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Ecological Diagnosis and Development of Ecological Management System of Urban Forest
− On Mt. Hwangryung in Pusan, Korea −

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도시림의 생태학적 진단과 생태적 관리시스템 개발
− 부산시 황령산을 중심으로 −

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ABSTRACT

The forest vegetation established on Mt. Hwangryung located in Pusan, southern Korea was analyzed through phytosociological procedure. Vegetation of the study area was categorized into 14 communities, 16 groups, and 13 subgroups. Vegetation units obtained from such an analysis were shown in a detailed vegetation map (scale 1:5,000). Ecological characteristics of each vegetation unit were discussed on the basis of the principle of restoration ecology. From those results, it was confirmed that some introduced vegetation under excessive artificial interference was in unstable state and then ecological restoration was needed. On the other hand, ecological information and management systems to maintain the urban forest as ecologically healthy state were developed using GIS.

Key words: Vegetation map, Vegetation landscape element, Ecological management, Landscape ecology, Restoration ecology

INTRODUCTION

Urban forest plays important roles in terms of protection of living environment of human and conservation of biodiversity as a basis of environment in urban area. But it can't play its ecological function in recent years due to quantitative reduction and qualitative degradation originated from severe environmental stresses and excessive artificial interference continued for a long time (Taoda 1979, Freedman 1986, Smith 1990, Miller 1997). The result leads to further aggravation of urban environment (Freedman 1986). Restoration to recover the diverse ecological functions of urban forest under such unfavorable circumstances is, therefore, needed urgently (Jordan Ⅲ *et al.* 1987, Lee 1996, Lee *et al.* 1998a). In this viewpoint, it is necessary to classify and to map actual vegetation of urban forest on the bases of ecological information, which they hold as a basis for ecological restoration.

Actual vegetation reflects not only characteristics of natural environment but also the past and present land-use patterns in a given area (Kamada and Nakagoshi 1996). Results of land-use are shown in distinct types, such as residential area, agricultural field, the area used for facilities, etc. and also in secondary effects induced from those uses as well (Lee *et al.* 1998a). That is, vegetation structure formed by characteristics of natural environment is changed by direct and indirect effects of human, and such changes are remarkable in urban area (Taoda 1979, Lee *et al.* 1998a).

Classifying vegetation and mapping the classified vegetation unit are indispensable subjects in clarifying the land-use pattern of the past and in preparing the plan to maintain vegetation as an ecologically healthy state in a given area. Landscape ecology, which plans to understand vegetation unit and manages it positively in a viewpoint different from classical plant sociology, is emerged as multidisciplinary science including the concepts of both natural and social sciences (Forman and Godron 1986, Golley 1987, Zonneveld and Forman 1990, Leser 1991, Naveh and Lieberman 1994, Zonneveld 1995). An ecological map including diverse ecological information is a fundamental tool for such study (Forman and Godron 1986, Küchler and Zonneveld 1988, Birks *et al.* 1988). Especially, classification and mapping of the actual vegetation are one of the fundamental requirements in landscape ecological approach, which is planning to create the ecologically healthy urban ecosystem (Hong and Lee 1997).

The aim of this study is (1) to classify the vegetation unit established on Mt. Hwangryung located at the center of Pusan, (2) to map the classified vegetation units, (3) to interpret each vegetation unit depicted as a map on the basis of restoration ecological principles, and (4) to develop the ecological information and management systems to maintain the urban forest as an ecologically healthy one.

STUDY AREA

The study area was chosen on Mt. Hwangryung located at the center of Pusan, southern Korea. Mt. Hwangryung is remained as a form of Green Island, in which ecological buffer zone is lost and its surrounding area is urbanized. It lies at longitude 129° 05′E and latitude 35°10′N and attains a height of 427.9m at elevation (Fig. 1). Dimension of the study area is about 950 ha. Its climate is oceanic type, with mean annual temperature of 14.1℃ and mean annual precipitation of 1,472.7mm (Korea Meteorological Administration 1990).

Vegetation in this study area is mainly composed of plantations and secondary forests, which have been strongly influenced by human activities. *Alnus firma, Pinus thunbergii*, and *Quercus serrata* communities are representative vegetation types. Most of the understory vegetation is comprised of species appearing frequently at initial stages of succession. On the other hand, evergreen plants also rarely appeared because the study area is located within the boundary of warm temperate forest.

METHODS

Vegetation survey was carried out from April 1996 to July 1997 by phytosociological method (Braun-Blanquet 1964, Mueller-Dombois 1974). 483 plots were selected subjectively for vegetation survey. Classification of vegetation units was accomplished by phytosociological procedures (Braun-Blanquet 1964, Mueller-Dombois 1974). Community, upper unit, was classified by physiognomic characteristics of dominant species, and group or subgroup, lower units, were by species composition. By analyzing aerial photograph accompanied with field survey was made a detailed vegetation map at a scale of 1:5,000. In the vegetation map, boundaries of upper vegetation units at community level were identified by analyzing aerial photographs and those of lower units by dominant or differential species of each unit.

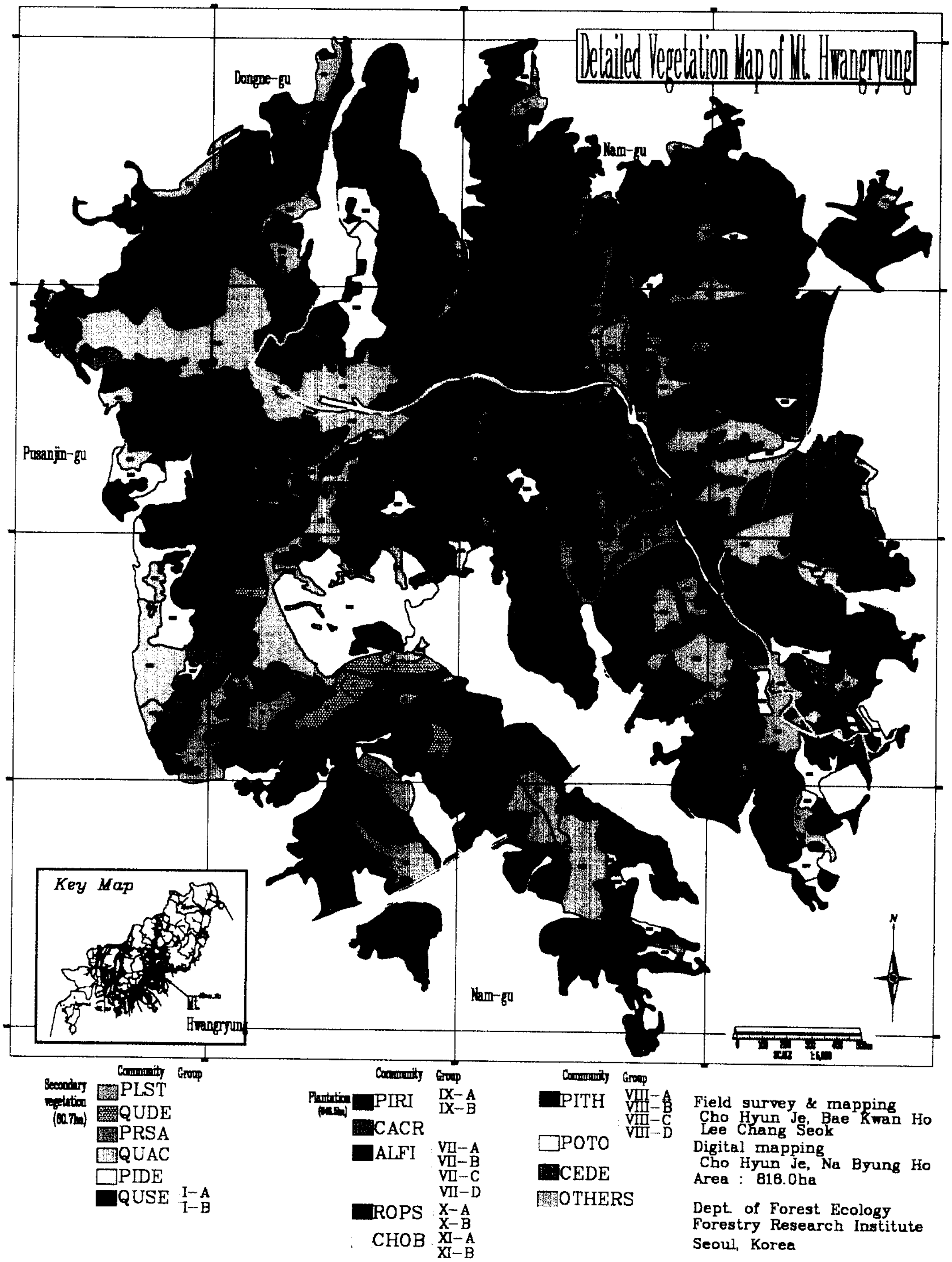

Fig. 1. A detailed vegetation map of Mt. Hwangryung in Pusan city, Korea.
(PLST *Platycarya strobilacea*, QUDE *Quercus dentata*, PRSA *Prunus sargentii*, QUAC *Quercus acutissima*, PIDE *Pinus densiflora*, QUSE *Quercus serrata*, PIRI *Pinus rigida*, CACR *Castanea crenata*, ALFI *Alnus firma*, ROPS *Robinia pseudoacacia*, CHOB *Chamaecyparis obtusa*, PITH *P. thunbergii*, POTO *Populus tomentiglandulosa*, CEDE *Cedrus deodara*, OTHERS facilities, road, etc.; I-A, I-B, VII-A, VII-B, VII-C, VII-D, VIII-A, VIII-B, VIII-C, VIII-D, IX-A, IX-B, X-A, X-B, XI-A and XI-B refer to table 1).

RESULTS AND DISCUSSION

Classification of vegetation units

Vegetation data collected in this study area were shown in Table 1. Forest vegetation of Mt. Hwangryung was divided into secondary forest and plantation. The former is composed of *Quercus serrata*, *Q. dentata*, *Platycarya strobilacea*, *Q. acutissima*, *Prunus sargentii*, and *Pinus densiflora* communities and the latter include *Alnus firma*, *P. thunbergii*, *P. rigida*, *Robinia pseudoacacia*, *Chamaecyparis obtusa*, *Castanea crenata*, *Populus tomentiglandulosa*, and *Cedrus deodara* communities.

6 communities of *Quercus serrata*, *Alnus firma*, *P. thunbergii*, *P. rigida*, *Robinia pseudoacacia*, and *Chamaecyparis obtusa* communities among those 14 communities were subdivided into group and/or subgroup as the followings: *Quercus serrata* community {*Disporum smilacinum* and typical groups}, *Alnus firma* community {*Stephanandra incisa* (*Athyrium yokoscence-Fraxinus sieboldiana*, *Athyrium yokoscence-Lespedeza maximowiczii*, and Typical subgroups), *Phytolacca americana* (*Q. dentata* and typical subgroups), *D. smilacinum-Q. mongolica*, and typical groups}, *P. thunbergii community* {*Stephanandra incisa* (*Styrax japonica* and typical subgroups) *Robinia pseudoacacia*, *Rhododendron schlippenbachii* (*R. mucronulatum* and Typical subgroups) and typical groups, and *P. rigida* community {*Q. dentata* (*Spodiopogon sibiricus* and typical subgroups)and typical groups}, *Robinia pseudoacacia* community {*Stephanandra incisa* (*Styrax japonica-Q. serrata*, *Ambrosia artemisiifolia* var. *elatior* subgroup) and Typical groups}, *Chamaecyparis obtusa* community {*R. yedoense var. poukhanense-Lindera erythrocarpa* and Typical groups}.

Above mentioned vegetation units were depicted in the vegetation map by identifying their boundaries from distribution range of differential and dominant species classifying them (Fig. 1).

Ecological characteristics of vegetation units

Ecological characteristics of each vegetation unit identified in the present study area are as the followings.

Quercus serrata community (QUSE, 22plots)

This community is partially distributed throughout the study area but is concentrated around the Maha temple being conserved as temple forest. In terms of topography, it is developed on the lower to middle parts of the gentle slope of northern aspect. Dimensions of this community are 22.2ha (2.7%). Total number of species appeared in this community was 85 and the number of species per unit area (100 m^2) was 17. Stratification this community is composed of 4 layers and mean height and DBH of trees consisting this community were 11±3m and 26±7cm, respectively. 3 exotic plants appeared but no evergreen plants appeared in this community.

On the other hand, any species, which will be successors of this community, were not found in this community. We, therefore, deduced that this community could be maintained continuously in the present location, in fact, this is recognized as potential natural vegetation in this area (Kim 1993).

Quercus dentata community (QUDE, 7plots)

This community is distributed on the relatively steep slope of southern aspect, especially on burned area. Dimensions of this community are 7.1 ha (0.9%). Total number of species appeared in this community was 43 and the number of species per unit area (100m^2) was 14. Stratification of this community is very simple as 2 layers. Mean height and DBH of trees consisting this community were 4±2 m and 9±4cm, respectively. 2 exotic plants appeared but no evergreen plants appeared in this community. In terms of succession, this is a pioneer community, which was established after the previous vegetation was lost by fire. A number of *Q. serrata* seedlings and/or saplings were established on the forest floor of this community. From those results, we could expect that succession will lead to *Q. serrata* community.

Platycarya strobilacea community (PLST, 5plots)

This community is developed on the lower parts of the gentle slope on the northern aspect or on the stony sites near the valley. Dimension of this community is 9.6ha (1.2%). Total number of species appeared in this community was 87 and the number of species per unit area (100m^2) was 20. Stratification this community is consisted of 3 or 4 layers depending on sites. Mean height and DBH of trees composing this community were 10±3 m and 16±3 cm, respectively. 2 exotic and 1 evergreen plants appeared in this community. In terms of succession, this community seems to be maintained by itself for the time being because competition with the other species is mild owing to habitat characteristics of stony site. But eventually, iN would be replaced by *Q. serrata* community, which appears frequently below the subtree layer.

Quercus acutissima community (QUAC, 12plots)

This community is developed on the gentle slope of the southern aspect. Dimension of this community is 17.3ha (2.1%). Total number of species appeared in this community was 65 and the number of species per unit area (100m^2) was 16. Stratification of this community is consisted of 3 layers. Mean height and DBH of trees composing this community were 9±3 m and 11±2 cm, respectively. 2 exotic and 4 evergreen plants appeared in this community. In terms of succession, this community is not in severe competitive relationship with other species. But seedlings and/or saplings of *Q. acutissima* were hardly found, while frequency of those of *Q. serrata* was high in the forest floor of this community. From this result, it could be expected that *Q. serrata* community would replace this community.

This community is mainly distributed around the human settlement, forest edge, and hiking trails as a typical secondary forest, which is closely related to artificial interference. That is, this community occurs as an important landscape element in landscape pattern native to Korea by developing in a form of village forest in many regions of the Korean peninsula (Lee *et al.* 1998a).

Prunus sargentii community (PRSA, plots)

This community is distributed at the lower part on the gentle slope of western aspect and at forest edge. Dimension of this community is 4.0ha (0.5%). Total number of species appeared in this community was 51 and the number of species per unit area (100 m^2) was 23. Stratification of this community is consisted of 3 or 4 layers depending on sites. Mean height and DBH of trees composing this community were 10±3 m and 14±1 cm, respectively. 1 exotic and 2 evergreen plants appeared in this community. In a viewpoint of succession, it was expected that *Q. serrata* community, which showed high frequency in layers below sub-tree, would replace this community. Considering that *Prunus sargentii* community is hardly found in ecologically healthy sites, it can be interpreted that occurrence of this community is related to the excessive artificial interferences. In fact, Lee *et al.* (1988b) interpreted that occurrence of this community in Mt. Nam, Seoul was originated from environmental stress related to excessive artificial interference.

Pinus densiflora community (PIDE, plots)

This community is mainly distributed on the ridge part of southeastern slope and around the bare rock of upper part of the slope. Dimension of this community is 0.6 ha (0.1%). The number of species that appeared in this community was 12. Stratification of this community is consisted of 3 layers. Mean height and DBH of trees composing this community were 8±1 m and 8±2 cm, respectively. No evergreen or

Table 1. Floristic composition of forest vegetation in Mt. Hwangryung, Pusan

Secondary forest(natural)
I. *Quercus serrata* community
I-A. *Disporum smilacinum* group
I-B. Typical group
II. *Q. dentata* co.
III. *Platycarya strobilacea* co.
IV. *Q. acutissima* co.
V. *Prunus sargentii* co.
VI. *Pinus densiflora* co.

Plantation
VII. *Alnus firma* plantation
VII-A. *Stephanandra incisa* gr.
VII-A-1. *Athyrium lanceolata* subgroup
VII-A-2. *A. lanceolata-L. maximowiczii* subgr.
VII-A-3. Typical subgr.
VII-B. *Phytolacca americana* gr.
VII-B-1. *Q. dentata* subgr.
VII-B-2. Typical subgr.
VII-C. *Disporum smilacinum-Q. mongolica* gr.
VII-D. Typical gr.

VIII. *Pinus thunbergii* pl.
VIII-A. *Stephanandra incisa* gr.
VIII-A-1. *Styrax japonica* subgr.
VIII-A-2. Typical subgr.
VIII-B. *Robinia pseudoacacia* gr.
VIII-C. *R. schlippenbachii* gr.
VIII-C-1. *R. mucronulatum* subgr.
VIII-A-2. Typical subgr.
VIII-D. Typical gr.

IX. *Pinus rigida* pl.
IX-A. *Q. dentata* gr.
IX-A-1. *Spodiopogon sibircus* subgr.
IX-A-2. Typical subgr.
IX-B. Typical gr.
X. *Robinia pseudoacacia* pl.
X-A. Stephanandra incisa gr.
X-A-1. *S. japonica-Q. serrata* subgr.
X-A-2. Typical subgr.
X-B. Typical gr.

X I. *Chamaecyparis outusa* pl.
X I-A. *R. yedoense var. poukhanense-Lindera erythrocarpa* gr.
X I-B. Typical gr.
X II. *Castanea crenata* pl.
X III. *Populus tomentiglandulosa* pl.
X IV. *Cedrus deodara* pl.

	Secondary forest(natural)							Plantation																							
Vegetation units	I		II	III	IV	V	VI	VII							VIII						IX			X			X I		X II	X III	X IV
	A	B						A			B		C	D	A		B	C		D	A		B	A		B	A	B			
								1	2	3	1	2			1	2		1	2		1	2		1	2						
Dominant community	QUSE	QUSE	QUDE	PLST	QUAC	PRSA	PIDE	ALFI	ALFI	ALFI	ALFI	ALFI	ALFI	ALFI	PITH	PITH	PITH	PITH	PITH	PITH	PIRI	PIRI	PIRI	ROPS	ROPS	ROPS	CHOB	CHOB	CACR	POTO	CEDE
Distribution area(m²)	15.8	6.4	7.1	9.6	17.3	4	0.6	2.1	13.2	41.4	70.2	38.5	16.9	67.5	12.9	34.3	8.9	31.9	25.6	14.2	10.5	9.2	0.8	17.6	16	18.7	10.7	3.1	2.1	3.7	1.4
Average no. of species	13	21	14	20	19	23	12	24	22	15	20	21	20	12	20	22	10	19	14	14	21	18	16	22	13	9	13	12	25	20	10
Total no. of species	71	50	43	87	65	51	12	62	67	83	99	94	50	81	56	111	44	72	66	96	62	74	67	52	78	44	42	38	54	43	10
No. of evergreen trees				1	4	1						2		2	1	1	-	1	-	5	3	1	-	1	-	-	2	1	-	4	-
No. of naturalized plants	-	3	2	2	2	2	-	3	2	2	1	1	-	1	1	3	1	1	2	3	4	3	2	2	6	5	1	1	1	2	2
No. of releves	14	8	7	5	12	3	1	11	12	17	19	21	8	33	8	15	8	13	10	61	6	6	2	15	20	22	6	16	3	5	1
1 *Alnus firma*	III12	II1	II+	II13	IV13	21		V45	V45	V45	V35	V45	V45	V35	III+1	III+2	III12	II12	IV12	II1	IV12	III12	212				II12			III+1	
Pinus thunbergii	III12		V13	V12	IV12	11		II1	IV1	II1	IV13	II12		IV13	V45	V35	V45	V45	V45	V35	IV12	III1	21	III12	II2	III13			31	II+	
Quercus serrata	V35	V35	III+1	V13	III1	2+	21	V13	IV14	III12	IV+2	IV13	V+3	IV13	V+2	IV+3	III+2	V13	V+3	IV+3	II+	II+	1+	III12		II+3		II1	212	III+2	
2 *Carex lanceolata*	IV15							IV13	IV+3	II14		III13	V12									II+				II+1	II+		213	II1	
Athyrium yokoscense	V+2				II+1	2+		III+3	IV+2	II12		II+1	IV14		II+	II+	II+	II+1						III+2					1+		
Lespedeza maximowiczii	IV1						11	II+	V+2				III+								II+1			II+					2+		
Disporum smilacinum	IV13							IV12	III+1				V12																2+1		
Q. mongolica	III12							III+3		II+2			IV13																		
3 *Q. dentata*	II1		V34	III+1	II+	2+					V+3			II+1	III+2	IV+2	II+1	III12	II13	III+2	V12	III12		II+			II+		1+	III+1	
4 *Platycarya strobilacea*				V35		11		II+1	II1	II15	II+2	III1			III12	II12		III+2	II+1			II+1								IV+1	
Ligstrum obtusifolium	II+1			IV+2		1+			III+1	II+1	III+1		III+1			II+2					II+			III+1	II+	II+2			1+		
Pueraria thunbergiana			II+4	III+2	II13									II+	II+		II+				II+	II+	1+		III+1		II+			II1	
5 *Q. acutissima*					V35	1+		II+2		II1								II+1						II12				II12			
6 *Prunus sargentii*	II12	III+				345		III+1	II1	II+1	II+1	III+1		II+2	III+1		II1				II+										
7 *Pinus densiflora*							245	II1										III13													
8 *Stephanandra incisa*	IV14			V13	II+2	223		V15	V14	V14					V13	V13			II+		III14			V25	V+2		II+2		313	II1	
9 *Phytolacca americana*						1+					V13	V+2				III+1		II+		II+1	II+	II+	1+			II+1			1+	III+1	
Rubus crataegifolius						1+			II+		III+1	III+1		II+1		II+1						II+			II+1			II+1		III+1	
Miscanthus sinensis var. *purpurascens*			V13	II13	III13	11	11				III+1	III+1		II+2	III+1	IV+3	II1	V+2	II+1	II+1	V14	IV13	213	III1	V13	II+4	II+	III+3		V+1	
Dioscorea japonica	II+			II+1	II+	1+					III+	III+				IV+			II+	II+					II+			II+	2+	II+	1+
10 *Fraxinus sieboldiana*	II12					1+		V13					III+3																		

Table 1. Continued

Vegetation units	I		II	III	IV	V	VI	VII							VIII						IX			X			XI		XII	XIII	XIV
	A	B						A			B		C	D	A		B	C		D	A		B	A		B	A	B			
								1	2	3	1	2									1	2		1	2						
11 *Rhododendron schlippenbachii*	II+1		II+					II+2	III13			II13	III13					V13	V+4												
12 *R. mucronulatum*	II+2		II+2				2+	III+1	IV+2			II15	IV+					V+3				II+							1+		
Corylus heterophylla var. *thunbergii*	II1		II+2	III+1		1+		III+1	II+	II+1	II+1				III+1	II+													1+		
13 *Pinus rigida*						11									II1						V25	V45	245	II+3							
14 *Spodiopogon sibiricus*	II+1		II+1	II+	III13	31	22	III1	III12	II+1	II+1	III+1	III+	II+2	IV+1	V+1	II+1	IV+2	II+1	II+1	V12			III12	II12				2+	II+	
Indigofera kirilowii	II+		II1	II+		11	1+	II+							III+1	II+1		IV+1	II+1		IV+2		1+						1+		
Rubus parvifolius											II+										IV+2	II+			V+2	II12				II1	+
Rosa wichuraiana		II+	II+	II+2		1+					II+1					II+		II+	II+1	II+	III+2	II+			II+1	II+			2+	III+1	
15 *Robinia pseudoacacia*					II1	21		II+1	II1	III1	II12	III13		III+3	III13		V12				II+2			V35	V35	V35				II1	
16 *Styrax japonica*	II+2				II13			II+1	II+4		II13	II13	II+1	II+2	V13		II13				II12		112	VI12					12		
Ambrosia artemisiifolia var. *elatior*																									III+						
17 *Chamaecyparis obtusa*														III5													V45	V45	11		
18 *R. yedoense* var. *poukhanense*	II+		IV13	II+	II+2			II1	III13	II+	III+4	II1	III13	II+2	III+1	IV+4	II+2	IV+2	IV+3	III+3	II+1	III1	II+			II+1	IV+2		3+1		
Lindera erythrocarpa	II+			II+1				II+1			II+1	II+1													II1		V+1				
19 *Castanea crenata*																				12									345		
20 *Populus tomentiglandulosa*																														V34	
21 *Cedrus deodara*																															15
22 *Oplismenus undulatifolius*	II1			II+2	II13	11	21	V12	IV+3	IV13	V14	V13	V14	III13	III13	III+2	III1	II12	III+3	IV+3	II12	III+2	2+	VI13	II+		II+	III+	12	IV23	
Smilax china		II1		III+1	IV13	2+1		IV+1	II+1	II+1	IV+1	IV+1	II+	III+1	V+1	IV+1	III+	IV12	IV+2	IV+2	II+1	III+2	1+1	III+1	II1		III+1	III+	3+1	III+1	
Rhus trichocarpa	III+1	II+			II+1	1+	11	V12	IV+1	II+2		III+1	IV13	II+1	III+	III+	II+1	III+1	III+2	III+2	II+			II+1				II+	1+		
Paederia scandens	II+			III+	II+	3+1		III+	IV+1	II+5	IV+2	V+1		II+2	II+1	III+1	II+1	III+	III+2	II+2	II+1	III+	1+	III+1	II+1	II+1	II+		1+	II+	1+
Commelina communis						1+				II+1	III+1	III+1										II+			III+	II+	II+			II+	1+
Parthenocissus tricuspidata	II+			II+1		1+		II+	II+1			II+2				II+1				II+2	II+3						II+	II+	1+		
Vitis thunbergii var. *sinuata*				II+							II+1					II+1						II					III+1		1+		1+
Smilax sieboldii	II+					1+		II+	IV+	II+			V+			II+					II+								1+		
Artemisia keiskeana				II+				III+1	II+		II+							II+1											1+		
Ampelopsis brevipedunculata			II+			2+					II+1					II+1					III+										
Lysimachia clethroides						11									II+5																
Symplocos chinensis for. *pilosa*						11		II+									II12												1+		
Celastrus orbiculatus				II+		1+										II+					II+1		1+						1+		
Coculus trilobus	II+							II+1							II+	II+1					III+	II+							1+		
Persicaria perfoliata										II+1		II+2									II+	II+	1+								
Persicaria filiforme								II+1					III+																		
Lespedeza maritima			III12		I 1													II+	II+										1+	II+	

Note : constancy class I and 106 species omitted exotic plants appeared in this community. *P. densiflora* established on the outcrop of the ridge part is recognized as an edaphic climax (Lee 1995a, b) but *P. densiflora* community of this area would be succeed by *Q. serrata* rather than be maintained as edaphic climax considering the characteristics of habitat with comparatively deep soil and the species composition.

Alnus firma community (ALFI, 121 plots)

This community is distributed evenly on the slope of all aspects but distribution area was larger on the northern slope than that on the other slopes. Slope degree of distribution area was relatively gentle as 24° on the average. Dimension of this community is 268.8ha (32.9%). Total number of species appeared in this community was 169 and the number of species per unit area (100m^2) was 19. Stratification of this community is consisted of 4 layers. Mean height and DBH of trees composing this community were 11±3 m and 25±5 cm, respectively. 2 evergreen and 4 exotic plants appeared in this community. *A. firma* is an early successional species origin ated from Japan introduced in 1960's when tree-planting project of the national land had proceeded actively as the representative afforested tree in the southern region of Korea. Many dead trees were found in this community because most trees, which had planted in 1960's, have done their ecological longevity and then this community is in degenerating phase at present. A number of plant species comprising *Q. serrata* and/or *Q. mongolica* community recognized as potential natural vegetation of this area were established in the lower layer and forest floor of non-disturbed stands as well as in gap occurred by death of trees. As it were, this community maintains species composition similar to natural vegetation. Especially stands classified as *Disporum smilacinum-Q. mongolica* group seem to be succeeded by *Q. mongolica* community in the near future (refer to Table 1).

Pinus thunbergii community (PITH, 115 plots)

This community is distributed on the gentle slope of southern aspect facing the sea. Most trees were planted, but large trees, which were naturally established in the past, often appeared. Dimension of this community is 255.9ha (31.4%). Total number of species appeared in this community was 111 and the number of species per unit area (100 m^2) was 20. Stratification of this community is consisted of 3 or 4 layers depending on sites. Mean height and DBH of trees composing this community were 9±2 m and 13±4 cm, respectively. 6 evergreen and 4 exotic plants appeared in this community. *Q. dentata, Miscanthus sinensis* var. *purpurascens, Smilax china, Rhododendron yedoense* var. *poukhanense, Rosa wichuraia, etc.* are frequently found in the understory of this community. Such results reflect that it is in the initial stage of recovery after disturbance by fire.

Pinus rigida community (PIRI, 14 plots)

This community is distributed on the relatively steep slope of southern aspect. Dimension of this community is 20.6ha (2.5%). Total number of species appeared in this community was 85 and the number of species per unit area (100m^2) was 8. Stratification of this community is consisted of 3 layers. Mean height and DBH of trees composing this community were 6±1m and 11±3cm, respectively. 4 evergreen and 5 exotic plants appeared in this community. This community, as an introduced vegetation in fire-disturbed area, has *Miscanthus sinensis* var. *purpurascens* with particularly high coverage in forest floor. Because this community is at an early stage of establishment after introduction, it is difficult to predict the succession tendency. But succession by *Q. serreta* community could be expected considering that it is located below mid-slope and has *Q. serrata* seedlings and/or saplings of a relatively high frequency in forest floor.

Robinia pseudoacacia community (ROPS, 57 plots)

This community is distributed on the lower part of southern slope. Dimension of this community is 52.3ha (6.4%). Total number of species appeared in this community was 106 and the number of species per unit area (100 m^2) was 15. Stratification of this community is consisted of 3 layers. Mean height and DBH of trees composing this community were 12 ± 3 m and 21 ± 5 cm, respectively. 2 evergreen and 6 exotic plants appeared in this community. There were many trees, which have done their ecological longevity in this community as the same as the case of *A. firma* community. This community is under excessive artificial interference because habitat is located closely to the residential area. Therefore, *Stephanadra incisa, Oplismenus undulatifolius, Paederia scandens, Ambrosia artemisiifolia, Phytolacca americana*, and so on, which frequently appear at the sites disturbed by excessive artificial interference, are flourishing in the forest floor of this community, and they inhibit the establishment of native vegetation. *R. pseudoacacia* community under the relatively mild artificial interference, however, showed a possibility to be restored to the native vegetation (Lee *et al.* 1998a). As a restoration plan to recover the naturalness of this site, mitigation of artificial interference is, therefore, preferentially required.

Chamaecyparis obtusa community (CHOB, 22plots)

This community is planted on the middle and upper parts of southern slope. Dimensions of this community are 41.7ha (5.1%). Total number of species appeared in this community was 42 and the number of species per unit area (100 m^2) was 13. Stratification of this community showed simple structure of 2 or 3 layers. Mean height and DBH of trees composing this community were 7 ± 2 m and 10 ± 3 cm, respectively. 2 evergreen and 1 exotic plants appeared in this community. Succession tendency of this community could not be predicted because undergrowth has been removed periodically for protection of fire.

Castanea crenata community (CACR, 3 plots)

This community is planted on the gentle slope nearby residential area or small temple. Dimension of this community is 2.1ha (0.3%). Total number of species appeared in this community was 54 and the number of species per unit area (100 m^2) was 25. Stratification of this community showed simple structure of 3 layers. Mean height and DBH of trees composing this community were 11 ± 4 m and 13 ± 2 cm, respectively. Evergreen plant did not appear and only 1 exotic plant appeared in this community. In terms of succession, this community would be replaced by *Q. serrata* with high frequency in strata below sub-tree.

Populus tomentiglandulosa community (POTO, 5 plots)

This community was planted on the lower parts of the slope near by valley. Dimension of this community is 3.7ha (0.5%). 43 species were found in this community and the number of species per unit area (100 m^2) was 20. Stratification of this community is composed of 3 layers. Mean height and DBH of trees composing this community were 9 ± 1 m and 14 ± 3 cm, respectively. 4 evergreen and 2 exotic plants appeared in this community. Dead trees, which have done their ecological longevity, were often found in this community. From this fact, it was expected that this community would be replaced by the other community in the near future but any species capable of replacing this community could not be found owing to the excessive artificial interference.

Cedrus deodara community (CEDE, 1 plot)

This community is planted around the road on the lower parts of the slope and its area is 1.4ha (0.2%).

10 species appeared in this community. Stratification of this community showed simple structure of 2 layers. Height and DBH of trees composing this community were 11±2 m and 15±5 cm, respectively. Only 1 exotic plant appeared but no evergreen plants were found in this community.

Ecological management system of urban forest

Ecological information and management system of urban forest was developed using GIS. It is divided into integrated ecological inventories, ecological management units, and information and management systems.

The integrated ecological inventories include elevation, slope, aspect, geology, vegetation, etc. The ecological management units were developed by integrating topography, microclimate, soil, and vegetation. A vegetation map was developed by classifying communities and sub-communities. The ecological management system is consisted of data query, data print, data management, data analysis, and other modules. In the data query module, we can query graphic and attribute data with simple or compound conditions from the database established. In the data printing modules, we can print maps and attribute data after office report forms on a paper. In the data management module, we can add, delete, and change graphic and attribute data. In this module we can classify and control users for data security. In the data analysis module, we can measure distance and area, set buffers, and perform suitability analysis, and topographic analysis such as slope, aspect, elevation, etc.

적 요

부산시 황령산의 삼림식생을 식물사회학적 방법으로 분석하였다. 이 지역의 식생은 14개 군락, 16개 군 및 13개 아군으로 구분되었다. 그러한 분석으로부터 얻은 식생단위를 축척 1:5,000의 식생도로 나타내었다. 각 식생단위의 생태적 특성이 복원생태학적 원리를 바탕으로 검토되었다. 그러한 결과로부터 과도한 인간간섭의 영향을 받고 있는 몇몇 도입식생이 생태적으로 불안정하여 그 복원이 필요한 것으로 판단되었다. 한편, 도시림을 생태적으로 건전하게 유지하기 위한 생태정보 및 생태적 관리시스템이 GIS기법을 이용하여 개발되었다.

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