

## Differences in Mammals Abundance in Different Distance Areas from Road

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**Abstract:** This study was conducted from June 2001 to March 2002 to obtain the basic information in mammals abundance caused by the road construction in different distance areas for sound protection and management of mammals and their habitats in 8 fragmented forest areas of Baekdudaegan mountain range. Field signs such as feces, foot print, feeding, roosting, and resting site of 10 mammal species could be found. Mammals abundances were much lower near roads. This means that roads would affect habitat usage patterns of mammals. Road design, management, and restoration need to be more carefully tailored to address full requirement of ecological processes for wildlife species that may be affected.

**Key words:** Field signs; Korea; Mammals abundance; Road

## 道路两边不同距离内哺乳动物丰富度的差异

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**摘要:** 为更好地保护和管理部分哺乳类动物及其栖息地, 自 2001 年 6 月至 2002 年 3 月在韩国白头大干山脉 8 个被道路切割的林区内调查了道路两边一定距离内所见哺乳动物随距离增加而变化的丰富度。我们共调查了 10 种哺乳类 (野猪、狍、獐、黄鼬、貉、豹猫、华南兔、松鼠、花鼠、鼯) 的各种痕迹 (粪便、足迹、食痕、卧迹及休息处), 发现距道路近处两边的丰富度确有较大下降。这说明道路建设的确影响哺乳类的生境选择及其利用方式。所以今后在道路设计、管理及扩充等方面均需充分考虑和满足所有野生动物整个生命过程所需的空间要求。

**关键词:** 痕迹; 韩国; 哺乳类丰富度; 道路

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Wildlife has been shown to interact with their habitats in complex and profound ways. Mammals are major agents of habitat changes in many parts of the world<sup>[1, 2]</sup>. Species interactions and responses to habitat fragmentation may vary for species within patches that adjoin different patch types (e. g., edge effect<sup>[3]</sup>). Human transformation of the world's landscape is increasing at an ever ac-

celeration pace<sup>[4]</sup>. These changes have led, in turn, to the extinction and endangerment of a growing number of species<sup>[5]</sup>, and loss of their habitats.

Habitat destruction is the primary cause for the extinction of most terrestrial species<sup>[6]</sup>, but the impacts of any human development or road may be far greater than the immediate area of the destruction. Among the most

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widespread forms of modification of the natural landscapes during the past century has been the construction and maintenance of roads<sup>[7]</sup>. One potential negative effect that roads and developments can have on native ecosystems is the increase in invasive, non-indigenous species in the surrounding areas<sup>[8]</sup>.

Roads of any kind may affect in seven general ways; (1) increased mortality from road construction; (2) increased mortality from collision with vehicles; (3) modification of animal behavior; (4) alteration of the physical environment; (5) alteration of the chemical environment; (6) spread of exotic species; and (7) increased alteration and use of habitat by humans<sup>[9]</sup>. These general effects overlay somewhat. In some cases animals modify their behavior and avoid roads because of concentrated human activities along roads. Roads may facilitate the spread of invasive species by disrupting native communities and changing physical habitats. Roads may cause pollutions through road kills and road avoidance<sup>[10]</sup>.

The aim of this study is to obtain basic information in mammal s abundance caused by the road construction in different distance areas for sound protection and management of those species, and their habitats. The relationships between mammal abundance and distance from roads in snow and non-snow seasons, were examined within fragmented forest areas of Baekdudaegan mountain ranges, South Korea.

## 1 STUDY AREA AND METHODS

Among the fragmented forest areas by road constructions in South Korea, 8 fragmented forest areas were selected in this study, i. e., Jinburyeong, Jingogae, Sapdangryeong, Baekbongryeong, Hwabangjae, Ihwaryeong, Deoksanjae, and Yeowonjae within the Baekdudaegan mountain range (Fig. 1).

In each fragmented forest area, we have set up 3 sites (4 hm<sup>2</sup>, 200 × 200 m) in each study areas. The road was located in the center of total 24 study sites. Each site was divided by grids. Each grid, marked with flags, consisted of a 25 × 25 m array of transect routes with 25 m spacing for tracking mammal trails<sup>[11]</sup>.

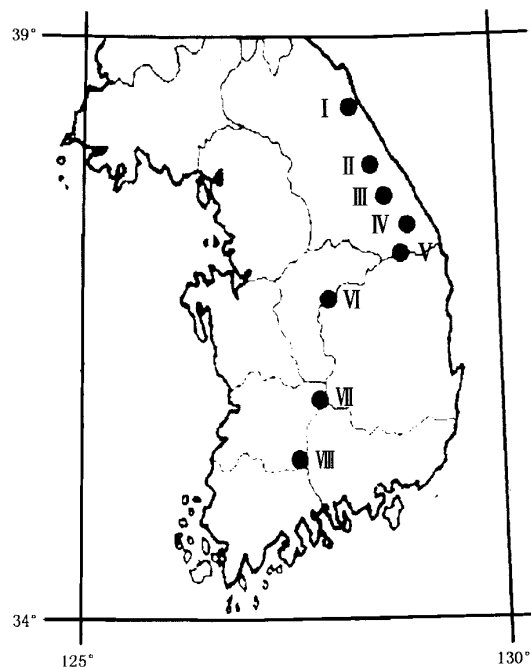


Fig. 1 The location of study areas in Baekdudaegan mountain range, South Korea

I: Jinburyeong, II: Jingogae, III: Sapdangryeong, IV: Baekbongryeong, V: Hwabangjae, VI: Ihwaryeong, VII: Deoksanjae, VIII: Yeowonjae

Mammal trails in the snow season were counted in December - March after a snow-fall during the preceding day<sup>[12, 13]</sup> and in the non-snow season they were carried out in June - September. These censuses were performed from June 2001 to March 2002. Data as within 50 m area (100 m width) and 50 - 100 m area (100 m width) from roads were analyzed. All the trails in two areas were statistically tested by Wilcoxon two-sample test.

## 2 RESULTS AND DISCUSSION

Field signs such as feces, foot print, feeding, roosting, and resting site of 10 mammal species could be found in study areas. Mean number of species and field signs were 1.50 (± 0.93, SD) and 1.88 (± 1.25) within 50 m area from roads in non-snow season, respectively (Table 1). Roe deer (*Capreolus capreolus*) and water deer (*Hydropotes inermis*) were most dominant species. In non-snow season, 4.13 (± 1.25) species and 8.50 (± 3.59) field signs within 50 - 100 m area from roads

were observed (Table 2). Siberian chipmunks (*Tamias sibiricus*), Korean hares (*Lepus sinensis*), and roe deer were dominant species.

There were significant differences in number of species (Wilcoxon two-sample test,  $Z = -3.04$ ,  $P < 0.01$ ) and field signs ( $Z = -3.17$ ,  $P < 0.01$ ) between 50 m area and 50 - 100 m from roads in non-snow seasons (Tables 1 and 2).

In the snow season, 3.13 ( $\pm 1.25$ , SD) species and 7.50 ( $\pm 3.02$ ) field signs of mammals were observed within 50 m area from roads (Table 3). And 4.63 ( $\pm 1.41$ ) and 14.88 ( $\pm 6.10$ ) of species and field signs were in 50 - 100 m area from road, respectively (Table 4). Korean hares, water deer, and Siberian weasels

(*Mustela sibirica*) were dominant species in both areas during snow season. There were more number of species ( $Z = -1.99$ ,  $P < 0.05$ ) and field signs ( $Z = -2.43$ ,  $P < 0.05$ ) between 50 m area and 50 - 100 m from roads in snow seasons (Tables 3 and 4).

Observed field signs ( $Z = -3.23$ ,  $P < 0.01$ ) and species ( $Z = -2.37$ ,  $P < 0.05$ ) were significant differences between snow and non-snow seasons within 50 m area from roads. Within 50 - 100 m area, number of field sign was significantly different ( $Z = -2.01$ ,  $P < 0.01$ ) but number of species was not different ( $Z = -0.76$ ,  $P > 0.413$ ) between snow and non-snow seasons.

Table 1 Mammals' abundance within 50 m area from roads in non-snow season

Scientific name	Study areas							
	I	II	III	IV	V	VI	VII	VIII
<i>Sus scrofa</i>				1				
<i>Capreolus capreolus</i>	2	2					1	
<i>Hydropotes inermis</i>				2				1
<i>Mustela sibirica</i>								
<i>Nyctereutes procyonoides</i>								
<i>Felis bengalensis</i>	1							
<i>Lepus sinensis</i>			1					
<i>Sciurus vulgaris</i>							1	1
<i>Tamias sibiricus</i>				1				
<i>Talpa micrura</i>						1		
No. of species	2	1	1	3		1	2	2
No. of field signs	3	2	1	4		1	2	2

I: Jinburyeong, II: Jingogae, III: Sapdangryeong, IV: Baekbongryeong, V: Hwabangjae, VI: Ilhwaryeong, VII: Deoksanjae, VIII: Yeowonjae

Table 2 Mammals' abundance within 50 - 100 m area from roads in non-snow season

Scientific name	Study areas							
	I	II	III	IV	V	VI	VII	VIII
<i>Sus scrofa</i>	1	2			1		1	
<i>Capreolus capreolus</i>	4	5				1	1	1
<i>Hydropotes inermis</i>			1		1	3		2
<i>Mustela sibirica</i>								
<i>Nyctereutes procyonoides</i>		2					1	
<i>Felis bengalensis</i>	1							
<i>Lepus sinensis</i>			2	2		4	1	2
<i>Sciurus vulgaris</i>				1			3	
<i>Tamias sibiricus</i>	2	6		4	3	1	3	2
<i>Talpa micrura</i>				1		1		2
No. of species	4	4	2	4	3	5	6	5
No. of field signs	8	15	3	8	5	10	10	9

I: Jinburyeong, II: Jingogae, III: Sapdangryeong, IV: Baekbongryeong, V: Hwabangjae, VI: Ilhwaryeong, VII: Deoksanjae, VIII: Yeowonjae

Table 3 Mammals' abundance within 50 m area from roads in snow season

Scientific name	Study areas							
	I	II	III	IV	V	VI	VII	VIII
<i>Sus scrofa</i>	2					1		
<i>Capreolus capreolus</i>	1			1	1			
<i>Hydropotes inermis</i>				2	3	1	1	1
<i>Mustela sibirica</i>		2			6		1	
<i>Nyctereutes procyonoides</i>		1						4
<i>Felis bengalensis</i>								
<i>Lepus sinensis</i>	4	1	4	4	1	7	8	
<i>Sciurus vulgaris</i>				1	1	1		
<i>Tamias sibiricus</i>								
<i>Talpa micrura</i>								
No. of species	3	3	1	4	5	4	3	2
No. of field signs	7	4	4	8	12	10	10	5

I: Jinburyeong, II: Jingogae, III: Sapdangryeong, IV: Baekbongryeong, V: Hwabangae, VI: Ihwaryeong, VII: Deoksanjae, VIII: Yeowonjae

Table 4 Mammals' abundance within 50 - 100 m area from roads in snow season

Scientific name	Study areas							
	I	II	III	IV	V	VI	VII	VIII
<i>Sus scrofa</i>		1			1			2
<i>Capreolus capreolus</i>	4	1		1	1			
<i>Hydropotes inermis</i>		2	1	3	5	3	6	5
<i>Mustela sibirica</i>	1	1		1	3		3	2
<i>Nyctereutes procyonoides</i>		3				4	3	1
<i>Felis bengalensis</i>				1				
<i>Lepus sinensis</i>	4	11	8	2	3	14	10	2
<i>Sciurus vulgaris</i>	1				1	3		1
<i>Tamias sibiricus</i>								
<i>Talpa micrura</i>								
No. of species	4	6	2	5	6	4	4	6
No. of field signs	10	19	9	8	14	24	22	13

I: Jinburyeong, II: Jingogae, III: Sapdangryeong, IV: Baekbongryeong, V: Hwabangae, VI: Ihwaryeong, VII: Deoksanjae, VIII: Yeowonjae

Our results indicated that, mammals abundance were much lower near roads. This means that roads would affect habitat usage patterns of the mammals. 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. 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<sup>[3, 10, 11]</sup>. 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<sup>[10]</sup>.

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<sup>[14]</sup>. Roads and traffic mortality are ubiquitous in landscapes modified by human. The survival of populations in such landscapes depends on the interactions between the spatial pattern of roads and the dispersal characteristics of the organisms<sup>[15]</sup>.

Forman and Alexander<sup>[16]</sup> coined the term, road-effect zone for the maximum distance at which significant

ecological effects of roads occur. Forman<sup>[17]</sup> estimated that the road-effect zone varies from 200 to 800 m in the United States of America (U. S.) and that about one-fiftieth of the U. S. land area is therefore directly affected by roads. But there would be different status in South Korea. The combined effect of a road network depends on the number of roads and their traffic volumes, and their placement relative to one another and to the various habitats in the landscape<sup>[18]</sup>. Even where only a small percentage of the land's surface is directly occupied by roads, few corners of the landscape remain untouched by their off-site ecological effects. The breadth of these effects cannot be appreciated unless one takes a broadly multidisciplinary view of ecosystems and biological communities.

Road engineers and construction personnel are currently evincing a great deal of interest in faunal welfare. Both groups are adding value to the research by assisting ecologists<sup>[19]</sup>. 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. 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.

## REFERENCES:

- [1] Alverson W, Waller D S, Solheim S L. Forests to deer: Edge effects in northern Wisconsin [J]. *Conservation Biology*, 1988, **2**: 348 - 358.
- [2] Anderson R C, Katz A J. Recovery of browse-sensitive tree species following release from white-tailed deer *Odocoileus virginianus* browsing pressure [J]. *Biological Conservation*, 1993, **63**: 203 - 208.
- [3] Paton P W C. The effect of edge on avian nest success: How strong is the evidence? [J]. *Conservation Biology*, 1994, **8**: 17 - 26.
- [4] Sisk T D, Launer A E, Switky K R, Ehrlich P R. Identifying extinction threats [J]. *Bio Science*, 1994, **44**: 592 - 604.
- [5] May R M, Lawton J H, Stork N E. Assessing extinction rates [A]. In: Lawton J H, May R M eds. *Extinction rate* [C]. Oxford: Oxford University Press. 1995. 1 - 24.
- [6] Baillie J, Groombridge B. *IUCN red list of threatened animals* [M]. Gand: World Conservation Union (IUCN). 1996.
- [7] Noss R F, Cooperrider A Y. *Saving nature's legacy* [M]. Washington DC: Island Press, 1994.
- [8] Forsy E A, Allen C R, Wojcik D P. Influence of the proximity and amount of human development and roads on the occurrence of the red imported fire ant in the lower Florida Keys [J]. *Biological Conservation*, 2002, **108**: 27 - 33.
- [9] Forman, R T T, Deblinger R D. The ecological road-effect zone of a Massachusetts (U. S. A.) suburban highway [J]. *Conservation Biology*, 2000, **14**: 36 - 46.
- [10] Trombulak S C, Frissell C A. Review of ecological effects of roads on terrestrial and aquatic communities [J]. *Conservation Biology*, 2000, **14**: 18 - 30.
- [11] Ministry of Construction and Transportation. Ecological survey for construction of eco-bridge in Korea [M]. Seoul: Ministry of Construction and Transportation, 2002. (in Korean)
- [12] Hansson L. Vertebrate distributions relative to clear-cut edges in a boreal forest landscape [J]. *Landscape Ecology*, 1994, **9**: 105 - 115.
- [13] Murie O J. *A field guide to animal tracks* [M]. Boston: Houghton Mifflin, Co. 1954.
- [14] Schoener T W, Spiller D A. Is extinction rate related to temporal variability in population size? An empirical answer for orb spiders [J]. *The American Naturalist*, 1992, **139**: 1176 - 1207.
- [15] Fahrig L, Grez A. Population spatial structure, human caused landscape changes and species survival [J]. *Revista Chilena de Historia Natural*, 1996, **69**: 5 - 13.
- [16] Forman R T T, Alexander L E. Roads and their major ecological effects [J]. *Annual Review of Ecology and Systematics*, 1998, **29**: 207 - 231.
- [17] Forman R T T. Estimate of the area affected ecologically by the road system in the United States [J]. *Conservation Biology*, 2000, **14**: 31 - 35.
- [18] Carr L W, Fahrig L. Effect of road traffic on two amphibian species of differing vagility [J]. *Conservation Biology*, 2001, **15**: 1071 - 1078.
- [19] Goosem M, Izumi Y, Turton S. Efforts to restore habitat connectivity for an upland tropical rainforest fauna: A trial of underpasses below roads [J]. *Ecological Management and Restoration*, 2001, **2**: 196 - 202.