The Importance of Field Margins as Wintering Sites for Grassland Birds at Haean Basin, Yangu, Korea

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Abstract: We surveyed patch use of wintering birds in order to understand the importance of field margins in an agricultural landscape. Of the twenty-eight bird species observed, we can suggest that 13 species are grassland birds in the study area. Birds frequently foraged food resources in deciduous and riparian forests in winter. We did not find a significant difference of species richness of birds between conventional and organic farms. Forest cover did not show a clear relationship with the number of birds in any groups of migration pattern and habitat types. However, overall, birds highly utilized the deciduous forest and riparian forests. Birds particularly showed preference to banks between fields. Agricultural biodiversity in paddy fields themselves have been emphasized in Asia, but we identify the importance of the riparian forests as similar with that of field margins in Europe as sustaining the biodiversity of the agricultural landscape in the study area. We can suggest a typical type of field margin (banks between fields) in steep regions of mountainous landscapes, Korea. Until thirty years ago in Korea, these banks had been managed clearly to remove the habitats for harmful insects and disease, however socio-economic changes such as the abandonment of farms and a decrease of young farmers seems to result in favourable habitat for biodiversity. These banks are clearly a particular and unique type of field margin.

Keywords: *banks, green revolution, paddy fields, riparian forests*

1. Introduction

Since the 1950s, the green revolution driven by advances in plant breeding and chemical crop protection has supported human population growth (FAOSTAT 2009). This has led to a great cost to biodiversity across many taxonomic groups all over the world (Foley et al. 2005; MEA 2005). Against this loss of biodiversity, organic and integrated farming systems have been recognized as sustainable agricultural production systems (Paccini et al. 2003). Diverse types of field margins are important foraging habitats on farmland for many declining birds and are a key component of Agri-Environment Schemes across Europe (Marshall et al. 2002; Vickery et al. 2009; Wuczynski et al. 2011). In Asia, many researchers have studied the indigenous ecological knowledge and traditional systems of forestry and agricultural system management (Rao et al. 2003, Yamaoka 2005). Especially, the multi-functionality of paddy agricultural systems has been recognized as a GIHAS (globally important agricultural heritage systems, Koohafkan and Altieri 2011), which promote biodiversity conservation and conservation of the rural landscape (Yamaoka 2005, Kobayashi and Harada 2010, Yamaoka et al. 2008). In Korea, the multi-functionality of paddy agricultural systems also has been studied at regional areas (Lee and Sin 2003). However, the importance of field margins (grassland and shrubs between fields) and riparian forests (shrub forests located in mountain stream) has been relatively neglected in agricultural systems in Korea. In steep geomorphologic land, farming practices have been creating a flat cultivation land such as the paddy field and dry field. Dividing the ownership, farmers make a steep bank with adjacent cultivation areas. This steep bank is composed of soils, pebbles, gravels and stones. This multi-porous bank system can provide the habitat for annual & perennial plants and diverse animals in the agricultural landscape, however farmers should annually manage the bank areas to diminish the damage from disease and harmful insects. In Korea, the diversity of birds in the agricultural landscape has been researched during breeding seasons (Park and Lee 2002, Park and Choi 2007, Park 2008). Little study on bird diversity has been conducted at non breeding seasons. At the study area, breeding birds highly used the riparian forests and villages (*MAEUL*) for staying, foraging and nesting, terrestrial insectivorous birds highly visited the riparian forests, and ground-foraging birds utilized the patch of villages (Park and Lee 2009). Therefore, this study

was conducted to reveal the importance of field margins as wintering habitat for birds, and to comprehend the characteristics of grassland birds at the study areas.

2. Materials and Methods

2.1. Study Areas

Haean Basin is located northeast of the city of Chuncheon in Yanggu County between longitude 128°5' to 128°11' E and latitude 38°13' to 38°20' N with a range in altitude from ca. 500 m to 1100 m. The average annual air temperature is ca.10.5°C at the valley sites and ca. 7.5°C at the northern ridge line. Average precipitation is estimated at 1200 mm with 50% falling during the summer monsoon. The forest vegetation is diverse but dominated by oak species. The major tree species include *Quercus dentata*, *Q. mongolica*, *Q. serrata*, *Betula davurica*, and *Tilia amurensis*. Major species of the understory are *Q. mongolica*, *Weigela florida*, *Stephanadra incisa*, *Ulmus laciniata*, *Symplocos chinensis*, *Euonymus alatus*, *Acer pseudosieboldianum*, and *Corylus heterophylla*. It represents the largest "highland dry field" farming area in the Soyang Watershed. Rice paddies cover ca. 25% of the cropland area in the Haean Basin. Dryland farms include potato (15% of cropland area), radish (20%), cabbage (15%), beans (5%), *Codonopsis pilosula* and ginseng (together 5%) as well as relatively new plantings of fruit trees and miscellaneous other crops (Tenhunen et al. 2011). Sixteen sites with conventional and organic farming practices were chosen to comprehend the biodiversity including plants, insects and birds (Figure 1).

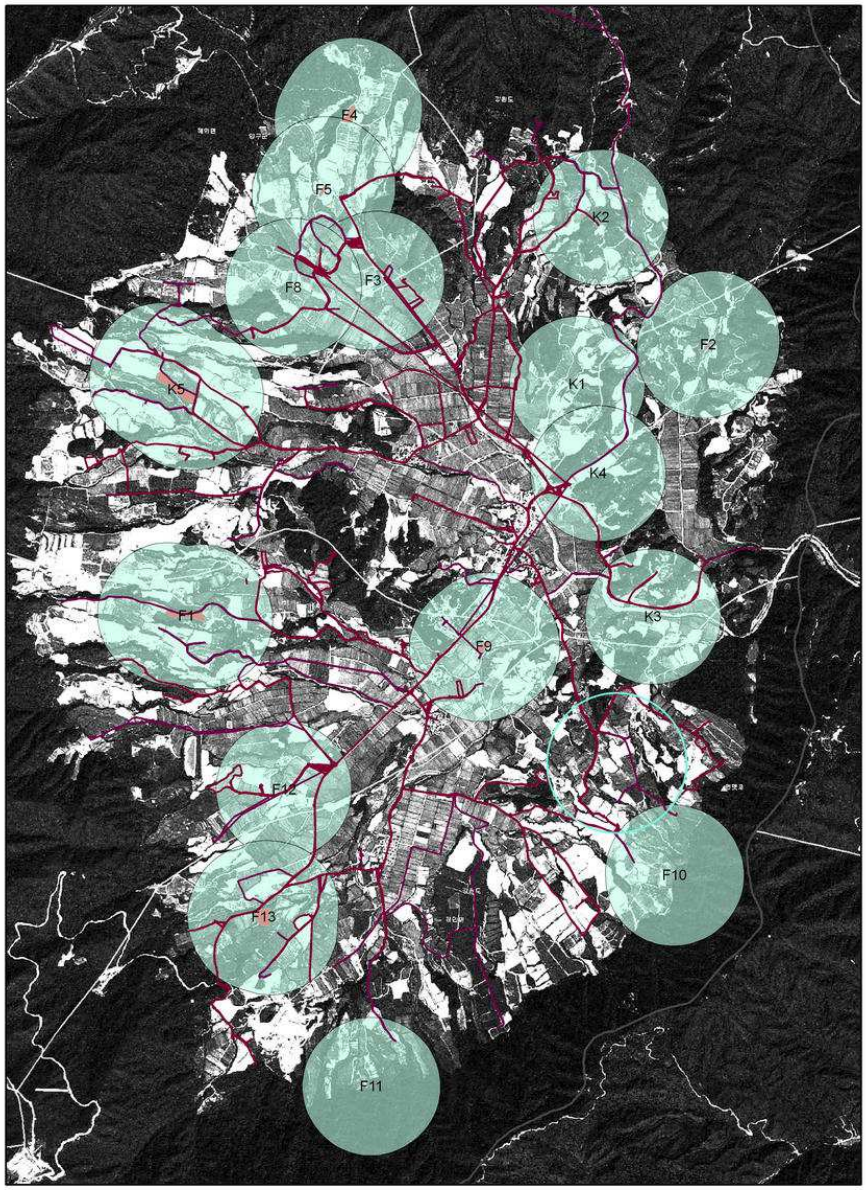

Figure 1. Study sites for birds at Haean catchments in Yanggu, Korea

2.2 Study Methods

2.2.1 Land Cover and Farming Practice

GIS data at the national level was limited due to military restricted region at study area. So, forest cover was investigated in the field at the 500m radius plot. Farming practices and crops were surveyed by interviewing the farmers in 2010. In order to differentiate organic and conventional farms, we utilized the national criteria on the organic farming practices.

2.2.2 Wintering Birds

To survey wintering birds, we selected survey periods from post-harvest to first snow, and surveyed birds and movement on the 11th, 19th, and 20th of November. After the snow piles up at the field area, all birds can aggregate at the canopy of the forest area without snow where they can utilize food resources. We classified birds' wintering habitats into fields, forests, paddies, streams, villages and others (Table 1). We categorized 19 habitat types, and recorded the number of birds staying at each point. Average densities of observed birds were analyzed to comprehend the species composition by use of ordination software (PC-ORD version 4.1).

Table 1. Classified type of land cover to survey bird movement among patches

Land cover	Acronyms	Classifications
Fields	BF	Bean Field
	DRF	Dryfield
	CAF	Cabbage field
	CDF	Corn Dryfield
	GF	Ginseng Field
	RAF	Radish Field
	PDF	Pepper Dryfield
	POF	Potato Field
Forests	DF	Deciduous Forests
	PF	Pines forests
	RF	Riparian Forests
Paddies	PAF	Paddy field
	BK	Bank of paddy and dryfield
Stream	STR	Stream
Maeul	PR	Paved Road
	ST	Street Tree
	HO	House
Others	EL	Electric line
	Sky	Sky

3. Results and Discussion

3.1. Patch Use by Wintering Birds

Twenty-eight bird species were recorded at total 16 sites, and 6 species (*Emberiza elegans*, *Parus major*, *Paradoxornis webbiana*, *Streptopelia orientalis*, *Carduelis sinica*, *Hypsipetes amaurotis)* were observed at more than 10 sites. It has been difficult to classify the grassland birds due to the mountainous landscape at breeding

periods (Park and Lee 2002), also there are few species exclusively observed at agricultural landscapes in Korea (Park and Choi 2007). Birds highly foraged at the patch of deciduous forest (DF) and riparian forests (RF) in the study area (Figure 2). Two species, *Passer montanus* and *Pica pica* showed the high observed frequency near the dwelling houses of the village. Thirteen species including woodpeckers and tits were frequently observed at pine forests and deciduous forests. Thirteen species including *Emberiza elegans*, *Paradoxornis webbiana*, and *Phasianus colchicus* utilized foraging patches as banks, riparian forests and paddy fields (Table 3, Figure 3). This result showed some species had a preference to agricultural landscape at wintering season in this area. The breeding bird community was aggregate at the village and riparian forest areas (Park and Lee 2009), and wintering birds showed a different preference with the breeding periods. Riparian forests provide a good habitat for birds over all seasons at this area.

3.2. Relationship between Land Cover and Wintering Birds

We analyzed relationships between the characteristics of wintering birds and forest cover. The number of birds in the migration pattern (residents and winter visitors) and habitat type (grassland and forest related birds) did not show a significant relationship with forest cover Also, no species showed a clear significant relationship with forest cover (Table 2). In a comparison of species richness between conventional and organic farming practices, there is a significant difference during the breeding season, however there is no relationship in non-breeding season. These results can be interrelated with relative low resolution of land cover data due to adversity in getting the data of land cover at study area. In non-breeding season, mixed-species flocks are common worldwide to reduce high predation and increase foraging efficiency (Morse 1977, Dimanond 1981, Powell 1985).

Table 2. Relationship between forest cover and dependent variables

Dependent variables	R^2	Significance
Overall number of species	0.03	NS
Overall density	0.15	NS
Forest-related birds	0.01	NS
Grassland-related birds	0.06	NS
Average density of *Emberiza elegans*	0.12	NS

3.3. Farming Practice and Biodiversity

Riparian forests can provide the nests for grassland birds such as Shrikes and buntings (Park and Lee 2009), and they serve as the wintering habitat for forest birds and grassland birds. Riparian forests are usually located at the small valley between fields, and they can increase habitat connectivity and movement of birds in this landscape (Figure 4). In addition, farmers have been mowing an approximately 1m area of field margins, however they seldomly remove the middle area of field margin (Figure 5). Older farmers with low labor intensity particularly showed a tendency to allow the middle part of field margin remain to remain. As the rural community depopulates, farmers control the weed on banks by electric mower, however, they still allow the middle area of field margin at steep banks (Figure 5) to remain. These farming patterns enable grassland birds to survive in the mountainous landscapes in Korea. In another viewpoint, these banks are preserved because adjacent forests belong to national forests and military regions, and prescribed fires to remove perennial plants and shrubs on banks have been restricted by law. Before thirty years ago, the high labor intensity removed plants and trees on banks. Today, due to a socio-economic shift and regional distinctiveness, diverse plants and trees remain on the banks. Therefore, this particular type of bank and riparian forests can be a biotope for biodiversity including birds, snakes, insects and plants. Future study on the overall slope and biodiversity could include quantitative analysis on banks in mountainous landscape. These Korean banks can represent a typical landscape in agricultural areas and could be compared with terrace fields of the Philippines and the paddy agro-ecosystem in Japan.

Table 3. Average individuals of observed birds at study sites

Scientific name	Sites	F1	F2	F3	F4	F5	F8	F9	F10	F11	F12	F13	K1	K2	K3	K4	K5	Freq.[2]
	Forest (%)	32.0	38.0	12.0	56.0	10.0	16.0	13.0	66.0	71.0	1.0	11.0	22.0	10.0	23.0	35.0	27.0	
	Farming[1]	org	org	org	org	org	org	org	org	org	org	org	con	con	con	con	con	
Emberiza elegans (EE)[3]		3.7	4.3	2.7	1.3	3.7	1.7	–	6.0	4.0	1.0	4.0	3.7	4.7	2.0	2.7	–	14

Parus major (PM)	2.7	2.7	2.0	1.0	1.3	2.0	–	1.0	2.3	–	4.7	1.7	2.0	7.3	2.7	2.3	14
Paradoxornis webbiana (PW)	8.3	–	3.7	2.3	3.0	0.7	3.3	4.0	–	13.3	5.7	9.7	6.7	4.0	–	–	12
Streptopelia orientalis (SO)	–	4.0	2.7	–	–	–	5.7	1.7	–	2.3	3.3	5.0	3.0	2.3	2.7	3.7	11
Carduelis sinica (CS)	10.7	15.3	4.0	16.7	12.3	–	14.0	–	1.7	7.7	–	17.0	10.0	–	5.0	–	11
Hypsipetes amaurotis (HO)	–	2.7	2.7	–	–	3.0	2.7	1.0	–	8.0	5.0	3.7	4.7	–	3.3	6.3	11
Cyanopica cyana (CC)	–	9.3	–	–	1.7	5.7	5.0	–	–	–	9.0	–	10.0	7.3	8.7	5.3	9
Garrulus glandarius (GG)	–	4.0	–	–	–	3.0	–	–	0.3	–	5.0	5.3	3.7	1.3	3.0	4.3	9
Fringilla montifringilla (FM)	4.0	3.3	3.3	–	–	2.0	–	8.3	–	–	–	–	3.3	4.0	–	4.0	8
Emberiza rustica (ER)	2.0	1.7	2.7	4.3	3.0	–	–	3.0	–	6.7	–	–	–	–	8.0	–	8
Aegithalos caudatus (AC)	4.0	–	–	4.0	2.0	2.7	–	–	2.3	–	3.7	–	–	2.0	–	3.3	8
Dendrocopos major (DM)	1.3	–	–	–	–	1.0	–	–	1.3	–	3.0	–	0.3	1.0	1.0	1.3	8
Phoenicurus auroreus (PHO)	1.0	–	0.3	1.3	1.3	–	3.3	–	–	1.3	–	–	–	–	0.7	–	7
Carpodacus roseus (CR)	3.3	–	–	–	0.3	–	–	1.7	–	2.0	–	–	0.7	1.7	–	3.3	7
Lanius bucephalus (LB)	–	0.3	–	–	0.3	1.0	–	–	0.7	–	–	–	–	1.0	0.3	–	6
Dendrocopos kizuki (DK)	2.0	–	–	0.7	0.3	–	–	–	1.3	–	–	–	0.3	–	–	2.0	6
Parus palustris (PP)	–	–	–	1.0	1.3	–	–	–	0.3	–	–	–	–	3.0	2.0	1.0	6
Parus varius (PV)	1.7	–	–	–	0.7	–	–	0.3	0.7	–	–	–	–	–	–	0.3	5
Buteo buteo (BB)	–	–	0.3	1.0	1.3	1.0	–	–	–	–	–	–	–	1.0	–	–	5
Corvus macrorhynchos (CM)	–	–	0.3	–	–	–	5.0	–	3.7	–	–	–	–	1.3	–	2.0	5
Phasianus colchicus (PHA)	0.3	–	–	–	–	–	–	1.0	1.0	–	1.0	–	–	–	–	–	4
Emberiza cioides (EC)	–	–	2.3	–	–	–	–	3.7	–	–	–	–	–	–	3.3	–	3
Bombycilla garrulous (BG)	–	20.0	3.3	–	–	3.3	–	–	–	–	–	–	–	–	–	–	3
Pica pica (PI)	–	–	–	–	–	–	6.3	–	–	3.7	–	–	–	–	–	–	2
Passer montanus (PAM)	–	–	–	–	–	–	15.3	–	–	3.3	–	–	–	–	–	–	2
Coccothraustes coccothraustes (CC)	–	1.3	–	–	–	–	–	–	1.7	–	–	–	–	–	–	–	2
Pyrrhula pyrrhula (PYP)	–	0.7	–	–	–	–	–	–	1.3	–	–	–	–	–	–	–	2
Tarsiger cyanurus (TC)	0.3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
Number of species	14	13	13	10	14	12	9	11	14	10	10	7	12	14	13	13	
Number of individuals	136	209	91	101	98	81	182	95	68	148	133	138	148	118	130	118	

1 Farming: org-organic, con-conventional, 2 Freq.: Observed frequency, 3 Abbreviations of scientific names of birds

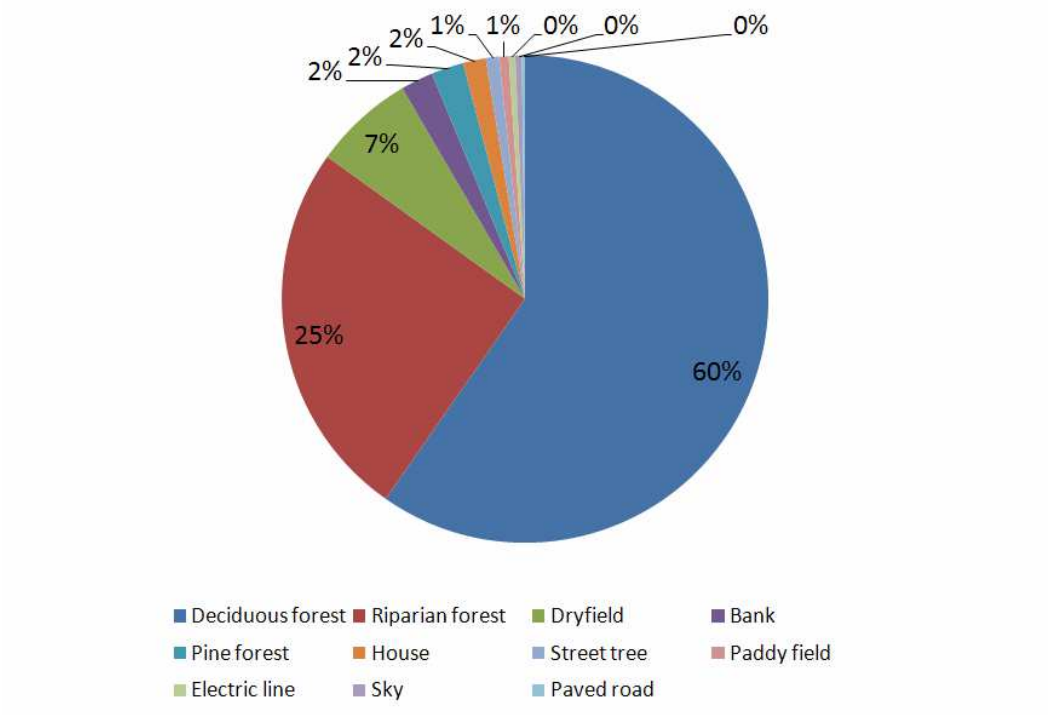

Figure 2. Patch use by birds in the study area

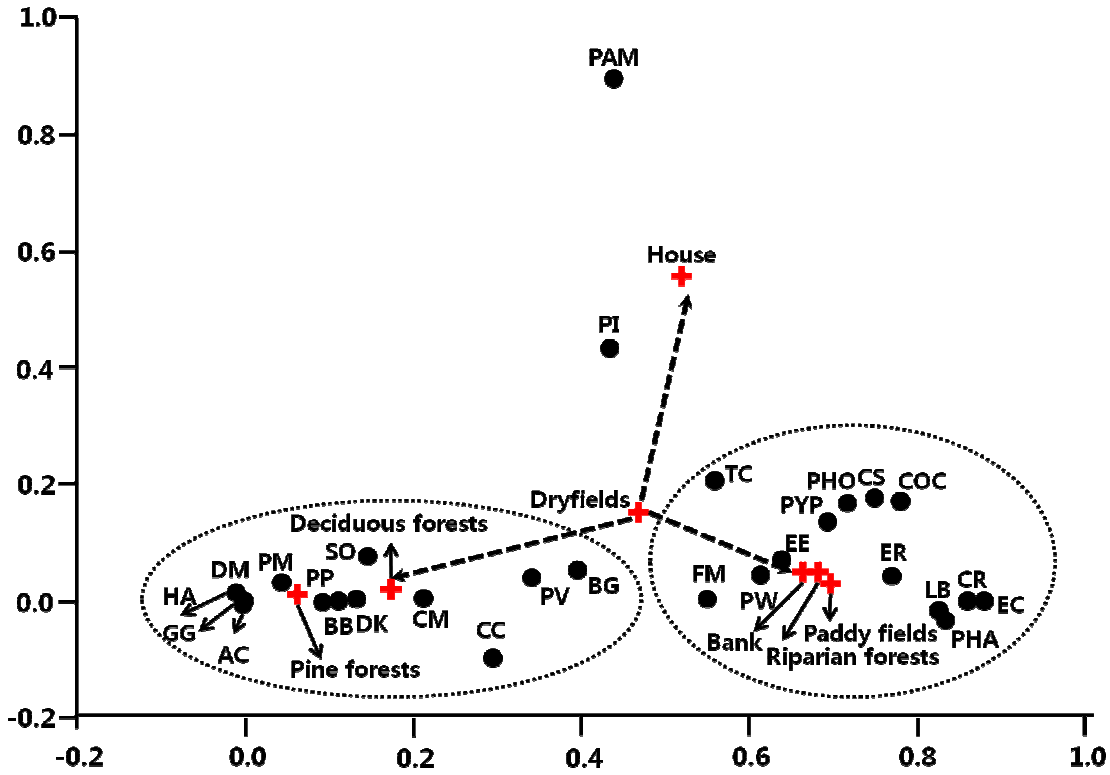

Figure 3. Classifications of observed birds along patches by Bray-Curtis ordination (PC-ORD, X-axis:38.3%, Y-axis: 15.8%, see the table 3 for abbreviations of birds)

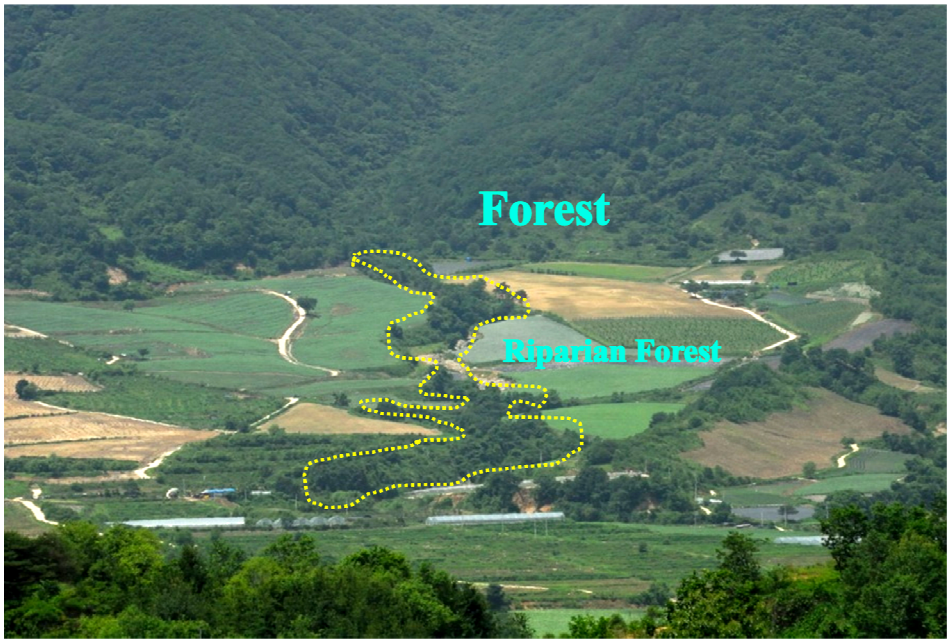

Figure 4. Riparian forests can increase habitat connectivity and bird movement in this area

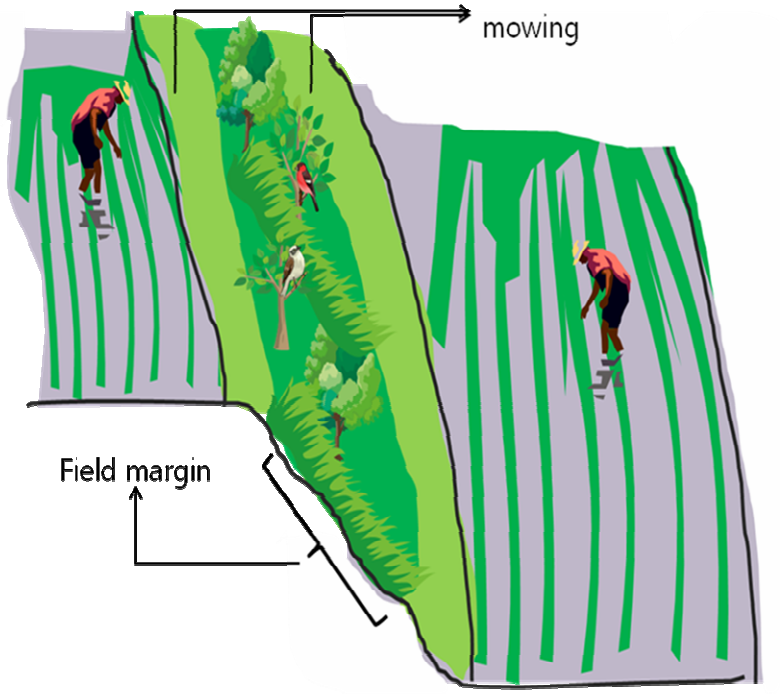

Figure 5. Type of field margin (banks between paddies) at study areas. Farmers have been mowing about 1m area of field margins, however they seldomly remove the middle area of field margin. Older farmers with low labor intensity showed a tendency to allow the middle part of field margin to remain. These farming patterns enable grassland birds to survive at mountainous landscape in Korea.

4. Conclusion

We can suggest that 13 species of grassland wintering birds foraged food resources at deciduous and riparian forests in the non-breeding season in the study area. We did not find a significant difference in species richness of birds between conventional and organic farming practices. There was no clear relationship between forest cover and the number of birds in any group of migration pattern and habitat type. However, overall, birds highly utilized the deciduous forest and riparian forests. Birds especially showed a preference to the banks between fields. The paddy

field itself has been emphasized in the study of agricultural biodiversity in Asia, especially terrace fields in the Philippines, fish-farming paddies in China, and rice paddy villages in Japan. In Korea, we can identify the importance of the riparian forests as similar to field margins of Europe in sustaining biodiversity in the agricultural landscape. A typical type of field margin is the bank between fields within steep regions in the mountainous landscape. Before thirty years ago, in the green revolution time, these banks had been managed to decrease the habitats of harmful insects and disease, however socio-economic changes such as the abandonment of farms and a decrease of young people seems to have created a good habitat for biodiversity. These banks can be suggested as particular type of field margin. In the future, research on the quantity (slope, width, and length) and quality (roughness, aspect, and grass & shrubs) of banks should be conducted to elucidate the biodiversity maintenance of the banks.

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