



野生鳥類

森林

破壞

山林

復元

研究

Studies on ecological restoration of destructed forest in
group breeding area of wild birds

1995

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SUMMARY

I. Title

A Study on ecological restoration of destructed forest in group breeding area of wild birds

II. Purpose and importance of survey

The aims of this survey were to protect forest destructed by feces dependent upon group breeding of wild birds, search for problems of their habitat and method of restoration of ecological state.

Many nest trees and soil in group breeding area of wild birds were severely destructed and became overnutrition by their feces.

So group of wild birds move to another new forest for breeding site and this transfer would be continuing to following years.

Therefore, we must have protective strategies for group breeding area of wild birds.

III. Contents and range of investigation

The following sites were investigated : Kamsung, Jinchon, Yoeju, Hoengsung, Yangyang, Muan, In Songjeul, etc. Some of them were designated as natural monuments in Korea.

Artificial nests for group breeding wild birds were constructed at In myon, Kongju, Chungnam Province and Songjeul, Cheongju, Chungbuk Province.

The contents of survey were as follows :

- (1) Environmental investigation of the forest where wild birds breed
- (2) Characteristics of physical and chemical substance in soil
- (3) Selection of seeds and trees having resistance against feces of group breeding birds
- (4) Food materials and numbers of birds at breeding site
- (5) Territory and behavior in breeding site
- (6) Carrying capacity and disturbance in breeding site
- (7) Artificial nests for group breeding birds

IV. Recommendation of result and Application

Our investigation result of the basic data about survey area showed that artificial nest must be constructed in winter at each breeding area than any other season.

It must be constructed in natural monuments area as well as non-designated natural monuments which were important for research, education, and conservation of biodiversity.

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· 가 , ,

10m × 10m , 5m × 5m , 1m
× 1m , ,

(1)

(가)

· , 1600 /ha, 34.6
cm, 1500 m2 .

· , 가
가 , 가

·
(*Robinia pseudo-acacia*), (*Castanea
crenata*), 가 (*Ailanthus altissima*), (*Quercus dentata*)가 1-2

가

(*Persicaria thunbergii*), (*Rumex crispus*), (*Chenopodium album*

var. *centrorubrum*), (*Humulus japonicus*), (*Persicaria perfoliata*), (*Achyranthes japonica*), (*Commelina communis*), (*Persicaria hydropiper*), (*Phytolacca americana*), (*Artemisia princeps* var. *orientalis*) (Table 1).

가 . 1995 9
277 g/m2 .

Table 1. Species composition of herb layer of pine forest, breeding site of herons, at Pomaeri, Yangyang.

Species	Relative frequency(%)	Relative cover(%)	Importance value
Herb layer : cover 90%			
<i>Humulus japonicus</i> ()	14	17	31
<i>Persicaria perfoliata</i> ()	13	17	30
<i>Commelina communis</i> ()	11	17	28
<i>Persicaria thunbergii</i> ()	13	13	26
<i>Rumex crispus</i> ()	13	8	21
<i>Chemopodium album</i> var. <i>centrorubrum</i> ()	11	8	19
<i>Achyranthes japonica</i> ()	8	8	16
<i>Persicaria hydropiper</i> ()	8	8	16
<i>Phytolacca americana</i> ()	6	2	8
<i>Artemisia princeps</i> var. <i>orientalis</i> ()	3	2	5

()

60%

26.7cm

2800 /ha

(*Rhododendron mucronulatum*), (*Rhododendron yedoense* var. *poukhanense*), (*Styrax japonica*), (*Prunus sargentii*), (*Rhus trichocarpa*), (*Quercus dentata*), (*Quercus aliena*) , 60% (Table 3).

가 , , , , 22.5 g/m² .

(2)

(가)

가 95% 가 . (*Fraxinus rhynchophylla*), (*Quercus serrata*), (*Quercus dentata*) 가 20,000 m² .

, , (*Quercus acutissima*) (Table 3). (*Corylus heterophylla*), 가 (*Ailanthus altissima*), (*Sambucus williamsii* var. *coreana*) 가 .

. (*Humulus japonicus*), 가 (*Persicaria fauriei*), (*Perisicaria perfoliata*), (*Commelina communis*), (*Chelidonium majus* var. *asiaticum*) (Table 3), (*Digitaria sanguinalis*), (*Achyranthes japonica*), (*Bidens bipinnata*), (*Setaria viridis*), (*Dioscorea*

Table 2. Species composition of shrub and herb layers of a control pine forest, at Pomaeri, Yangyang.

Species	Relative frequency(%)	Relative cover(%)	Relative density(%)	Importance value
Shrub layer : cover 60%				
<i>Rhododendron mucronulatum</i> ()	37	40	33	140
<i>Quercus dentata</i> ()	11	16	17	44
<i>Rhododendron yedoense</i>				
var. <i>poukhanense</i> ()	15	16	8	39
<i>Prunus sargentii</i> ()	15	8	13	36
<i>Rhus trichocarpa</i> ()	15	8	13	36
<i>Quercus aliena</i> ()	4	8	8	20
<i>Quercus acutissima</i> ()	4	4	8	16
	Relative frequency(%)	Relative cover(%)	Importance value	
Herb layer :cover 30%				
<i>Carex lanceolata</i> ()	30	35	65	
<i>Miscanthus sinensis</i> ()	18	24	42	
<i>Melampyrum roseum</i> ()	18	18	36	
<i>Polygonatum odoratum</i>				
var. <i>pluriflorum</i> ()	15	14	29	
<i>Carex siderosticta</i> ()	10	6	16	
<i>Potentilla freyniana</i> ()	8	4	12	

batatas)

가

, 1995 9

289 g DW/m²

Table 3. Species composition of larch forest, breeding site of herons, at Appogri, Hoengsung, Kangwon Province

Species	R.F (%)	R.C (%)	R.D (%)	Importance value
Tree layer				
<i>Larix leptolepis</i> ()	33	35	26	94
<i>Fraxinus rhynchophylla</i> ()	27	24	32	83
<i>Quercus serrata</i> ()	20	24	25	69
<i>Quercus dentata</i> ()	20	18	18	56
Shrub layer				
<i>Fraxinus rhynchophylla</i> ()	20	29	20	69
<i>Quercus dendata</i> ()	20	19	18	57
<i>Quercus acutissima</i> ()	15	19	18	52
<i>Corylus heterophylla</i> ()	10	5	8	23
<i>Ailanthus altissima</i> (ㄗ))	10	5	8	23
<i>Smilax sieboldii</i> (ㄗ))	7	7	8	22
<i>Sambucus williamsii</i> var. <i>coreana</i> ()	5	5	4	14
<i>Zanthoxylum schinifolium</i> ()	2	5	6	13
<i>Styrax obassia</i> ()	5	2	2	9
<i>Juniperus rigida</i> ()	5	2	2	9
<i>Maackia amurensis</i> ()	2	2	4	8
	R.F (%)	R.C (%)	Importance value	
Herb layer				
<i>Humulus japonicus</i> ()	11	15	26	
<i>Persicaria fauriei</i> (ㄗ))	11	13	24	
<i>Persicaria perfoliata</i> ()	11	13	24	
<i>Commelina communis</i> ()	9	12	21	
<i>Chelidonium majus</i> var. <i>asiaticum</i> ()	9	10	19	
<i>Digitaria sanguinalis</i> ()	9	7	16	
<i>Bidens bipinnata</i> ()	7	7	14	
<i>Dioscorea batatas</i> ()	7	7	14	
<i>Solanum nigrum</i> ()	5	5	10	
<i>Achyranthes japonica</i> ()	6	3	9	
<i>Siegesbeckia glabrescens</i> ()	6	3	9	
<i>Setaria viridis</i> ()	5	3	8	
<i>Stellaria aquatica</i> ()	2	3	5	
<i>Persicaria nepalensis</i> ()	1	2	3	
<i>Amaranthus mangostanus</i> ()	1	1	2	

R.F: Relative frequency, R.C: Relative cover, R.D: Relative density

()

2-3m

16.3cm

100%

Table 3

2m

(*Euonymus sachalinensis*)

가

가

가

가

36% 7%

가

. 1995 9

23 gDW/m²

1/12

Tilman(1982)

가

(Tilman, 1987; Mun and Whitford, 1989).

가

Jakucs(1991)가

Grime(1979)

(Ruderlas)

가

가

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 1990 가
 가 4-5
 2600/ha , 95%
 100%
 가 300/ha ,
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4. Species composition of shrub and herb layers of control larch forest, at Apgokri, Hoengsung, Kangwon Province

Species	R.F (%)	R.C (%)	R.D (%)	Importance value
Shrub layer (cover, 100%)				
<i>Quercus dentata</i> ()	16	21	16	53
<i>Quercus serrata</i> ()	16	18	16	50
<i>Quercus acutissima</i> ()	14	15	13	42
<i>Euonymus sachalinensis</i> ()	12	12	16	40
<i>Corylus heterophylla</i> ()	8	9	8	25
<i>Rhus trichocarpa</i> ()	10	6	6	22
<i>Symplocos chinensis</i> for. <i>pilosa</i> ()	8	6	6	20
<i>Smilax sieboldii</i> (가)	6	6	9	21
<i>Prunus sargentii</i> ()	4	3	5	12
<i>Lonicera maackii</i> ()	4	3	3	10
<i>Pinus densiflora</i> ()	2	3	3	8
	R.F (%)	R.C (%)	Importance value	
Herb layer (cover, 15%)				
<i>Disporum viridescens</i> ()	16	11	27	
<i>Polygonatum odoratum</i> var. <i>pluriflorum</i> ()	11	11	22	
<i>Convallaria keiskei</i> ()	11	11	22	
<i>Phryma leptostachya</i> var. <i>asiatica</i> ()	8	11	19	
<i>Dioscorea batatas</i> ()	8	11	19	
<i>Potentilla freyniana</i> ()	11	5	16	
<i>Viola grypoceras</i> ()	5	5	10	
<i>Aster scaber</i> ()	5	5	10	
<i>Solidago virga-aurea</i> var. <i>asiatica</i> ()	5	5	10	
<i>Hemerocallis fulva</i> ()	5	5	10	
<i>Syneilesis palmata</i> ()	5	5	10	
<i>Lilium distichum</i> ()	3	5	8	
<i>Arisaema amurense</i> var. <i>serratum</i> ()	3	5	8	
<i>Osmunda japonica</i> ()	3	5	8	

R.F: Relative frequency, R.C: Relative cover, R.D: Relative density

가 , (,) 가 , , 가 , 가 5cm .

Table 5. Species composition of breeding site in pitch pine forest at Sinjerbri in 1995, Yeosu, Kyeonggi Province

Species	R.F (%)	R.C (%)	R.D (%)	Importance value
Tree layer (cover 80%)				
(<i>Pinus rigida</i>)	65	75	68	208
(<i>Pinus densiflora</i>)	20	15	24	59
(<i>Quercus acutissima</i>)	10	7	6	23
(<i>Castana crenata</i>)	5	3	2	10
Shrub layer (cover 60%)				
(<i>Quercus dentata</i>)	63	67	40	170
(<i>Symplocos chinensis</i> for. <i>pilosa</i>)	15	13	15	43
(<i>Castana crenata</i>)	12	14	15	41
(<i>Quercus acutissima</i>)	5	3	18	26
(<i>Quercus aliena</i>)	5	3	12	20

R.F; , R.C; , R.D; , Importance value;

80% 가 , , 가 가

Table 6. Herb species composition of breeding site in pitch pine forest at Sinjerbri in 1996, Yeosu, Jeonnam Province

Species	R.F (%)	R.C (%)	Importance value
<i>Humulus japonicus</i> ()	16	40	56
<i>Persicaria perfoliata</i> ()	12	15	27
<i>Digitaria sanguinalis</i> ()	10	10	20
<i>Bidens bipinnata</i> ()	10	8	18
<i>Stellaria media</i> ()	8	3	11
<i>Achyranthes japonica</i> ()	8	2	10
<i>Commelina communis</i> ()	7	2	9
<i>Cardamine flexuosa</i> ()	5	2	7
<i>Echinochloa crus-galli</i> var. <i>frumentacea</i> ()	4	2	6
<i>Solanum nigrum</i> ()	4	2	6
<i>Pueraria thunbergiana</i> ()	3	4	7
<i>Dioscorea batatas</i> ()	3	2	5
<i>Cyperus amuricus</i> ()	3	2	5
<i>Setaria viridis</i> ()	1	2	3
<i>Erigeron annuus</i> ()	1	1	2
<i>Artemisia princeps</i> var. <i>orientalis</i> ()	1	1	2
<i>Persicaria blumei</i> ()	1	1	2
<i>Lactuca indica</i> var. <i>laciniata</i> ()	1	1	2
<i>Youngia japonica</i> ()	1	+	1
<i>Chenopodium album</i> var. <i>centrorubrum</i> ()	1	+	1

1995

(Table 5) 1996

1996

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(Table 6). 1995

1995

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가 가

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(Table 7).

80%

13.2cm,

2500- 2600/ha

5- 8cm

10%

Table 7. Species composition of pitch pine forest, control site, at Sinjebri, Yeosu, Kyeonggi Province

Species	R.F (%)	R.C (%)	R.D (%)	Importance value
Tree layer (cover 80%)				
<i>(Pinus rigida)</i>	60	66	70	196
<i>(Pinus densiflora)</i>	22	18	15	55
<i>(Quercus acutissima)</i>	11	10	10	31
<i>(Prunus sargentii)</i>	5	3	3	11
<i>(Castana crenata)</i>	2	3	2	7
Shrub layer (cover 100%)				
<i>(Quercus acutissima)</i>	20	30	19	69
<i>(Rhododendron mucronulatum)</i>	18	22	19	59
<i>(Quercus dentata)</i>	18	15	11	44
<i>(Indigofera kirilowii)</i>	5	4	15	24
<i>(Zanthoxylum schinfolium)</i>	9	4	7	20
<i>(Rhus trichocarpa)</i>	8	6	4	18
<i>(Corylus heterophylla)</i>	5	6	7	18
<i>(Euonymus sieboldiana)</i>	6	4	6	16
<i>(Symplocos chinensis</i> for. <i>pilosa)</i>	5	3	6	14
<i>(Ampelopsis heterophylla)</i>	5	3	6	14
<i>(Castana crenata)</i>	5	4	4	13
Herb layer (cover 10%)				
<i>(Atractylodes japonica)</i>	33	32		64
<i>(Sanguisorba officinalis)</i>	27	24		51
<i>(Cocculus trilobus)</i>	9	11		20
<i>(Artemisia viridissima)</i>	13	5		18
<i>(Lysimachia barystachys)</i>	4	11		15
<i>(Clematis brachyura)</i>	4	8		12
<i>(Lilium tigrinum)</i>	4	5		9
<i>(Echinops setifer)</i>	4	5		9

가 , , 가
가 , ,
90% ,
가 ,
가 .

(4)

(가)

, , ,
(400- 500/ha)
가

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가 .
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가 (1500- 1600/ha)

Table 8. Species composition of breeding site in *Quercus acutissima* forest at Nowonri, Jincheon, Chungbuk Province

Species	R.F (%)	R.C (%)	R.D (%)	Importance value
Tree layer (cover 20%)				
(<i>Quercus acutissima</i>)	38	33	42	113
(<i>Quercus variabilis</i>)	25	33	33	91
(<i>Pinus densiflora</i>)	25	22	17	64
(<i>Robinia pseudo-acacia</i>)	13	11	8	32
Shrub layer (cover 50%)				
(<i>Robinia pseudo-acacia</i>)	19	26	2	72
(<i>Quercus acutissima</i>)	19	15	14	48
(<i>Rosa multiflora</i>)	14	12	8	34
(<i>Quercus variabilis</i>)	9	12	8	29
가 (<i>Ailanthus altissima</i>)	9	9	11	29
(<i>Zanthoxylum schinifolium</i>)	9	6	11	26
(<i>Lindera obtusiloba</i>)	5	9	8	22
(<i>Celastrus orbiculatus</i>)	7	6	8	21
(<i>Sambucus williamsii</i> var. <i>coreana</i>)	9	6	5	20
Herb layer (cover 80%)				
(<i>Humulus japonicus</i>)	15	14		29
(<i>Commelina communis</i>)	13	14		27
(<i>Persicaria perfoliata</i>)	12	13		25
(<i>Persicaria thunbergii</i>)	12	11		23
(<i>Liriope platyphlla</i>)	11	12		23
(<i>Dioscorea batatas</i>)	11	7		18
(<i>Impatiens textori</i>)	8	9		17
(<i>Chelidonium majus</i> var. <i>asiaticum</i>)	9	7		16
(<i>Solanum nigrum</i>)	3	5		8
(<i>Achyranthes japonica</i>)	3	3		6
(<i>Digitaria sanguialis</i>)	2	3		5
(<i>Bidens bipinnata</i>)	2	3		5
(<i>Artemisia princeps</i> var. <i>orientalis</i>)	1	1		2
(<i>Sophora flavescens</i>)	1	1		2

Table 8

가

18- 23cm

가

가

가

가

가

Table 9. Species composition of oak forest, control site, at Nowonri, Jincheon, Chungbuk Province

Species	R.F (%)	R.C (%)	R.D (%)	Importance value
Tree layer (cover 80%)				
(<i>Castana crenata</i>)	33	40	29	102
(<i>Prunus serrulata</i> var. <i>spontanea</i>)	29	30	29	88
(<i>Pinus densiflora</i>)	24	20	18	62
(<i>Quercus acutissima</i>)	14	10	24	48
Shrub layer (cover 40%)				
(<i>Stephanaadra incisa</i>)	27	12	12	51
(<i>Prunus serrulata</i> var. <i>spontanea</i>)	12	18	10	40
가 (<i>Smilax sieboldii</i>)	12	12	15	39
(<i>Acer palmatum</i>)	9	12	12	33
(<i>Quercus dentata</i>)	12	9	7	28
(<i>Rubus crataegifolius</i>)	9	6	12	27
(<i>Zanthoxylum</i> <i>schinifolium</i>)	9	6	7	22
(<i>Lespedeza bicolor</i>)	6	6	9	21
(<i>Lindera obtusiloba</i>)	6	6	7	19
(<i>Rhus trichocarpa</i>)	6	6	5	17
(<i>Symplocos</i> <i>chinensis</i> for. <i>pilosa</i>)	3	6	5	14
Herb layer (cover 10%)				
(<i>Parthenocissus</i> <i>tricuspidata</i>)	43	36		79
(<i>Pteridium aquilinum</i>)	29	27		56
(<i>Liriope platyphlla</i>)	21	18		39
(<i>Dioscorea batatas</i>)	7	18		25

가

가

(5)

(가)

2000/ha

18.2cm

40% 가

20%

가

가

200/ha

34.2cm

가

1000/ha

40%

가

1995

1996 9

60% 가

. 2

()

650/ha

33.4cm

가

300/ha

13.6cm

60%

가

400/ha

가

Table 10. Species composition of breeding site in pitch pine forest at Gamsung, Chungnam Province

Species	R.F (%)	R.C (%)	R.D (%)	Importance value
Tree layer (cover 80%)				
(<i>Pinus rigida</i>)	83	77	80	240
(<i>Pinus densiflora</i>)	12	14	15	41
(<i>Quercus acutissima</i>)	5	9	5	19
Shrub layer (cover 15%)				
(<i>Robinia pseudo-acacia</i>)	90	85	88	263
(<i>Castana crenata</i>)	10	15	12	37
Herb layer (cover 60%)				
(<i>Pueraria thunbergiana</i>)	85	82		167
(<i>Humulus japonicus</i>)	10	14		24
(<i>Commelina communis</i>)	3	2		5
(<i>Dioscorea batatas</i>)	2	2		4

. 1995 8

1996 9

(6)

(7)

16.4cm, 3,700 /ha .

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가 가

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1996

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가 가

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4-5

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9

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가.

· 가 10

2 3m

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가 .

2mm

pH : 1:5 1 pH meter

650 4

microKjeldahl ,

NH₄F ammonium molybdate stannous chloride

spectrophotometer (Allen *et al.* 1974). , ,

ammonium acetate Atomic Absorption Spectrophotometer

(Perkin- Elmer 3110) . Total- Sulfur Bardsley and

Lancaster(1960) (Wilde *et al.* 1979).

NaHCO₃ (NaH₂PO₄ 4.6g 2N 1L

) spectrophotometer 420nm

t-

5%

(1)

Table 4 . Table

4 , , ,

Table 11. Comparisons of soil properties between the breeding site and non-breeding site of *Pinus densiflora* in Yangyang, Kangwon Province

Items	Breeding site	Control site
Organic matter (%)	27.2 ± 8.61**	10.2 ± 1.13
Soil pH	4.0 ± 0.17**	4.6 ± 0.05
Total nitrogen(mg/g)	14.8 ± 5.75***	2.8 ± 0.35
Phosphate(μ g/g)	19.3 ± 4.63***	0.6 ± 0.18
Potassium(μ g/g)	108.8 ± 8.03***	13.2 ± 0.33
Calcium(μ g/g)	266.6 ± 9.78***	35.2 ± 1.01
Magnesium(μ g/g)	2.7 ± 1.33NS	1.6 ± 0.36
Total sulfur(mg/g)	92.0 ± 3.85***	18.8 ± 2.04

NS; Not significant, *; p<0.05, **; p<0.01, ***; p<0.001

가

가

1%

가
가 (Press *et al.* 1986, Fowler *et al.* 1989, Wellburn
1990, Bell 1994).

가 (Fowler *et al.* 1989, Pyo 1994).

가

가

가

가,

가

가

가

가

가 가

가

가

(Nagy and Nagy 1981, Jakucs 1991, Bell

1994),

가 가

(Table 2).

가

, , 가
27
가
가 가
가
가
가 가

(3)

가
가 5 Table 13
가
2
가 가
가
가 가

Table 13. Comparisons of soil properties between the breeding site and non-breeding site of *Pinus rigida* forest in Yeosu

Soil properties	Breeding site	Non-breeding site
Organic matter (%)	29.1 ± 3.12***	13.0 ± 0.33
Soil pH	4.2 ± 0.08NS	4.3 ± 0.07
Total nitrogen(mg/g)	23.8 ± 2.01**	6.2 ± 0.70
Phosphate(ppm)	23.0 ± 4.69***	0.8 ± 0.07
Potassium(ppm)	240.3 ± 3.47***	27.9 ± 0.39
Calcium(ppm)	244.2 ± 5.28***	20.6 ± 0.12
Magnesium(ppm)	22.1 ± 0.39*	7.6 ± 0.18
Total sulfur(mg/g)	86.5 ± 11.77**	34.8 ± 2.12

NS; Not significant, *, p<0.05, **, p<0.01, ***, p<0.001

pH 가 (Table 13).
 pH가
 가 4 ,
 가 가
 28
 가 ,
 가 (Table 13).
 가
 5%

가 , 가
가 가
가

(4)

가 1960
30
1995 가
200

(Table 14).

가
가
pH 가 4.8 가 4.3 pH
가 pH

Table 14. Comparisons of soil properties between the breeding site and non-breeding site of *Quercus acutissima* forest in Jinchon, Chungbuk Province

Soil properties	Breeding site	Non-breeding site
Organic matter (%)	14.6 ± 1.78*	7.2 ± 1.85
Soil pH	4.3 ± 0.17*	4.8 ± 0.15
Total nitrogen(mg/g)	9.4 ± 0.87*	4.6 ± 1.20
Phosphate(ppm)	21.7 ± 3.73**	1.7 ± 0.12
Potassium(ppm)	45.5 ± 1.53**	17.3 ± 0.23
Calcium(ppm)	199.2 ± 5.67***	19.5 ± 0.34
Magnesium(ppm)	10.3 ± 0.53NS	11.6 ± 0.07
Total sulfur(mg/g)	51.4 ± 6.58**	17.8 ± 0.55

NS; Not significant, *, p<0.05, **, p<0.01, ***, p<0.001

(5)

(가)

가 가 4-5
가

Table 15. Comparisons of soil properties between the breeding site and non-breeding site of *Pinus rigida* forest in Gamsung, Chungnam Province

Soil properties	Breeding site	Non-breeding site
Organic matter (%)	15.0 ± 1.44*	12.1 ± 1.32
Soil pH	4.4 ± 0.16NS	4.5 ± 0.15
Total nitrogen(mg/g)	4.8 ± 0.59*	3.7 ± 0.35
Phosphate(ppm)	23.1 ± 4.08**	3.0 ± 0.82
Potassium(ppm)	99.9 ± 7.62**	26.1 ± 4.25
Calcium(ppm)	140.8 ± 8.65**	51.7 ± 6.55
Magnesium(ppm)	23.0 ± 4.47*	13.0 ± 2.82
Total sulfur(mg/g)	39.5 ± 2.26*	27.5 ± 2.54

NS; Not significant, *, p<0.05, **, p<0.01, ***, p<0.001

()

가
가
22
pH , 1%
1%

(6)

가
(Table 17). 가 1%
0.1%

Table 16. Comparisons of soil properties between the breeding site and non-breeding site of *Quercus acutissima* forest in Gamsung, Chungnam Province

Soil properties	Breeding site	Non-breeding site
Organic matter (%)	17.2 ± 1.79*	11.6 ± 1.56
Soil pH	4.3 ± 0.17**	5.0 ± 0.10
Total nitrogen(mg/g)	5.8 ± 0.17*	3.7 ± 0.86
Phosphate(ppm)	75.2 ± 3.85***	3.4 ± 0.57
Potassium(ppm)	78.8 ± 3.44*	51.0 ± 3.75
Calcium(ppm)	145.5 ± 8.49**	75.8 ± 4.12
Magnesium(ppm)	11.6 ± 2.01**	32.5 ± 4.95
Total sulfur(mg/g)	39.5 ± 2.26*	27.5 ± 2.54

*; p<0.05, **; p<0.01, ***; p<0.001

가 , 가가
 가
 가
 가 , pH
 가

Table 17. Comparisons of soil properties between the breeding site and non-breeding site of *Pinus thunbergii* forest in Muan, Cheonnam Province

Soil properties	Breeding site	Non-breeding site
Organic matter (%)	19.2 ± 1.24**	10.3 ± 0.89
Soil pH	4.2 ± 0.12**	4.8 ± 0.11
Total nitrogen(mg/g)	6.8 ± 0.15*	2.6 ± 0.77
Phosphate(ppm)	46.1 ± 2.47***	5.5 ± 0.73
Potassium(ppm)	83.2 ± 2.70**	21.4 ± 2.31
Calcium(ppm)	125.4 ± 6.41***	31.8 ± 5.75
Magnesium(ppm)	25.1 ± 1.42NS	28.6 ± 5.47
Total sulfur(mg/g)	76.8 ± 3.91**	23.7 ± 1.72

*; p<0.05, **; p<0.01, ***; p<0.001

3.

가.

(), , ,
 , ,
 1995
 1996 가 , ,
 (4)
 (1996), 가
 ,
 가 3.5- 5.0g

가 . 30cm x
 20cm x 10cm pot ,
 mineral soil . 가
 ,
 .
 4 10 , pot 20 ,
 3 . 가 1
 .
 , 가
 30 , 4 15
 8 15 4 .

(1)

2m x 1m x 1m frame . frame
 pot . (L10) 50% (L50),
 10% (L10) .
 , 50% 2-3 , L10 4-5
 , .

(2)

mineral .

(3)

1997 3 1996 3 ,

(4)

3 1997 , 9 15

(1)

92.4% , 50% 96.3%
10% 55.2% 50%
(Table 18).

50% 95.6% 97.2%
10% 70.5% (Table
19).

가

10%

(Table 20).

45.2% , 50% 72.0% , 10%
50.0%

Table 18. Germination rates of *Pinus densiflora* at various light intensities

Light Gradients	Weeks after first germination				
	1	2	3	4	5
Full light (L100)	45.9	74.2	85.1	92.4	92.4
50% light (L50)	30.5	63.4	82.7	96.3	96.3
10% light (L10)	-	20.5	40.6	55.2	55.2

Table 19. Germination rates of *Pinus rigida* at various light intensities

Light Gradients	Weeks after first germination				
	1	2	3	4	5
Full light (L100)	48.2	65.3	80.1	95.6	95.6
50% light (L50)	52.8	73.2	89.5	97.2	97.2
10% light (L10)	10.4	52.0	64.0	70.5	70.5

50%

가

50%

가

Table 20. Germination rates of *Quercus acutissima* at various light intensities

Light Gradients	Weeks after first germination				
	1	2	3	4	5
Full light (L100)	10.1	24.0	38.6	45.2	45.2
50% light (L50)	15.5	42.4	56.2	67.5	72.0
10% light (L10)	20.4	30.1	44.6	50.0	50.0

(2)

Tables 21-23

가

가

5 가

92.5%

45.3%

5 가

95.0% ,

84.5%

가

Table 21. Germination rates of *Pinus densiflora* at different soil conditions

Soil conditions	Weeks after first germination				
	1	2	3	4	5
Breeding site soil	-	32.5	40.1	45.3	45.3
Control soil	30.0	57.5	68.2	92.5	92.5

Table 22. Germination rates of *Pinus rigida* at different soil conditions

Soil conditions	Weeks after first germination				
	1	2	3	4	5
Breeding site soil	32.5	56.4	75.0	84.5	84.5
Control soil	45.8	67.4	85.5	95.0	95.0

Table 23. Germination rates of *Quercus acutissima* at different soil conditions

Soil conditions	Weeks after first germination				
	1	2	3	4	5
Breeding site soil	10.0	26.5	38.2	45.6	45.6
Control soil	15.5	34.7	42.5	48.0	48.0

(3)

(가)

			50%		
	가	10%		50%	
		(Table 24).	8	15	
10%		50%		가	48.5%
61.0%					

Table 24. Changes of seedling height(cm) of *Pinus densiflora* grown at different light intensities

Light Gradients	Date of measurement				
	Apr.15	May 15	Jun.15	Jul.15	Aug.15
Full light (L100)	3.5	4.8	6.4	10.5	13.2
50% light (L50)	3.2	3.9	5.2	7.5	10.5
10% light (L10)	3.2	3.5	4.6	5.7	6.4

Table 25. Changes of seedling height(cm) of *Pinus rigida* grown at different light intensities

Light Gradients	Date of measurement				
	Apr.15	May 15	Jun.15	Jul.15	Aug.15
Full light (L100)	3.6	4.5	7.2	12.4	16.5
50% light (L50)	3.4	5.0	8.5	14.8	18.5
10% light (L10)	3.2	4.0	5.2	8.6	10.4

50%
 10% (Table 25). Table 25
 8 15 10%
 50% 63.0% 56.2%
 50% 가

가 (Table 26).

. Table 26 10% 50%

Table 26. Changes of seedling height(cm) of *Quercus acutissima* grown at different light intensities

Light Gradients	Date of measurement				
	Apr.15	May 15	Jun.15	Jul.15	Aug.15
Full light (L100)	4.2	4.7	6.0	10.4	12.6
50% light (L50)	4.4	5.9	7.5	13.6	15.4
10% light (L10)	4.3	4.9	6.7	11.3	12.1

()

. Table 27

8 15

139% 가

135.1% 가 가 (Table 28).

118.2% 가

Table 27. Changes of seedling height(cm) of *Pinus densiflora* grown at different soil conditions

Soil conditions	Date of measurement				
	Apr.15	May 15	Jun.15	Jul.15	Aug.15
Breeding site soil(A)	3.5	6.3	10.3	14.7	18.5
Control soil(B)	3.3	4.3	7.4	11.6	13.3
Ratio(A/B)(%)		146.5	139.1	126.7	139.1

Table 28. Changes of seedling height(cm) of *Pinus rigida* grown at different soil conditions

Soil conditions	Date of measurement				
	Apr.15	May 15	Jun.15	Jul.15	Aug.15
Breeding site soil(A)	3.5	6.8	11.5	16.9	20.8
Control soil(B)	3.3	5.2	8.7	14.5	15.4
Ratio(A/B)(%)		130.7	132.2	116.6	135.1

Table 29. Changes of seedling height(cm) of *Quercus acutissima* grown at different soil conditions

Soil conditions	Date of measurement				
	Apr.15	May 15	Jun.15	Jul.15	Aug.15
Breeding site soil(A)	4.3	6.5	10.3	15.1	17.5
Control soil(B)	4.2	5.3	9.6	12.1	14.8
Ratio(A/B)(%)		122.6	107.3	124.8	118.2

가

(4)

1996 3

1997 3

60% 가

가 가

(Tables 26- 28),

가

(5)

1 1997 4

(Tables 30 and 31).

가

가

(1-2 m)

가

Table 30. Changes of sapling height(cm) of *Quercus acutissima*, transplanted at breeding site and control site in Gamsung

Site	Date of measurement					
	Apr.15	May 15	Jun.15	Jul.15	Aug.15	Sep.15
Breeding site	17.5	17.8	-	-	-	-
Control site	17.0	17.9	19.5	21.3	24.8	25.3

Table 31. Changes of sapling height(cm) of *Pinus rigida*, transplanted at breeding site and control site in Yeosu

Site	Date of measurement					
	Apr.15	May 15	Jun.15	Jul.15	Aug.15	Sep.15
Breeding site	16.4	16.8	17.3	-	-	-
Control site	16.4	17.1	18.6	21.7	22.8	23.2

가 .

가

가 .

4.

가 .

(400- 500/ha)

가 .

2.3 ± 1.2 m

1.8 ± 0.5m

가

가

가

1

(10x10 m)

가

가

2

5. 가

가.

가

가

가 (*Ardea cinerea*) 2

8

(*Egretta intermedia*)

(*Bubulcus ibis*)

3

8

(*Egretta*

garzetta)

(*Nycticorax nycticorax*) 3

(Table 32).

가

()

Table 32. Comparison of breeding period at survey area.

(Species) \ (Month)	Feb.	Mar.	Apr.	May	Jun	Jul.	Aug	Sep.	Oct.
가 (<i>Ardea cinerea</i>)	**	***	***	***	***	***	***		
(<i>Egretta intermedia</i>)		***	***	***	***	***	***		
(<i>Egretta garzetta</i>)		***	***	***	***	***	**		
(<i>Bubulcus ibis</i>)		***	***	***	***	***	*		
(<i>Nycticorax nycticorax</i>)		***	***	***	***	***	**		

.

가

.

4 (12)

13 가 가 225.7, 가 47.3 ,

가 13.3 292.0 가

가

가 211

가 , , , 823.2

가 (Table 33).

가 (*Ardea cinerea*)가

(*Egretta intermedia*)가

(*Egretta garzetta*), (*Nycticorax nycticorax*)

(*Bubulcus ibis*) 가 .

가

Table 33. The species and number of birds at survey area (Natural Monument)

Site	Species & Number (Mean \pm SD, n =12)					Total
	<i>Ardea cinerea</i>	<i>Egretta intermedia</i>	<i>Egretta garzetta</i>	<i>Nycticorax nycticorax</i>	<i>Bubulcs ibis</i>	
Jinchon	225.7 \pm 15.9	47.3 \pm 5.4	13.3 \pm 1.5	4.7 \pm 0.2	1.0 \pm 0.2	292.0
Yeoju	169.5 \pm 10.6	250.0 \pm 12.5	169.0 \pm 9.7		7.3 \pm 0.8	595.8
Heyong Sung	188.0 \pm 15.0	227.3 \pm 11.0	179.0 \pm 5.8		11.6 \pm 0.1	605.9
Yang Yang	245.5 \pm 14.9	240.0 \pm 9.0	7.0 \pm 0.5		2.0 \pm 0.1	494.5
Muan	305.5 \pm 20.3	175.7 \pm 8.7	327.5 \pm 17.6	0.5 \pm 1.8	4.0 \pm 0.1	823.2
Total	1134.2	940.3	695.8	15.2	25.9	2811.4

5 가

가 2478.8

1478.8 , 가

1239.0 가 .

76.6 (Table 34).

가 가 가 .

가 (625.0) 가 3.5 .

가 가 (1080.0) 가

(8.3). 가 (962.5)

가 가 (7.5). 가

(595.0) 가 (14.7)

. 387.0 가

가 (5.4) (Table 34).

Table 34. The species and number of birds at survey area (Non-Natural Monument)

Site		Species & Number (Mean \pm SD, n=5)					Total
		<i>Ardea cinerea</i>	<i>Egretta intermedia</i>	<i>Egretta garzetta</i>	<i>Nycticorax nycticorax</i>	<i>Bubulcus ibis</i>	
Kang won	Pyong Chang	153.8 \pm 10.5	137.8 \pm 8.7				291.5
	Kan Sung	3.5 \pm 0.4	345.0 \pm 15.5				348.5
	Hoo Kok	5.0 \pm 0.6	415.0 \pm 21.1	41.3 \pm 2.7			461.3
	Dong Myon	625.0 \pm 20.1	614.5 \pm 20.5				1239.5
	Mokok Ri	65.0 \pm 4.5	46.0 \pm 9.8	31.0 \pm 1.9			142.0
Kyong gi	An Sung	621.5 \pm 25.0	106.3 \pm 5.3	185.0 \pm 5.7			912.8
	Pyong Tek	244.8 \pm 14.3	20.0 \pm 7.1	57.5 \pm 5.1		56.0 \pm 23.5	378.3
	Joung Nam	137.5 \pm 8.5	18.8 \pm 5.0	327.5 \pm 17.5	595.0 \pm 20.1		1078.8
Chung Puk	Song Jeul	223.8 \pm 15.7	382.5 \pm 16.5	135.0 \pm 5.9		387.0 \pm 19.8	1138.3
	ChoungChoun	122.3 \pm 9.0	96.3 \pm 8.4				218.5
	Jeuk Sung	375.0 \pm 18.7					375.0
	JiJe Myon	28.8 \pm 3.4	82.5 \pm 2.9				111.3
	Dong Ryang	282.5 \pm 14.1	1080.0 \pm 52.9	962.5 \pm 29.0	153.8 \pm 5.2		2478.8
C h u n g Nam	Kode Myon	465.0 \pm 17.9	367.5 \pm 16.7	42.5 \pm 5.8	23.3 \pm 3.7		898.3
	Mokchon	571.0 \pm 20.0	28.5 \pm 5.1	7.5 \pm 2.2	14.7 \pm 2.9		621.7
	Heng Am	68.3 \pm 6.4	8.3 \pm 1.0				76.6
	Sedo Myon	50.0 \pm 2.9	320.0 \pm 16.7	178.8 \pm 11.0	381.3 \pm 19.8	34.3 \pm 5.6	974.3
Chon Puk	Kim je	70.5 \pm 6.3	301.4 \pm 18.8	202.5 \pm 14.5	570.2 \pm 20.0	125.5 \pm 8.4	1270.1
Chon Nam	Seung ju	150.4 \pm 8.6	245.5 \pm 19.0	35.5 \pm 4.4		5.4 \pm 1.0	436.8
Kyong Puk	Hyo Ryong	560.2 \pm 10.0	120.1 \pm 5.3	145.3 \pm 4.1			825.6
K y o n g Nam	Ga Rae	420.5 \pm 19.8	150.4 \pm 6.1	570.6 \pm 19.8		310.2 \pm 17.8	1451.7
	Ok Jong	545.4 \pm 16.4	576.3 \pm 14.0	700.2 \pm 29.0		354.7 \pm 21.4	2176.6
Total		5789.8	5462.7	3622.7	1723.6	1273.1	17906.3

Table 22 . 가 가 가 (*Ardea cinerea*)
7.5 \pm 2.1m . (*E. intermedia*) 6.4 \pm 1.5 m,
(*Egretta garzetta*) (*Bubulcus ibis*) 5.3 \pm 1.3m 5.4 \pm 0.9m
가
가 (*Ardea cinerea*) (*E. intermedia*)가 가 4.5 \pm

1.5 가 (*N. nycticorax*) 3.5 ± 1.9 가

(Table 35).

88.6 % - 95.0 %

73.8 % 91.2 %

Table 35. The height of nest, clutch size, numbers of hatching and fledgling

(Species)	High(m) (Mean ± SD) (n=100)	Clutch size(egg) (Mean ± SD) (n=150)	Hatching(birds) (Mean ± SD) (n = 75)	Fledgling(birds) (Mean ± SD) (n=57)
가 (<i>Ardea cinerea</i>)	7.5 ± 2.1	4.3 ± 1.7	4.0 ± 1.7 (93.0 %)	3.2 ± 1.9 (80.0 %)
(<i>E. intermedia</i>)	6.4 ± 1.5	4.5 ± 1.5	4.2 ± 1.5 (93.3 %)	3.1 ± 1.7 (73.8 %)
(<i>Egretta garzetta</i>)	5.3 ± 1.3	4.1 ± 1.7	3.9 ± 1.8 (95.0 %)	3.4 ± 1.2 (87.2 %)
(<i>Bubulcus ibis</i>)	5.4 ± 0.9	3.8 ± 1.1	3.4 ± 1.4 (89.5 %)	3.1 ± 1.0 (91.2 %)
(<i>N. nycticorax</i>)	5.1 ± 0.8	3.5 ± 1.9	3.1 ± 1.4 (88.6 %)	2.9 ± 1.3 (93.5 %)

.

가

가 66.5 ± 13.1 % 가 (22.7 ± 12.5 %),

(2.4 ± 1.2 %), (1.2 ± 0.3 %), 1.8 ± 1.1 % 4.3 ± 1.4 %

(Table 36).

(74.1 ± 12.1%)

(27.4 ± 11.5 %),

(4.4 ± 1.4 %)

(3.2 ± 0.9 %)

(Table 35).

7.

가. 가

(Nesting)

(55.0 ± 2.5%)

(Courtship)

(07:00 09:00)

(12.0 ± 2.5%),

(Agnostic)

(Courtship)

07:00 09:00

17:00 18:00

(Table 38).

(Alert)

(09:00 15:00)

(Resting)

05:00 07:00

17:00

19:00

Table 38. Percentage of behavior pattern of *Ardea cinerea* in breeding season(%)

Behavior	Time (Mean ± SD, n=60)													
	0500	0700	0700	0900	0900	1100	1100	1300	1300	1500	1500	1700	1700	1900
Nesting	55.0 ± 2.5	47.5 ± 2.5	41.3 ± 2.5	35.0 ± 2.5	26.5 ± 2.5	38.2 ± 2.5	52.2 ± 2.2							
Courtship	3.3 ± 0.5	12.0 ± 2.5	8.6 ± 0.3	5.6 ± 0.7	3.4 ± 0.6	2.1 ± 0.5	3.5 ± 0.1							
Agnostic	4.0 ± 1.5	8.1 ± 1.5	8.8 ± 1.4	7.4 ± 1.5	8.3 ± 1.0	8.0 ± 2.2	10.5 ± 4.5							
Alert	5.1 ± 2.5	5.4 ± 2.0	10.0 ± 2.5	15.6 ± 3.8	17.2 ± 2.5	10.3 ± 2.5	6.4 ± 3.3							
Resting	20.5 ± 4.1	6.3 ± 4.1	6.9 ± 4.2	10.0 ± 3.1	13.4 ± 4.1	18.3 ± 4.1	19.0 ± 4.7							
Flying	5.4 ± 0.1	8.7 ± 1.5	11.3 ± 0.4	7.4 ± 0.3	10.2 ± 0.1	8.2 ± 0.1	5.1 ± 0.1							
Out of sight	6.7 ± 0.5	12.0 ± 0.9	13.1 ± 1.8	19.0 ± 2.5	21.0 ± 1.6	14.9 ± 2.0	3.3 ± 0.9							
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0							

* Rest : Comfort, Preening, Stretching etc.

* Out of sight : Include feeding

(Flying) 09:00 11:00 가

(Nesting) 가

(Courtship) 17:00

(Agonistic) (Alert) (Resting)

07:00 09:00 (Table 39).

09:00 15:00 가

(Flying) 05:00 07:00 17:00 가

Table 39. Percentage of behavior pattern of *Nycticorax nycticorax* in breeding season

Behavior	Time (Mean ± SD, n=60)													
	0500	0700	0700	0900	0900	1100	1100	1300	1300	1500	1500	1700	1700	1900
Nesting	40.6 ± 2.5	39.0 ± 2.5	41.2 ± 12.4	37.1 ± 10.4	34.0 ± 11.2	35.5 ± 10.3	33.0 ± 11.0							
Courtship	3.3 ± 0.2	2.7 ± 2.5	1.5 ± 0.4	3.4 ± 1.7	3.6 ± 0.8	2.5 ± 0.4	5.7 ± 1.2							
Agonistic	4.5 ± 1.5	2.5 ± 0.5	8.3 ± 2.3	7.2 ± 2.1	8.3 ± 2.1	6.0 ± 1.5	10.4 ± 2.5							
Alert	2.3 ± 0.5	15.0 ± 2.0	8.7 ± 3.0	11.0 ± 3.4	12.4 ± 3.5	12.3 ± 5.4	4.3 ± 2.4							
Resting	3.2 ± 0.1	18.2 ± 5.1	23.0 ± 11.6	23.0 ± 6.5	25.0 ± 7.3	13.0 ± 3.7	2.5 ± 0.3							
Flying	39.4 ± 0.8	10.5 ± 1.5	2.3 ± 0.1	1.9 ± 0.4	2.5 ± 0.2	16.1 ± 4.2	26.0 ± 10.0							
Out of sight	8.7 ± 0.5	12.1 ± 0.9	15.0 ± 3.8	16.4 ± 5.0	14.2 ± 1.6	14.6 ± 6.1	18.1 ± 2.5							
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0							

* Rest : Comfort, Preening, Stretching etc.

* Out of sight : Include feeding

(*Carassius auratus*),
(*Cyprinus carpio*), (*Rana nigromaculata*) (*Monopterus*
albus) 100 g .

17- 20 가 17- 25%

(Table 40).

Table 40. Vomiting food materials at breeding site

Vomiting food materials	Weight (Mean ± SD)	Digestion rate	Age from Hatching (Day)
<i>Carassius auratus</i> (n= 15)	123.2 ± 12.5	> 25 %	<i>A. cinerea</i> : 20- 25
<i>Cyprinus carpio</i> (n=21)	141.5 ± 11.0	> 25 %	<i>E. intermedia</i> : 20- 25
<i>Monopterus albus</i> (n=3)	142.1 ± 15.7	> 30 %	<i>E. garzetta</i> : 17- 23
Frog sp. (n=32)	87.6 ± 5.8	> 20 %	<i>N.nycticorax</i> : 20- 25

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가 (*Ardea cinerea*)

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가 (*Ardea cinerea*)가

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Table 41. The Carrying Capacity of *Ardea cinerea* and *E.intermedia* at Survey area

Site	Species & Mean Number							
	<i>Ardea cinerea</i>				<i>E.intermedia</i>			
	A	B	C	D	A	B	C	D
Mokchon Myon,Chung Nam Prov.	3.5	75	3.2	840.0	3.1	60	3.1	576.0
HengAm Ri,Chung Nam Prov.	40.0	1	3.2	128.0	2	1	3.1	6.0
Daedeuk myon,Gyonggi Prov.	3.2	200	3.2	2048.0	2.5	150	3.1	1162.5
Jinuoe y myon,Gyonggi Prov.	3.0	65	3.2	624.0	2.5	35	3.1	271.0
JoungNam myon,Gyonggi Prov.	2.4	65	3.2	499.2				
SongJeul dong,Chung Puk Prov.	2.1	45	3.2	302.4	2.5	54	3.1	459.0
Choung Choun myon,Chung Puk Prov.	3.5	35	3.2	392.0	2.2	33	3.1	230.0
Jeuk Sung myon,Chung Puk Prov.	5.7	57	3.2	1039.7				
yong Pyong myon,KangWon Prov.	3.7	20	3.2	240.0	2.2	40	3.1	270.0
Kan Sung Eup,KangWon Prov.	4.7	52	3.2	782.1	4.3	52	3.1	693.2
Hoo Kok myon,KangWon Prov.	1.0	5	3.2	16.0	2.2	64	3.1	440.0
Dong Myon,KangWon Prov.	3.7	65	3.2	779.0	2.2	97	3.1	661.5
Seo myon,KangWon Prov.	3.7	20	3.2	236.0	2.2	20	3.1	136.4
JiJe Myon,Gyonggi Prov.	2.7	15	3.2	129.6	2.2	30	3.1	204.6
Kode Myon,Chung Nam Prov.	3.1	58	3.2	575.1	2.2	52	3.1	360.0
Dong Ryang myong,Chung Puk Prov.	3.4	50	3.2	544.0	3.5	200	3.1	2170.0
Sedo MyonChung Nam Prov.	2.7	15	3.2	129.6	2.3	75	3.1	534.8

* A : , B : 가 , C : , D : 가

Table 43. A comparisons of utility factor of artificial nest

Materials	Price(Won) (nest 10)	Working(day) (Worker=5)	Durability (Year)	Form	Preference
Wood	> 1,500,000	1- 2	3- 5	**	***
Iron	> 1,000,000	2- 3	5- 10	*	*
Artificial Wood	> 3,000,000	3- 5	10- 20	****	**

* : Common, ** : Good, *** : Better, **** : Best

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