-on observation field trips, exhibitions, lectures, and open symposiums, have surely contributed to the formation of bridging social capital. Although researchers have successively revealed hidden facts and values of paddy fields, this knowledge is usually difficult to access and needs interpretation for many people. The farmer's enjoyment

of being in contact with diverse animals and plants in the paddies is difficult to appreciate for inexperienced people. Increasing the opportunities for social interaction and direct exposure to the habitat and its wildlife will help to fill in these gaps and thus, borrowing from the Belgrade Charter, develop a local population that is aware of, and concerned about, the paddy field biodiversity, and which has the knowledge, skills, attitudes, motivations and commitment to work individually and collectively toward solutions of current problems over rice farming and the prevention of new ones.

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