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Differences in Field Sign Abundance of Mammal Species Around the Roads in Baekdudaegan Mountains

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Abstract : This study was conducted to obtain the information of distribution, protection and management for mammal species in fragmented forest areas around the road from June 2002 to May 2003 in 9 study sites of Baekdugdaegan mountains, Korea. Field signs of twelve mammals, moles *Molera robusta*, Korean hares *Lepus coreanus*, Manchurian chipmunk *Tamias sibiricus*, red squirrels *Sciurus vulgaris*, Korean racoon dogs *Nyctereutes procyonoides*, Siberian weasels *Mustela sibirica*, badgers *Meles meles*, otters *Lutra lutra*, Bengal cats *Felis bengalensis*, wild boars *Sus scrofa*, water deer *Hydropotes inermis* and roe deer *Capreolus pygargus* were recorded in this study. There were no differences in total number of species between 50 m areas and 50-100 m areas from road in snow and non-snow season. Number of mammals' field signs were different in non-snow season between both areas. Red squirrels and Siberian weasels were more abundant in 50 m areas, and Korean hares and Manchurian chipmunks were in 50-100 m areas. Habitat using pattern of mammal species may be affected by the road. Reasonable road construction and maintenance would be needed for protection and management of wildlife and their habitats.

Key words **:** *baekdudaegan, field sign, mammal, road*

Introduction

Human transformation of the world's landscape is increasing at an even acceleration pace (Sisk *et al.*, 1994). These changes lave led, in turn, to the extinction and endangerment of growing number of species (Lawton and May, 1995), and loss of their habitats. Among the most widespread forms of modification of the natural landscapes during the past century has been the construction and maintenance of roads (Noss and Cooperrider, 1994).

As barriers to movement, roads create smaller patches and increase patch isolation. Smaller populations are at a greater risk of extinction by chance from demographic, genetic and environmental stochastic events. Isolated populations also have a higher chance of extinction without the demographic and genetic input of immigrants and a lower chance of recolonization after (Schoener and Spiller, 1992).

The ecological effects of roads can reach substantial distances from the road in terrestrial ecosystems, creating habitat fragmentation and facilitating fragmentation through human exploitative activities (Trombulak and Frissell, 2000). Roads contribute to biodiversity loss, both directly via animal mortality related to traffic, and indirectly through the destruction and fragmentation of habitats. As conducts for human vehicular traffic, roads represent major barriers to the movements of many organisms and a source of mortality across taxonomic groups, from seeds and invertebrates through to birds and large mammals (Bellamy *et al.*, 2000; Rondinini and Doncaster, 2002). Their ecological effects are not limited to the road clearance itself but can spread to a much large area (Meuiner *et al.*, 1999).

Road right-of-way areas attract many small mammal species (Adams and Geis, 1983) and offer nesting sites for birds (Warner, 1992). However, beneficial effects may be limited to only generalist species (Reed *et al.*, 1990). Their ecological importance for various species has received considerable attention in recent years (Angold, 1997; Meunier *et al.*, 1999).

We studied the relationship between field sign abundance of mammal species and distance from the road in

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snow and non-snow season. This study was conducted for sound protection and management of mammal species in the fragmented forest area caused by road construction.

Methods

We selected in 9 fragmented forest areas, Hangyeryeong, Dakmogryeong, Daetjae, Doraegijae, Beoljae, Bamtijae, Jilmaejae, Sinpungryeong and Bokseongijae within the Baekdudaegan mountains, Korea (Figure 1). In each 9 fragmented forest areas, we have set up 12 ha (600× 200 m) size study site. We established the study site as road was located in the center of study sites. Each study site was divided by grid. Each grid, marked with flags, consisted of a 25×25 m array of transect route with 25 m spacing for mammal trails tracking (Ministry of Environment, 2003).

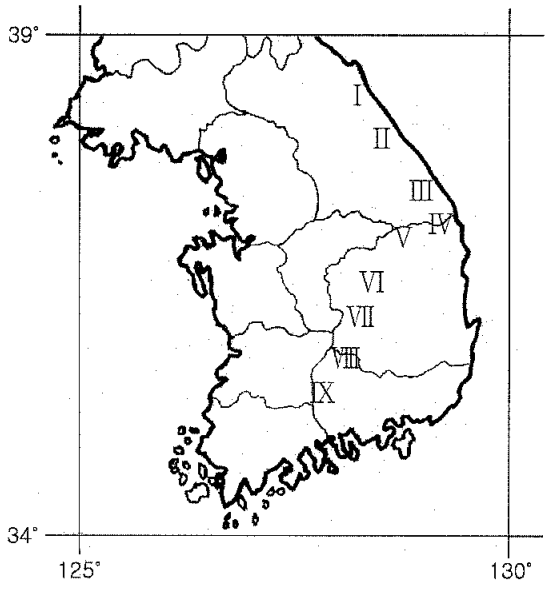

Figure 1. The location of study sites in Baekdudaegan mountains, Korea. (I: Hangyeryeong, II: Dakmogryeong, III: Daetjae, IV: Doraegijae, V: Beoljae, VI: Bamtijae, VII: Jilmaejae, VIII: Sinpungryeong, IX: Bokseongijae)

Field signs of mammals in the snow were counted in December-February after a snow-fall during the preceding day (Rhim and Lee, 2002) and in the non-snow were in July-September. These censuses were performed from June 2002 to May 2003. Field surveys were carried out 2 times in both season. Mean number of field signs were used in data analysis. We analyzed our data as within 50 m area (100 m width and 6ha size) and 50-100 m area (100 m width and 6ha size) from road. Field signs were feces, foot print, feeding, roosting and resting sites of mammals (Won 1967; Yoon 1992; Yoo, 2000).

Results and Discussion

Total twelve species of mammals were recorded in this study. Field signs of Korean hares *Lepus coreanusand* water deer *Hydropotes inermis* were observed in all study sites. Foot prints and feces of otters *Lutra lutra* were just observed in Dakmogryeong. Badgers *Meles meles* and roe deer *Capreolus pygargus* were recorded in 2 sites, respectively. The number of mammal species were varied from 4 to 8 species in study sites (Table 1).

Nine species of mammals were recorded in snow season. Field signs of Korean hares, water deer and Sibe-

Table 1. Mammal species based on observed field signs in 9 study sites of Baekdudaegan mountains.

Mammal species	study site[1]								
	I	II	II	IV	V	VI	VII	VIII	IX
Monera robusta		○					○		○
Lepus coreanus	○	○	○	○	○	○	○	○	○
Tamias sibiricus	○			○			○	○	
Sciurus vulgaris					○	○	○	○	○
Nyctereutes procyonoides	○				○	○	○	○	○
Mustela sibirica		○	○		○	○	○	○	○
Meles meles				○	○				
Lutra lutra		○							
Felis bengalensis		○		○	○				
Sus scrofa			○	○	○	○	○	○	○
Hydropotes inermis	○	○	○	○	○	○	○	○	○
Capreolus pygargus	○			○					
No. of species	5	6	4	7	8	6	8	7	7

[1]study site- I: Hangyeryeong, II: Dakmogryeong, III: Daetjae, IV: Doraegijae, V: Beoljae, VI: Bamtijae, VII: Jilmaejae, VIII: Sinpungryeong, IX: Bokseongijae.

Table 2. Differences in observed number of mammals' field signs between 0-50 m areas and 50-100 m areas from the road in snow season within 9 study sites of Baekdudaegan mountains.

Mammal species	study site[1]								
	I	II	II	IV	V	VI	VII	VIII	IX
Lepus coreanus	0:3[2]	1:6	1:3	0:2	4:12	3:5	14:25	17:39	6:5
Tamias sibiricus				0:1					
Sciurus vulgaris					5:0	1:0	2:0	2:3	4:0
Nyctereutes procyonoides	1:0				3:4	1:2	0:1	2:0	1:0
Mustela sibirica		2:0	0:1		7:2	4:1	3:1	5:2	6:0
Lutra lutra		1:2							
Felis bengalensis		0:1			0:1				
Sus scrofa			0:3	0:2		1:5	0:1		0:3
Hydropotes inermis	3:0		0:2	3:0	1:0	4:6	2:0	3:1	3:4
Total no. of field signs	4:3	4:9	1:9	3:5	20:19	14:19	21:28	29:45	20:12
No. of mammal species	2:1	3:3	1:4	1:3	5:4	6:5	4:4	5:4	5:3

[1]study site- I: Hangyeryeong, II: Dakmogryeong, III: Daetjae, IV: Doraegijae, V: Beoljae, VI: Bamtijae, VII: Jilmaejae, VIII: Sinpungryeong, IX: Bokseongijae.
[2]no. of field signs within 0-50 m : no. of field signs within 50-100 m areas from road.

Table 3. Differences in observed number of mammals' field signs between 0-50 m areas and 50-100 m areas from the road in non-snow season within 9 study sites of Baekdudaegan mountains.

Mammal species	study site[1]								
	I	II	II	IV	V	VI	VII	VIII	IX
Monera robusta		1:0					1:1		2:2
Lepus coreanus	2:12[2]		1:3	0:2	2:1	1:3	0:1	4:7	2:0
Tamias sibiricus	1:5			0:4			1:1	1:3	
Sciurus vulgaris							0:1	4:3	
Nyctereutes procyonoides	1:0							1:1	
Mustela sibirica								2:1	1:0
Meles meles				1:0	1:0				
Felis bengalensis		1:0		0:1					
Sus scrofa			0:1	0:2	0:2	0:1		1:0	1:1
Hydropotes inermis	0:1	2:0	1:2	1:0	1:0	0:1	1:0		1:2
Capreolus pygargus	0:2			0:1					
Total no. of field signs	4:20	4:0	2:6	2:10	4:3	1:5	3:4	13:15	7:5
No. of mammal species	3:4	3:0	2:3	2:5	3:2	1:3	3:4	6:5	5:3

[1]study site- I: Hangyeryeong, II: Dakmogryeong, III: Daetjae, IV: Doraegijae, V: Beoljae, VI: Bamtijae, VII: Jilmaejae, VIII Sinpungryeong, IX: Bokseongijae.
[2]no. of field signs within 0-50 m : no. of field signs within 50-100 m areas from road.

rian weasels were most abundant and those of badgers and Manchurian chipmunks *Tamias sibiricus* were rare in snow season (Table 2). Mean number of field signs were 12.89 (±10.15, SD) per site within 50 m areas from road and 16.56 (±13.25, SD) within 50-100 m areas. There were no differences in total number of field signs (Mann-Whitney U-test, $Z = 0.67$, $P > 0.3$) and species ($Z = 1.45$, $P > 0.2$) between 50 m and 50-100 m areas from road. Korean hares ($Z = -12.73$, $P < 0.01$) and wild boars *Sus scrofa* ($Z = -4.11$, $P < 0.01$) were more abundant in 50-100 m areas than in 50 m areas from road. The field signs of red squirrels *Sciurus vulgaris* ($Z = -5.35$, $P < 0.01$) and Siberian weasels ($Z = -3.483$, $P < 0.01$) were more observed in 50 m areas than in 50-100 m areas. There were no differences in observed number of field signs of Manchurian chipmunk, Korean racoon dog *Nyctereutes procyonoides*, otters, Bengal cats *Felis bengalensis* and water deer between both areas in snow season (Table 2).

Total eleven species of mammals were recorded in non-snow season. Field signs of Korean hares and water deer were most abundant and those of badgers, Bengal cats and roe deer were rare in non-snow season (Table 3). Mean number of field signs of mammals were sig-

nificantly different between 50 m areas (4.44±3.64, SD) and 50-100 m areas (7.56±6.35, SD) from road ($Z = -4.11$, $P < 0.01$). But there were no differences in number of species between both areas ($Z = 2.46$, $P > 0.1$). Korean hares ($Z = -4.25$, $P < 0.01$) and Manchurian chipmunks ($Z = -3.54$, $P < 0.01$) were significantly higher in 50-100 m areas than in 50 m areas from road. There were no differences in field signs of the other species ($P > 0.1$) in non-snow season (Table 3).

Although there were high number of species in non-snow than snow season, number of field signs were more abundant in snow and non-snow season in study sites ($Z = -2.04$, $P < 0.05$). Because field signs on the snow would be observed more clear and easy. But there were no significant differences in mammal species between both seasons ($Z = 0.18$. $P > 0.5$).

A road transforms the physical conditions on and adjacent to it, creating edge effects with consequences that extend beyond the time of road's construction. Red squirrels and Siberian weasels may preferred the forest edge areas (Huijser, 1999; Rhim and Lee, 2002). Those species may used the edge areas around the road (Ministry of Environment, 2003). The field signs of Korean hares and wild boars were less within adjacent area of road in snow season, and Korean hares and Manchurian chipmunks were less in non-snow season. Those species maybe avoid around road, because there were noise, shock and other disturbances by human and vehicles (Huijser, 2000). Road would affect habitat usage patterns of the mammals.

The presence of a road may modify an animal's behavior either positively or negatively. This can occur through five mechanisms: home range shifts; altered movement patterns; altered reproductive success; altered escape response; and altered physiological state (Paton, 1993; Trombulak and Frissell, 2000).

Reasonable road construction and maintenance would be needed for protection and management of wildlife and their habitats (McGarigal *et al.*, 2001). Road design, management and restoration need to be more carefully tailored to address the full requirements of ecological processes for wildlife species that may be affected (Huijser, 2000). Construction of eco-bridge or eco-road would be necessary at critical area for wildlife (Ministry of Environment, 2003). Deliberate monitoring on mammals' abundance is necessary to ensure that the research has maximal ecological benefits, and minimal adverse effects and that they are cost-effective relative to their actual benefits.

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