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Community Characteristics of Waterbirds in Junam Reservoir, Changwon-si, Korea

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Abstract: The study was performed for birds living around Junam Reservoir, a representing place for migrant birds in Korea for 10 times from February to December (except November) in 2011. The result states that a total of 11,742 individuals, 102 species, 41 families and 13 orders of birds were found around the reservoir and anseriformes including *Anser albifrons* (16.42%), *Anser fabalis* (14.44%), *Fulica atra* (14.08%), *Anas platyrhynchos* (10.01%), *Anas clypeata* (7.70%), *Aythya ferina* (6.88%) and *Anas poecilorhyncha* (6.59%) are dominant species. By seasons, winter shows high frequencies of types, number of species, number of individuals and diversity. The result of comparing individuals of swans from 1989 to 2011 shows large fluctuation of individuals, irregular repetition and the number of individuals gradually decreases. The number of geese, dabbling ducks and diving ducks between 1999 and 2011 shows gradual increase. Number of species and individuals of birds in the Junam Reservoir have increased and it is estimated that about between 12,000 and 14,000 individuals of 60~65 species spend winter. The reservoir is important as a habitat for migratory birds, as well as ecological study. It requires administrative supports to provide stable environment for birds to spend winter.

Keywords: dominant species, wintering, swans, geese, dabbling ducks, diving ducks

Introduction

The Junam Reservoir is located in the southern land of Korea and is one of major habitat for winter migratory birds including the Nakdong Estuary, Upo Swamp, the Han River, the Geumgang Estuary and Cheonsu Bay (Yu and Hahm, 1994; Hahm, 1997; Hamn *et al*., 1999). In addition, the reservoir is used as a space for ecological studies for students and people by forming facilities for ecological features and the 10th Ramsar Convention was held in Changwon City with the center of the Junam Reservoir.

The reservoir is known as a major habitat for water birds during the winter (Yu and Hahm, 1994; Hahm *et al*., 1999) and a resting and vegetarian diet place for ardeidae including black-crowned night heron (*Nycticorax nycticorax*), summer migratory birds. Also, Geese including natural monument, white-naped crane (*Grus vipio*) and swans spend winter (Park and Won, 1993; Hahm, 1997; Hahm and Kim, 2001) and more than 20,000 individuals is the *Anas formosa* under the threat of extinct come to spend winter (Allport *et al*., 1990; Yu and Hahm, 1994; Kang and Cho, 1996). There are many studies on bird groups in 1980s and 1990s. After that, however, the Ministry of Environment performs the only simultaneous census of birds in winter.

In this trend, the study was performed as basic information to protect and preserve Junam Reservoir as a habitat for migratory birds by investigating seasonal distribution and changes of birds living in the reservoir through 10 times investigation between February and December 2011.

Materials and Methods

Study areas

The Junam Reservoir is located in Dong-eup, Changwon-si

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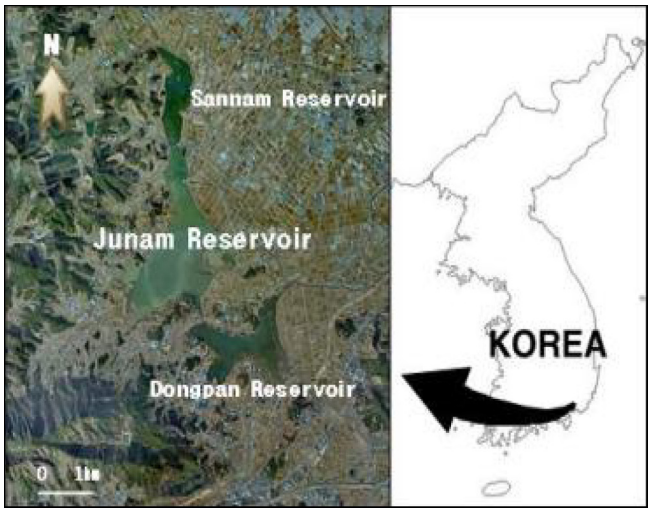

Fig. 1. Map showing the survey areas in Junam Reservoir, Chongwon-si, Gyrongsangnam-do, Korea.

and Daesan-myeon, Haman-gun, Gyeongsangnam-do, Korea, has formed as a back marsh with developing flood plain in the mid- and low-stream of the Nakdong River and consists of 3 reservoirs including Sannam (0.75 km^2), Junam (2.85 km^2) and Dongpan (2.42 km^2) (Fig. 1). Large agricultural land around the reservoir plays a role as a major passage and food supply. The existing vegetation of the survey area has the dominance of Zizania latifolia community, *Salvinia natans* community, *Miscanthus sacchariflorus* community, *Nelumbo nucifera* community, *Euryale ferox* community, *Numphoides peltata* community, *Phragmites australis* community, *Setara chondrachne* community, *Salix koreensis* community, *Eichhornia crassipes* community, *Trapa japonica-Ceratophyllum demersum* community (Changwon City, 2005).

Study methods

The study surveys the avifauna around the Junam Reservoir for a total of 10 times per month from February to December (except November) 2011 and consists of the spot census which calculates the total individuals in bird clusters or major observation points and the line transect which records birds shown up by walking around the reservoir at 2km/h (Bibby *et al*., 1992). The birds were observed by binoculars (10x25, Nikon) and telescopes (x15 ~ 45, Nikon) and by sounds for birds not seen inside forests.

The tally of the survey results refer to the Illustration Flora & Fauna of Korea, vol. 25 of animal (bird ecology) by Won (1981) and A Field Guide to the Birds of Korea (Lee *et al*., 2000) by regions and the Natural Monuments of Korea in Color (Yoon *et al*., 1998) and Endangered and Reserved Wild Species in Korea (Won and Yoon, 1998) for legally protective species.

Formulas used to analyze the survey results are as follows (Brower *et al*., 1990; Shannon and Weaver, 1949; Margalef, 1963).

1) Dominance

$$\text{Dom. } (\%)=\frac{ni}{N}\times 100$$

ni: number of species
N: Total individuals in the observed area

2) Species diversity

$$H'=-\Sigma(ni/N)\times\ln(ni/N)$$

3) Species richness (Da)

$$Da=(s-1)/\ln(N)$$

s: total observed species
N: Total individuals in the observed area

Result

Birds observed

The result states that a total of 11,742 individuals, 102 species, 41 families and 13 orders of birds were found around the reservoir and anseriformes including *Anser albifrons* (16.42%), *Anser fabalis* (14.44%), *Fulica atra* (14.08%), *Anas platyrhynchos* (10.01%), *Anas clypeata* (7.70%), *Aythya ferina* (6.88%) and *Anas poecilorhyncha* (6.59%) are dominant species (Table 1, Fig. 2).

Based on the simultaneous census of birds in winter performed by the Ministry of Environment from 1999 to 2010 and the survey result conducted in December 2011, the number of species and individuals of birds recorded in the Junam Reservoir show increase (Fig. 3). The number of species was less than 40 in 2005 but increased to more than 60 from 2006. It is considered that the survey mainly based on water birds in the reservoir contains passeriform and there are about 60~65 species of birds around the reservoir. In addition, the number of individuals was less than 10,000 in 2005. However, it has increased to more than 10,000 in since 2006, sharply increased to more than 20,000 in 2008 then maintained between 12,000 and 14,000 individuals.

Birds observed by month

Comparing number of species and individuals on months, December marks the highest 56 species, followed by 51 species in February 41 species in March and 33 species in May and June shows the lowest 17 species. In addition, December shows the largest individuals of 9,000 in December, followed by 4,012 individuals in October, 2,637 individuals in February, 1,469 individuals in March and the least number is 190 individuals in June (Fig. 4). The

Table 1. List of birds observed in Junam Reservoir form February to December, 2011

No.	Scientific name	Korean name	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Dec.	Max.	Dom.
1	*Podiceps ruficollis*	논병아리									2	2	2	0.02
2	*Podiceps cristatus*	뿔논병아리										8	8	0.07
3	*Phalacrocorax carbo*	민물가마우지	99	5	1						151	81	151	1.29
4	*Ardea cinerea*	왜가리	5	10	30	56	28	50	39	29	7	26	56	0.48
5	*Egretta alba modesta*	중대백로			1	22	35	23	30	32	1	3	35	0.30
6	*Egretta alba alba*	대백로	13	1							10	37	37	0.32
7	*Egretta intermedia*	중백로					12	15		1			15	0.13
8	*Egretta garzetta*	쇠백로	7	7	3	6	15		3	3		37	37	0.32
9	*Bubulcus ibis*	황로				5	6	4					6	0.05
10	*Ardeola bacchus*	흰날개해오라기						2					2	0.02
11	*Butorides striatus*	검은댕기해오라기				1							1	0.01
12	*Nycticorax nycticorax*	해오라기							1			41	41	0.35
13	*Ciconia boyciana*	황새									4		4	0.03
14	*Platalea leucorodia*	노랑부리저어새	15	1							7	23	23	0.20
15	*Cygnus cygnus*	큰고니	75									127	127	1.08
16	*Anser cygnoides*	개리	4										4	0.03
17	*Anser fabalis*	큰기러기	508	94							333	1,696	1,696	14.44
18	*Anser albifrons*	쇠기러기	421	784							550	1,928	1,928	16.42
19	*Aix galericulata*	원앙								4	9		9	0.08
20	*Anas penelope*	홍머리오리									2	1	2	0.02
21	*Anas falcata*	청머리오리	2	8		5					10	249	249	2.12
22	*Anas strepera*	알락오리		15							7	5	15	0.13
23	*Anas formosa*	가창오리	350									37	350	2.98
24	*Anas crecca*	쇠오리	202	11	15				40	80	47	323	323	2.75
25	*Anas platyrhynchos*	청둥오리	56	83						4	103	1,175	1,175	10.01
26	*Anas poecilorhyncha*	흰뺨검둥오리	64	64	34	15	3	402	774	763	202	774	774	6.59
27	*Anas acuta*	고방오리	197	1							3	205	205	1.75
28	*Anas clypeata*	넓적부리	124	76					12	31	11	904	904	7.70
29	*Aythya ferina*	흰죽지	16	16	10				1	1	808	431	808	6.88
30	*Aythya fuligula*	댕기흰죽지	15	5							4	29	29	0.25
31	*Mergus albellus*	흰비오리	38									132	132	1.12
32	*Pandion haliaetus*	물수리							1	1			1	0.01
33	*Haliaeetus albicilla*	흰꼬리수리	3									3	3	0.03
34	*Aegypius monachus*	독수리										1	1	0.01
35	*Circus cyaneus*	잿빛개구리매	1										1	0.01
36	*Accipiter nisus*	새매	1	1								2	2	0.02
37	*Accipiter gentilis*	참매	1									1	1	0.01
38	*Buteo buteo*	말똥가리	2									2	2	0.02
39	*Falco tinnunculus*	황조롱이	2	3	4	2		1				2	4	0.03
40	*Falco subbuteo*	새홀리기							2	2			2	0.02
41	*Falco peregrinus*	매								1		2	2	0.02
42	*Phasianus colchicus*	꿩	3	3	1	1	1						3	0.03
43	*Grus monacha*	흑두루미	9										9	0.08
44	*Grus vipio*	재두루미	150									7	150	1.28
45	*Gallinula chloropus*	쇠물닭			1	1		15	29	29	2		29	0.25
46	*Fulica atra*	물닭	46	112	69	1		28		300	1,653	231	1,653	14.08
47	*Hydrophasianus chirurgus*	물꿩						2					2	0.02
48	*Himantopus himantopus*	장다리물떼새			2								2	0.02
49	*Vanellus vanellus*	댕기물떼새	12									45	45	0.38
50	*Charadrius dubius*	꼬마물떼새				12							12	0.10
51	*Tringa nebularia*	청다리도요							1				1	0.01
52	*Tringa glareola*	알락도요			31								31	0.26
53	*Actitis hypoleucos*	깝작도요				1							1	0.01
54	*Gallinago gallinago*	꺅도요			1				4	4		2	4	0.03
55	*Calidris alpina*	민물도요										3	3	0.03
56	*Larus crassirostris*	괭이갈매기	1										1	0.01
57	*Larus argentatus*	재갈매기	1									9	9	0.08
58	*Larus ridibundus*	붉은부리갈매기										32	32	0.27

Table 1. List of birds observed in Junam Reservoir form February to December, 2011

No.	Scientific name	Korean name	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Dec.	Max.	Dom.
59	*Sterna albifrons*	쇠제비갈매기				8							8	0.07
60	*Streptopelia orientalis*	멧비둘기	29	33	6	20	14	7	3	3	57	128	128	1.09
61	*Cuculus canorus*	뻐꾸기				11	2	2					11	0.09
62	*Alcedo atthis*	물총새						1				1	1	0.01
63	*Eurystomus orientalis*	파랑새			2								2	0.02
64	*Upupa epops*	후투티				1							1	0.01
65	*Dendrocopos kizuki*	쇠딱다구리			2							2	2	0.02
66	*Dendrocopos leucotos*	큰오색딱다구리				2							2	0.02
67	*Picus canus*	청딱다구리	1										1	0.01
68	*Alauda arvensis*	종다리				1						7	7	0.06
69	*Hirundo rustica*	제비				6	12						12	0.10
70	*Motacilla cinerea*	노랑할미새	1	1									1	0.01
71	*Motacilla alba*	알락할미새		2							6	7	7	0.06
72	*Motacilla lugens*	백할미새	3	2							1	21	21	0.18
73	*Motacilla grandis*	검은등할미새										2	2	0.02
74	*Anthus rubescens*	밭종다리	21									30	30	0.26
75	*Hypsipetes amaurotis*	직박구리	10	12	3	8	1	11	2	2	2	2	12	0.10
76	*Lanius tigrinus*	칡때까치					2						2	0.02
77	*Lanius bucephalus*	때까치	1	3	8	1		1	3	2	2	1	8	0.07
78	*Bombycilla japonica*	홍여새	1										1	0.01
79	*Phoenicurus auroreus*	딱새	3	1		8		1			2	3	8	0.07
80	*Turdus pallidus*	흰배지빠귀		2									2	0.02
81	*Turdus naumanni eunomus*	개똥지빠귀	2	2									2	0.02
82	*Paradoxornis webbianus*	붉은머리오목눈이	71	47	40	24	9	10	40	44		62	71	0.60
83	*Acrocephalus orientalis*	개개비				45	12	10					45	0.38
84	*Ficedula zanthopygia*	흰눈썹황금새				2							2	0.02
85	*Aegithalos caudatus*	오목눈이	3						2	5			5	0.04
86	*Parus palustris*	쇠박새		2									2	0.02
87	*Parus major*	박새	6	5	5	5					2	1	6	0.05
88	*Parus varius*	곤줄박이		1									1	0.01
89	*Zosterops japonicus*	동박새				2							2	0.02
90	*Emberiza rustica*	쑥새	5	5									5	0.04
91	*Emberiza elegans*	노랑턱멧새	15	12							7		15	0.13
92	*Emberiza spodocephala*	촉새		2									2	0.02
93	*Emberiza pallasi*	북방검은머리쑥새										6	6	0.05
94	*Fringilla montifringilla*	되새	3	8									8	0.07
95	*Carduelis sinica*	방울새				8							8	0.07
96	*Carduelis spinus*	검은머리방울새		2									2	0.02
97	*Passer montanus*	참새	13	21	38	21	7	20	30	33		87	87	0.74
98	*Sturnus cineraceus*	찌르레기	2	2	3	10	5					10	10	0.09
99	*Oriolus chinensis*	꾀꼬리				11		2					11	0.09
100	*Garrulus glandarius*	어치									1		1	0.01
101	*Pica pica*	까치	4	4	18	8	26	20	4	5	6	12	26	0.22
102	*Corvus macrorhynchos*	큰부리까마귀							1	1		2	2	0.02
	Number of species		51	41	24	33	17	21	21	24	32	56	102	
	Number of individuals		2,637	1,469	328	330	190	627	1,022	1,380	4,012	9,000	11,742	
	Species diversity(H')		2.70	1.98	2.51	2.93	2.47	1.54	1.11	1.53	1.82	2.51	2.78	
	Species richness(Da)		6.35	5.49	3.97	5.52	3.05	3.11	2.89	3.18	3.74	6.04	10.78	

Max.; The maximum number of individuals, Dom.; Dominance

number of individual increases from October when wintery migratory birds come, peaks in January and decreases from March (Yu and Hahm, 1994; Hahm *et al*., 1999) and summer hits the bottom. The fact that winter marks the highest number of species and individuals shows that the Junam Reservoir is a major habitat for wintery migratory birds.

Comparing species diversity and richness on monthly basis, the former ranges 1.11 to 2.93 with the mean value of 2.11 and May marks the highest and August marks the lowest figure. The latter ranges 2.89 to 6.35 with the mean value of 4.33 and February marks the highest and August marks the lowest figure (Fig. 5). The species diversity of the reservoir is also high in winter when types and individuals

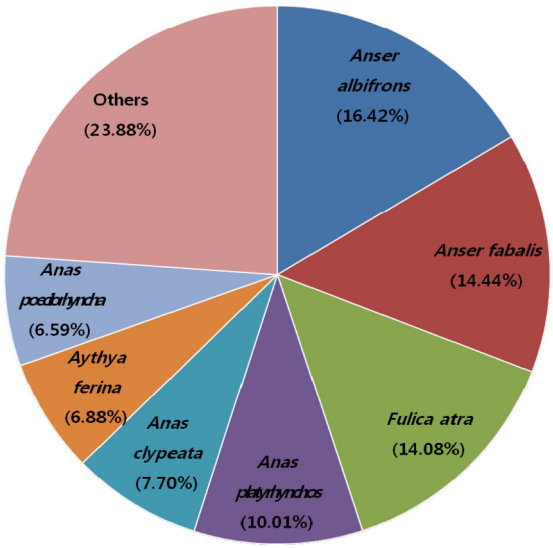

Fig. 2. Dominance of bird species in Junam Reservoir during survey period.

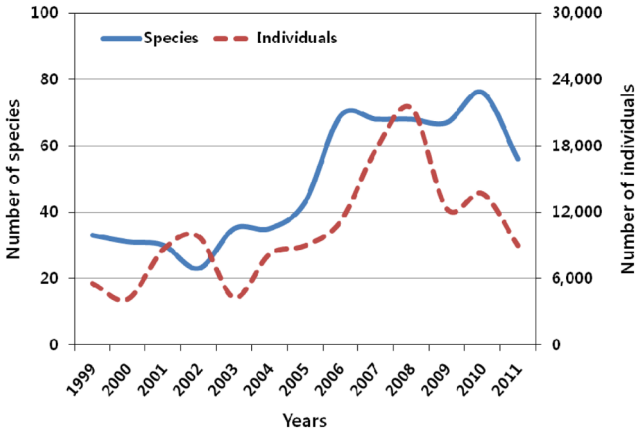

Fig. 3. Yearly variation of the number of species and individuals in Junam Reservoir from 1999 to 2011 (refer to the simultaneous census of birds in winter of the Ministry of Environment).

mark high points and low in summer and autumn.

Birds Community Changes by Groups

The comparison of individuals of swimming birds on yearly basis of swans, geese, dabbling ducks and diving ducks (including little grebes and Eurasian coots) are shown in Fig. 6.

Swans

The swans include *Cygnus cygnus* and *C. columbianus* and the data are based on previous research data from 1989 to 2010 (Hahm and Kim, 2001; Ministry of Environment, 2004; 2005; 2006; 2007; 2008; 2009; 2010) and the survey data in December 2011. The result ranges 39 individuals (2004) to 1,177 individuals (1992). Peaks appear in 1992, 2003 and 2009; the individuals show repeated fluctuation and the different tend to be large. Overall, the individuals of

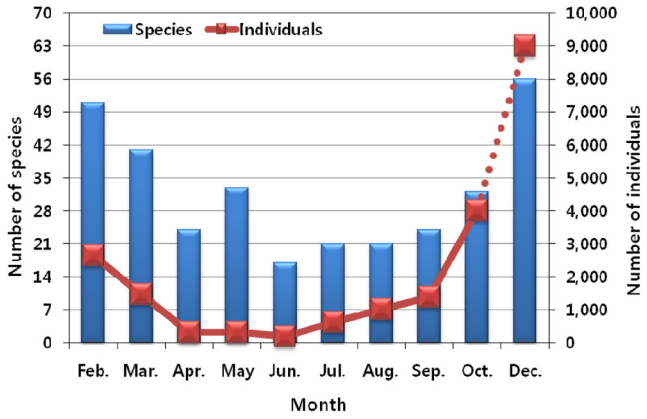

Fig. 4. Monthly variation of the number of species and individuals in Junam Reservoir from February to December, 2011.

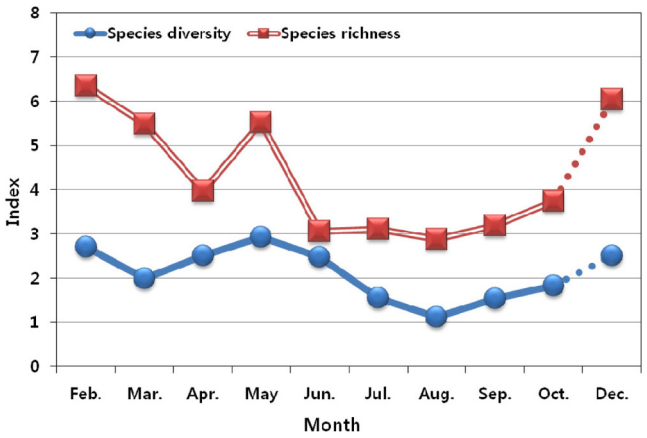

Fig. 5. Monthly variation of the species diversity and species richness in Junam Reservoir from February to December, 2011.

swans gradually decrease (Fig. 6). About 4,000 individuals are estimated to spend winter in Korea (Won and Yoon, 1998; Yoon *et al*., 1998) and it is known that about 50%, 2,000 individuals, stays in the Nakdong Estuary (Yu *et al*., 2009; Yu *et al*., 2010). It is found that the average individuals which spend winter are 350 individuals ranging between 39 individuals (2004) and 1,034 individuals (2003), showing that the reservoir plays an important role as a wintery habitat for swans.

Geese

Geese include *Anser fabalis*, *A. albifrons* and *A. cygnoides* the data are based on previous research data from 1999 to 2010 (Hahm and Kim, 2001; Ministry of Environment, 2004; 2005; 2006; 2007; 2008; 2009; 2010) and the survey data in December 2011. The result ranges 883 individuals (2002) to 3,628 individuals (2011). Peaks appear in 2001, 2004, 2006 and 2011 the individuals show repeated fluctuation larger than that of geese and the different tend to be smaller than their counterpart. Overall, the individuals of geese gradually increase (Fig. 6).

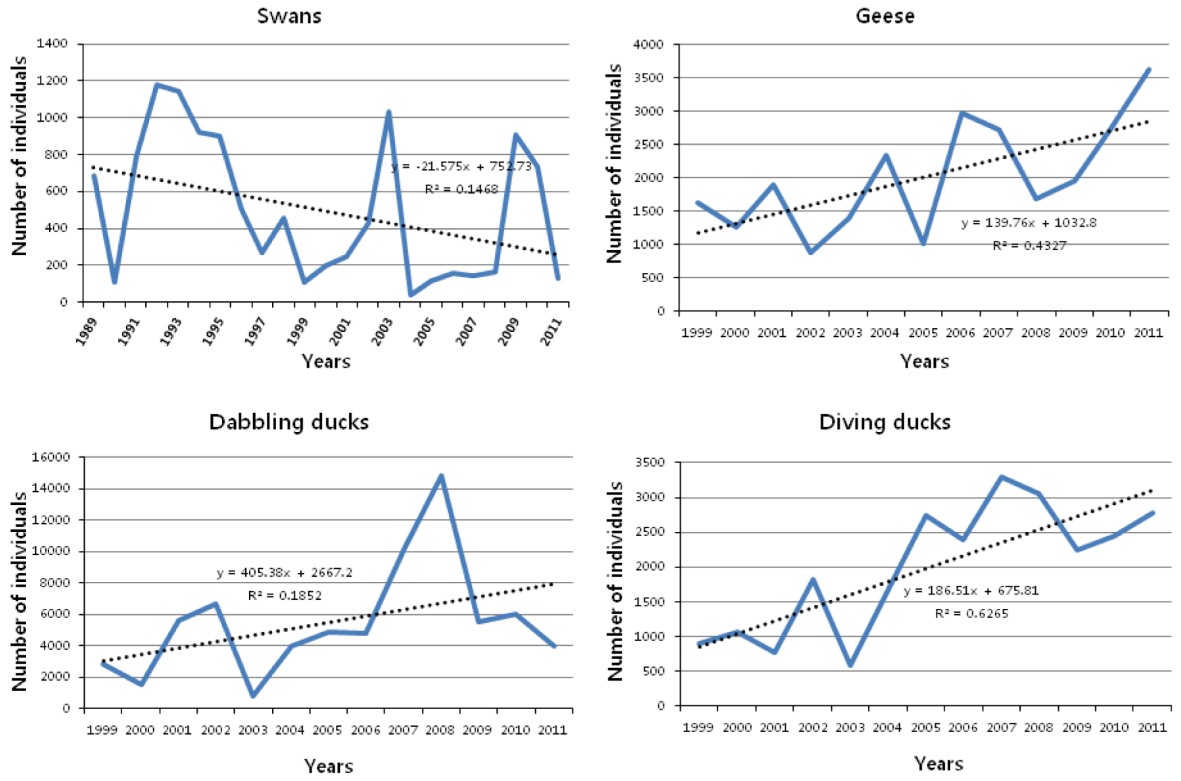

Fig. 6. Yearly variation of the number of individuals by birds groups from 1999 to 2011(Swans: 1989~2011) (refer to the simultaneous census of birds in winter of the Ministry of Environment).

Dabbling ducks

Dabbling ducks except swans and geese include *Anas platyrhynchos*, *A. poecilorhyncha*, *A. formosa*, *A. penelope* and *A. clypeata*. The data are based on previous research data from 1999 to 2010 (Ministry of Environment, 2004; 2005; 2006; 2007; 2008; 2009; 2010) and the survey data in December 2011. The result ranges 760 individuals (2003) to 14,841 individuals (2008). The individuals sharply increased in 2007 and 2008 with more than 10,000 individuals. Then, the number decreased by half to 4,000~ 6,000 individuals, showing a slight increase compared to before 2007 (Fig. 6). It is estimated that between 8,000 and 9,500 individual dabbling ducks including swans and geese visit the Junam Reservoir.

Diving ducks

Diving ducks include pochards, mergansers, grebes and coots. The data are based on previous research data from 1999 to 2010 (Ministry of Environment, 2004; 2005; 2006; 2007; 2008; 2009; 2010) and the survey data in December 2011. The result ranges 586 individuals (2003) to 3,292 individuals (2007). Overall, the individuals tend to increase and it is estimated that about 2,700 individuals have visited the reservoir since 2005 (Fig. 6).

Government protected species

The government-protected species recorded in the survey are 2,391 individuals of 19 species including 10 species of birds of prey including *Pandion haliaetus*, followed by 5 Anseriformes, 2 Gruidae, *Ciconia boyciana* and *Platalea leucorodia*. There are 14 species of natural monuments and 16 species of endangered species including 4 Class I and 12 Class II (Table 2).

Discussion

The total of 11,742individuals, 102 species, 41 families and 13 orders were observed in the Junam Reservoir during the study period, 127 species, 31 families and 12 orders are found in the Nakdong Estuary (Hong, 2009) and 86 species, 35 families and 13 orders are found in the Upo Wetland (Kang and Hahm, 1997), showing that the figure of the reservoir is larger than that of the wetland. In addition, 104 species are found in the Geumgang Estuary, another habitat for migratory birds including 71 species excepting Passeriformes (Lee *et al*., 2001) and 67 species including birds of prey are found in the Han River (Kang *et al*., 2008). Also, it is reported that 52 species, 69 species and 84 species of water birds including birds of prey are found between 1999 and 2000, 2002 and 2003, and 2008 and 2009, respectively (Kang *et al*., 2011). Despite differences in survey period, the results show that the Junam Reservoir is a major habitat for swimming birds approaching the Nakdong Estuary, the Geumgang Estuary, the Han Estuary

Table 2. Protection of species recorded in Junam Reservoir

No.	Scientific name	Korean name	A Natural Monument	Endangered Species	Individuals
1	*Ciconia boyciana*	황새	199	I	4
2	*Platalea leucorodia*	노랑부리저어새	205-2	I	23
3	*Cygnus cygnus*	큰고니	201-2	II	127
4	*Anser cygnoides*	개리	325-1	II	4
5	*Anser fabalis*	큰기러기	-	II	1,696
6	*Aix galericulata*	원앙	327	-	9
7	*Anas formosa*	가창오리	-	II	350
8	*Pandion haliaetus*	물수리	-	II	1
9	*Haliaeetus albicilla*	흰꼬리수리	243-4	I	3
10	*Aegypius monachus*	독수리	243-1	II	1
11	*Circus cyaneus*	잿빛개구리매	323-6	II	1
12	*Accipiter nisus*	새매	323-4	-	2
13	*Accipiter gentilis*	참매	323-1	II	1
14	*Buteo buteo*	말똥가리	-	II	2
15	*Falco tinnunculus*	황조롱이	323-8	-	4
16	*Falco subbuteo*	새홀리기	-	II	2
17	*Falco peregrinus*	매	323-7	I	2
18	*Grus monacha*	흑두루미	228	II	9
19	*Grus vipio*	재두루미	203	II	150
	Total		14	16	2,391

and the Saemangeum by comparing types of water birds. Also, there are about 12,000 to 14,000 individuals of 60 to 65 species spend winter around the reservoir on yearly basis by combining the census of birds in the winter performed by the Ministry of Environment.

The dominant species in the survey include *Anser albifrons*, *A. fabalis*), *Fulica atra* and *Anas platyrhynchos*, showing large difference from the past 1990s including *Anas formosa*, and *Anser fabalis* (Yu and Hahm, 1994; Hahm *et al*., 1999). The *Anas formosa* was the most dominant species in the past. However, the individuals have decreased since 2000 and small number of the geese is irregularly recorded. There are only 350 individuals *Anas formosa* in the study. Meanwhile, the 3rd dominant species, *Anser fabalis* and *A. albifrons*, become the most dominant, showing that the pattern has changed. Until the early 1990s, the number of *Anas Formosa* spending winter in the Junam Reservoir reached from 20,000 to 40,000 individuals (Yu and Hahm, 1994). Then, the number has decreased and maximum 300,000~450,000 individuals are found in the Geumgang Estuary, showing increase groups in the winter (Kang *et al*., 2010). Currently, it is considered that the groups found in the Junam Reservoir are a part of main groups.

Factors which affect the number of individuals include climate, hunting, vegetation place and moving habitat due to dearth of preys (Newton, 1998; Lee and Hong, 2008). Water birds living in the reservoir are hardly affected by hunting or poaching but expected to be affected by decreasing food sources due to decreasing size of rice paddies from frozen reservoirs and altering agricultural land uses during the winter. In addition, fishing activities in the reservoir by residents may pose threat to dabbling ducks, as well as geese spending winter. Changwon city shall take more aggressive protection and supports for migratory birds by purchasing nearby agricultural lands and preventing residents from fishing during the winter.

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