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The Relation of the Species Number of Bird to the Urban Biotope Area in Seoul[1a]

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서울의 도시 비오톱에서 면적과 조류의 종수와의 관계[1*]

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ABSTRACT

This study is conducted to investigate number of species in various habitat size in the area of urban biotope in Seoul from October to November in 2001 and from May to June in 2002. It is established that habitat size does not significantly affect the number of species in urban biotope. Thirty-two bird species were observed in 54 sites. Thirteen species of birds used sites of up to 1ha, 29 species from 1 to 10 ha, and 8 species in the sites larger than 10ha. We find that most of species appeared in size (1-10ha), rather than in size (<1ha, >10ha). The cumulative number of species for a given cumulative area was consistently higher when small sites were added first. We think that this habitat size is the actual area to promote number of species within the urban area. Also, there was significant increase of number of species at biotope with water source and multiple vegetation structure. Therefore, if water resources and multiple vegetation structure is maintained, even small area can be helpful to the bird species promotion.

KEY WORDS : URBAN AREA, HABITAT SIZE

요 약

본 연구는 서울 도시 비오톱(n=54)을 대상으로 서식지 면적에 따른 조류 종수를 파악하고자 2001년 가을과 2002년 봄에 실시하였다. 도시 비오톱을 대상으로 조사한 조류종수의 연구에서 비오톱 면적의 크기가 조류종수에 뚜렷한 영향을 미치지 않는다고 생각되어진다. 전체 대상지에서 32종의 조류가 관찰되었으며 1ha미만에서는 13종, 1-10ha에서는 29종, 10ha이상의 면적에서는 8종의 조류가 나타났다. 비오톱 면적 크기에 따른 조류종수의 증가에 관한 연구에서, 면적의 크기가1-10ha인 대상지가 <1ha 이거나, > 10ha인 대상지보다 더욱 많은 조류가 관찰되었다. 또한, 종-면적 축적곡선에서는 작은 면적의 서식지가 추가되어졌을 때 종수의 증가율이 지속적으로 높아졌다. 이에 도시 지역에서 조류 종수의 증가를 위해 필요한 최소면적은 1-10ha가 효과적일 것이라 생각된다. 또한, 수자원과 다양한 식생구조를 가진 비오톱에서 조류종의 뚜렷한 증가를 보였다. 따라서 이러한 환경의 조성은 작은 면적의 서식

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지도 조류종의증가에 도움이 될 수 있을 것이다.

주요어 : 도시지역, 서식지 크기

INTRODUCTION

Most of the earlier research directed towards determining the habitat needs of various birds has centered on 'natural' communities, while urban ecosystems have largely been ignored. However, with the rapid expansion of urban development, the importance of understanding the relationship between wildlife and urban habitats is evident (Jokimki and Suhonen, 1998). Studies surveying multiple sites within urban areas (e.g. Mills *et al.*, 1989; Jokimki and Suhonen, 1998) demonstrate variation in the capacity of different developed sites to support bird populations. This suggests that we have the opportunity to design urban landscapes better able to sustain birds than those we live in now.

Decisions are made by a variety of players that impact the landscape from limited scales (e.g. homeowners) to broad scales (e.g. city planners). Each of these decisions has the potential to affect different species of animals in urban environments, depending on the scale at which a species responds to landscape structure (Kotliar and Wiens, 1990; Holling, 1992; Hostetler, 1999; Hostetler and Holling, 2000). Overall, the end result of human decisions creates a heterogeneous urban landscape, where certain area may or may not be attractive to wildlife species.

In terms of habitat size, the value of large ecological reserves and large patches is well accepted, but more work is needed on the value of intermediate-sized reserves and patches (Zuidema *et al.*, 1996), small area habitat features (Semlitsch and Bodie, 1998; Gilfedder and Kirkpatrick, 1998). Such information is critical for the development of effective and realistic conservation and ecosystem restoration strategies in highly modified landscapes (Fischer and Lindenmayer, 2002).

This study is conducted to investigate number of species with various habitat size in the area of urban biotope in Seoul, Korea. A goal of this study is to survey 1) the relationship between area and bird species in metropolitan area, 2) the realistic and effective restoration method of existing habitats and establishment of new habitats.

MATERIALS AND METHODS

1. Study site

The study area, Seoul in Korea, has been heavily affected by urbanization. This is especially evident in Seoul, the nation' s densely populated capital: 10.2 million people residing the area of within roughly 605㎢. Many efforts have been made in recent years to protect the landscape from further deterioration, including establishing the Urban Landscape Management Plan of Seoul (Oh, 2001). Seoul city has land use map similar to most others metropolitan areas (Figure 1). Biotope materialization is made of land use, map of impermeable pavement ratio, present vegetation data attained through field survey. Because of the feature of urban space, the present land use with human activity is the principle of axis of biotope materiality division.

In detail, it is divided into Residential Area Biotope, Commercial or Business Area Biotope, Industrial or Urban Infrastructure Facilities Area Biotope, Transportation Facilities Biotope, Landscape or Green Area Biotope, Stream or Wetland Biotope, Farmland Biotope, Forest Biotope and Unused Area Biotope. In this map the word "biotope" is synonymous with the word "habitat", and is defined as any demarcated area in which animals and plants can live, and thus primarily represents different land-use classes.

For this paper, we randomly selected sites (n=54) with different areas of Seoul urban biotopes and surveyed bird species (Table 1).

2. Bird data

Birds were surveyed using a single-visit study plot method. A survey plot did not consist of a single route in a plot, but rather a zigzag walk through the plot. Thus we also inspected the backyards of the houses and buildings. This kind of transect count reduces many problems associated with counting birds in urban areas, such as varying noise and visibility (DeGraaf *et al.*, 1991).

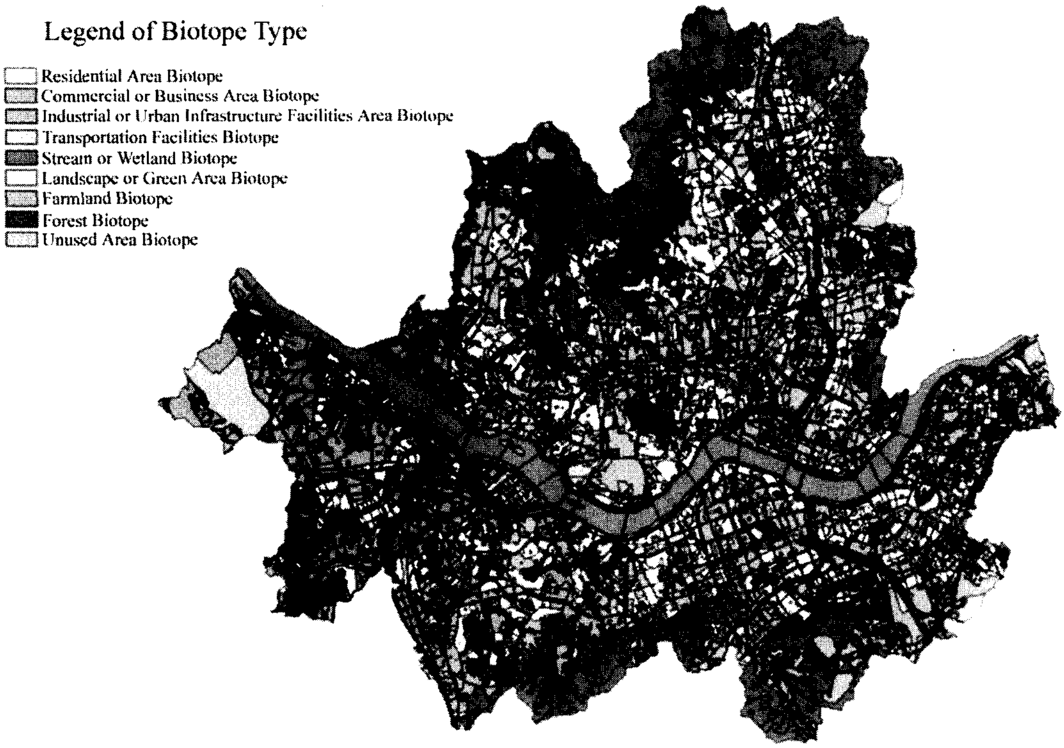

Figure 1. Present biotope map of Seoul

Surveys were not conducted during rainy or extremely windy conditions (greater than 20 mph). To include the fall and spring migration seasons, Birds were surveyed twice in each site with this method from October to November in 2001 and from May to June in 2002. All surveys were conducted within 4 h after sunrise.

3. Data analysis

Cumulative species-area curves were used to assess the contribution that small patches made to species richness. Patch areas were first ordered from large to small, and values for cumulative area and cumulative number of species were calculated: for comparison, the analysis was repeated with patches ordered from small to large (Quinn and Harrison, 1988). To assess whether the contribution of small patches to species richness was caused only by certain species, we repeated all analyses after the exclusion of waterbirds.

For analyzing the change of occurrence rates with the area of biotope, the areas were divided into three subareas (<1, 1-10, >10 ha). The occurrence rate of each species was obtained by dividing the number of sites present by the total number of sites in each subarea.

RESULTS

Thirty-two bird species were observed in 54 sites. Thirteen species of birds used sites of up to 1ha, 29 species from 1 to 10 ha, and 8 species in the sites larger than 10ha (Table 2).

Eighteen species of birds were observed only in the sites (1-10ha). When waterbirds were excluded, the total number of remaining species was 23. Ten of these species were found only in sites (1-10ha).

The cumulative number of species for a given cumulative area was consistently higher when small sites were added first (Figure 2). In the cumulative species-area curves, number of species was increased in the full set more than the restricted set excluded waterbirds. Also, the sharp increase in Figure 3 appeared that there

Table 1. The number of bird species in urban biotope

No.	Biotope pattern*	No. of species**	Area(ha)
1	FLB	3	0.15
2	FRB	5	0.18
3	FRB	6	0.19
4	LGB	3	0.19
5	SWB	0	0.23
6	UAB	0	0.23
7	SWB	0	0.24
8	FLB	3	0.29
9	IUB	1	0.34
10	FRB	3	0.35
11	RAB	1	0.41
12	UAB	4	0.45
13	FLB	4	0.46
14	TFB	0	0.50
15	FLB	6	0.53
16	SWB	1	0.56
17	FRB	7	0.56
18	FLB	3	0.66
19	LGB	1	0.80
20	LGB	2	0.80
21	SWB	0	0.97
22	LGB	2	1.23
23	SWB	0	1.25
24	IUB	2	1.33
25	RAB	8	1.36
26	RAB	3	1.36
27	FRB	5	1.60
28	SWB	9	1.61
29	RAB	4	1.73
30	RAB	2	1.79
31	TFB	1	1.80
32	IUB	2	1.98
33	FRB	9	2.01
34	FLB	5	2.14
35	SWB	3	2.31
36	FLB	1	2.40
37	IUB	1	2.72
38	RAB	5	2.84
39	LGB	4	2.96
40	FLB	6	3.13
41	TFB	4	3.47
42	FLB	9	3.53
43	SWB	6	3.64
44	IUB	2	4.64
45	UAB	10	4.83
46	SWB	3	5.60
47	LGB	2	5.74
48	IUB	10	6.18
49	RAB	6	6.26
50	RAB	4	17.93
51	TFB	4	21.06
52	FLB	4	21.56
53	IUB	6	31.90
54	FLB	3	32.06

* a sort of the biotope pattern :
Residential Area Biotope(RAB), Commercial or Business Area Biotope(CBB), Industrial or Urban Infarastructure Facilities Area Biotope(IUB), Transportation Facilities Biotope(TFB), Landscape or Green Area Biotope(LGB), Stream or Wetland Biotope(SWB), Farmland Biotope(FLB), Forest Biotope(FRB), Unused Area Biotope(UAB)

** Number of species recorded bird species in spring and fall

Table 2. The occurrence rates of observed spedies

No.	Scientific name	Area		
		<1 ha	1-9.9	>10 ha
1	*Egretta alba modesta**			0.20
2	*Ardea cinerea**		0.07	
3	*Anas platyrhynchos**		0.07	
4	*Anas poecilorhyncha**		0.07	
5	*Anas crecca**		0.04	
6	*Ana acuta**		0.04	
7	*Phasianus colchieus*	0.05	0.04	
8	*Gallinula chlochicus*		0.07	
9	*Larus crassirostris**		0.04	
10	*Streptopelia orientalis*	0.19	0.18	0.20
11	*Picus canus*	0.05		
12	*Dendrocopos Major*	0.05		
13	*Dendrocopos Kizuki*		0.07	
14	*Alauda Arvensis*		0.04	
15	*Hirundo rustica*		0.11	
16	*Motacilla alba leucopsis**		011	
17	*Anthus hodgsoni*		0.04	
18	*Hypsipetes amaurotis*		0.21	
19	*Lanius bucephalus*		0.04	
20	*Phoenicurus auroreus*		0.07	
21	*Paracoxornis webbiana*	0.14	0.11	0.60
22	*Phoenicurus auroreus*		0.04	
23	*Parus palustris*	0.24	0.29	0.40
24	*parus ater*	0.05	0.14	
25	*Parus varius*		0.04	
26	*Paarus major*	0.33	0.43	0.60
27	*Emberiza rustic*	0.05	0.07	
28	*Emberiza elegans*	0.19	0.25	0.20
29	*Passer maontanus*	0.67	0.89	1.00
30	*Sturnus cineraceus*		0.07	
31	*Garrulus glandarius*	0.05	0.07	
32	*Pica pica*	0.62	0.79	1.00
No. of species		13	29	8
No. of sites		21	28	5

* Waterbirds are marked wiht an asterisk

was significant increase of number of species at Stream or Wetland Biotope (SWB), Forest Biotope (FRB) and Unused Area Biotope (UAB), with water source and multiple vegetation structure. Size of these sites was between 1ha and 10ha (Figure 3). Therefore, if water resources and multiple vegetation structure is maintained, even small area can be helpful to the bird species promotion.

DISCUSSION

Although it is known that an obvious factor influencing the number of species is the area size, there is no clear tendency of increasing number of species with respect to habitat size. Number of species is preferably high in size(1-10 ha) rather than in size (<1ha, >10ha).

Also, as seen in Figure 3, if it maintains water resources and the diversity of vertical landscape, even small area can be helpful for promotion of the number of species. The reason of distinct increase of effect in the graph is the security of water resources and the diversity of vertical landscape. Small habitat patches can be valuable complements to large patches.

For instance, well-vegetated residential areas constitute aerial corridors through their tree canopy. Such corridors are especially useful for migrating birds which use them extensively as they provide food and protection against aerial predators (Savard, 1978).

We do not suggest that any of the bird species we observed maintain viable populations in the small patches, and some may not attempt to breed there. Rather, the sharp increase in cumulative species richness in Figure 2 suggests that small patches are used on a daily basis by many species. As such, they have important values other than providing breeding areas (Fischer and Lindenmay, 2002).

In particular, metropolitan areas have a documented impact on avian communities. Researchers have reported higher bird densities of only a few species in urban areas when compared to natural areas, and species composition and diversity change as the degree of urbanization increases (e.g. Woolfenden and Rohwer, 1969; Emlen, 1974; Walcott, 1974; Degraaf and Wentworth, 1981; Blair, 1996). In this paper, the high density showed up in *Passer montanus*, *Pica pica*, and the tendency like this is more clear in more exploited site.

Therefore, from a policy perspective on how to man-

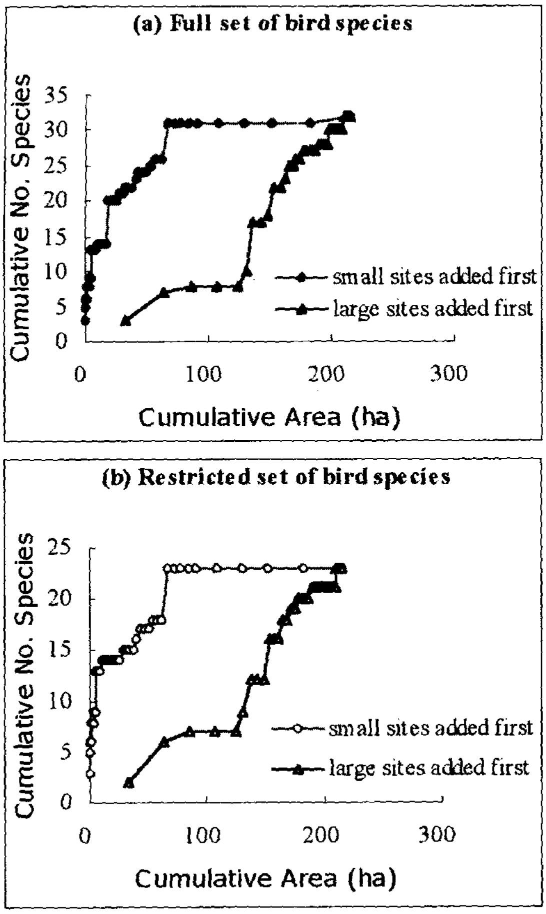

Figure 2. Cumulative number of species versus cumulative patch area. Part ais based on the full dataset, and include all bird species; for part b waterbirds were excluded. In graphs, sites were added from large to small or small to large, respectively

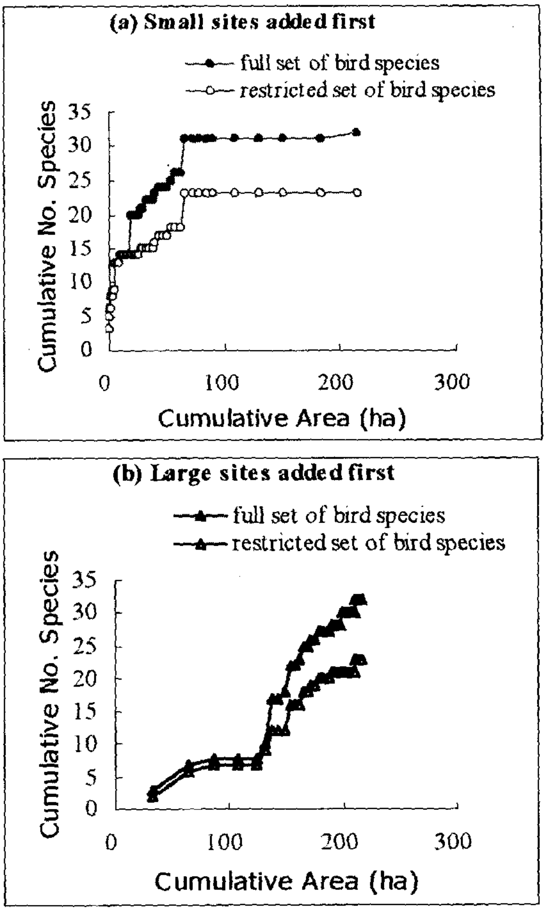

Figure 3. Cumulative number of species versus cumu-lative patch area. Part a is that sites were addedfrom small to large. Part b is that sites were added from large to small. In graphs, it is compared the full set included all bird species with restricted set excluded waterbirds

age urban areas for birds, it would be useful to know whether land use can area be attractive to a particular species in given area. Such information will give pertinent information to homeowners, developers, landscape architects, and city planners to evaluate whether a piece of property (under a specific land use designation) could be designed for a given bird species (Hostetler and Knowles Yanez, 2003). Species diversity and abundance are often related to the quality of urban life (Adams, 1994; Middleton, 1994).

As looked over in this study, number of species distinctly increased with size ranging from 1ha to 10ha. From this result, it may be possible to limit habitat size when habitat development is established for realistic and effective conservation of number of species.

It is especially in Seoul important to decide the habitat size considering an increase of land prices and density of population, and, therefore, promoting of habitat less than 10ha only would be very helpful to increase number of species. In addition, due to their lower costs, small scale restoration programmes using small patches as a starting point are more likely to be implemented in the short term than large scale projects that can be very expensive (Fenton, 1997).

Also, linear features are of great concern to conservationists and planners, because their role as corridors (for dispersal, movement or alternative habitat) can be viewed as a compensation for fragmentation (Saunders and Hobbs, 1991; Noss, 1993; bischoff and Jongman, 1993; Clergeau, 1993). Hence, As looked over in this study, Biotope network of designated sizes is needed for urban environment. Our proposal showed that small habitat with multiple vegetation structure can provide bird shelter and be active as corridors for dispersion.

Our study is summarized as follows :

1) Number of species is hardly affected by increase of habitat size in urban biotope.
2) When conserving and developing biotope for number of species in urban planning, it is necessary to consider realistic and substantial area.
3) If it maintains water resources and the diversity of vertical landscape, even small area can be helpful to the number of species promotion.

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