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Preliminary Study of Population Size and Habitat Characteristics for Amur Goral in the DMZ of Gangwon Province in South Korea

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Abstract : This study was conducted to estimate population size and investigate habitat characteristics for the conservation and management of Amur goral *Nemorhaedus caudatus raddeanus* in DMZ (Demilitarized Zone) of Gangwon Province in South Korea from November 2003 to May 2004. The Amur gorals counting were carried out by assistance of military soldiers who guards the southern boundary of DMZ. Four hundred sixty individuals were estimated as total population size in DMZ of Gangwon Province. Deciduous forest, rocky area and coniferous forest were dominant land cover types in habitat of Amur goral. DMZ and its vicinity of Gangwon Province are very important areas for the conservation of this species. It is needed to establish management plan for the conservation of Amur goral and their habitats in DMZ.

Key words **:** *amur goral, DMZ, habitat, Korea, population size*

Introduction

Due to the urbanization and civilization, a number of wildlife is faced with extinction in Korea. Amur goral *Nemorhaedus caudatus raddeanus* is one of them (Rhim and Lee, 2004). The Amur goral is an endangered species. After the 1950's, its population size and distribution area were sharply decreased in South Korea by poaching, habitat loss and reducing habitat quality. The population size in South Korea is presumed to be less than 250 (Cultural Heritage Administration, 1999). It is listed as "Vulnerable" in the 1996 IUCN Red List of the Threatened Animals (IUCN, 1996; Shackleton, 1997). Conservation of Amur goral is a highly priority of the Korean government, as indicated by its designation as Natural Monument animal species number 217 (Yoo, 2000).

Amur goral is known as inhabitants in rocky, steep habitats of mountain area in South Korea, especially the DMZ (Demilitarized Zone) and its vicinity in Gangwon Province (Won, 1992; Cultural Heritage Administration, 1999; Lee and Rhim, 2002; Yang, 2002). But ecology and behavior of this species were poorly known in Korea (Lee and Rhim, 2002; Kim *et al.*, 2004). Information of the relationship between habitat and population dynamics is indispensable for wildlife management and various attempts at habitat management for Amur goral (Ochiai *et al.*, 1993; Sheng *et al.*, 1999).

The DMZ, which was established after Korean War, has divided Korea into two areas since 1953. The DMZ is 4km wide and 248 km long and lies across the middle part of Korea along the Military Demarcation Line. Another 10-20 km was added to the width as the Civilian Control Zone (CCZ) that allowed only the military access in the southern part of the DMZ, while preventing public access keeps some area from human disturbances (Korea Forest Research Institute, 2000; John *et al.*, 2003; Lee *et al.*, 2004; Shin *et al.*, 2004).

DMZ in Gangwon Province included Baekdudaegan mountains systems. This area has been less disturbed, well-conserved, and plays important roles as good habitat for wildlife until now (Lee *et al.*, 2003). Mountain peaks and ridges which provided habitats for the Amur goral and musk deer, and valleys which provide food for wildlife in the winter should be reserved. Amur goral is forest and mountain dwelling species. This study was conducted in mountain area in DMZ of Gangwon Province.

This preliminary study was done for basic information

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on population size and habitat characteristics of Amur goral in DMZ under the cooperation with military authorities. In order to establish conservation and restoration plan for threatened wildlife species, it is necessary to know population size and distribution of the species.

Methods

Amur goral counts were conducted by military soldiers who guards the southern boundary of the DMZ under the cooperation with the Department of Defense and several divisions of Korean Army. This species can be easily identified from its characteristic appearance. Military soldiers on guard duties can monitor the whole border of DMZ in Gangwon province at the same time.

Population size of the species were estimated within the DMZ area in Gangwon province based on the total counts. Education programs were developed and done for soldiers before the survey period. Study area was the DMZ in Gangwon province, and subdivided into 4 major areas: Hwacheon, Yanggu, Inje and Goseong areas (Ganwon province, 2004).

We selected one day in each month from November 2003 to May 2004. All soldiers on guard duties have recorded the number and locations of Amur goral within a visible range (200 m away from border fences) in DMZ (Figure 1) at the same time to avoid overlap every 4 hours. All counts were analysed by months and locations. Finally survey results were sorted as maximum number of individuals by 4 major areas for estimation of local population size.

Vegetation types and land covers were surveyed for investigation of habitat characteristics of Amur goral. A total of 9 plots (100×100 m) were established in repeatedly observed points of Amur goral. Habitat survey was done using binocular, telescopes and digital cameras, because survey areas were unidentified mine field.

Results and Discussion

Maximum observed number of Amur gorals was 46 individuals within DMZ of Gangwon Province. In Yanggu area, Amur gorals were observed not inside but outside of DMZ. This individuals were excluded in the results of observed number of Amur goral. Maximum 32 individuals (23 adults and 9 juveniles) were recorded in grassland of Inje area. Nine and five individuals were observed in Hwacheon and Goseong areas, respectively (Table 1).

The length of mountain area of DMZ in Gangwon Province is about 123 km. Southern part of DMZ is well

Table 1. Observed number of amur gorals in dmz of gangwon province from november 2003 to May 2004.

	Hwacheon	Yanggu	Inje	Goseong
November 2003	0	0	2	0
December 2003	1	0	6	0
January 2004	4	0	16	0
February 2004	0	0	2	0
March 2004	1	0	32	0
April 2004	5	0	1	9
May 2004	1	0	0	0
Maximum no. of individuals	5	0	32	9

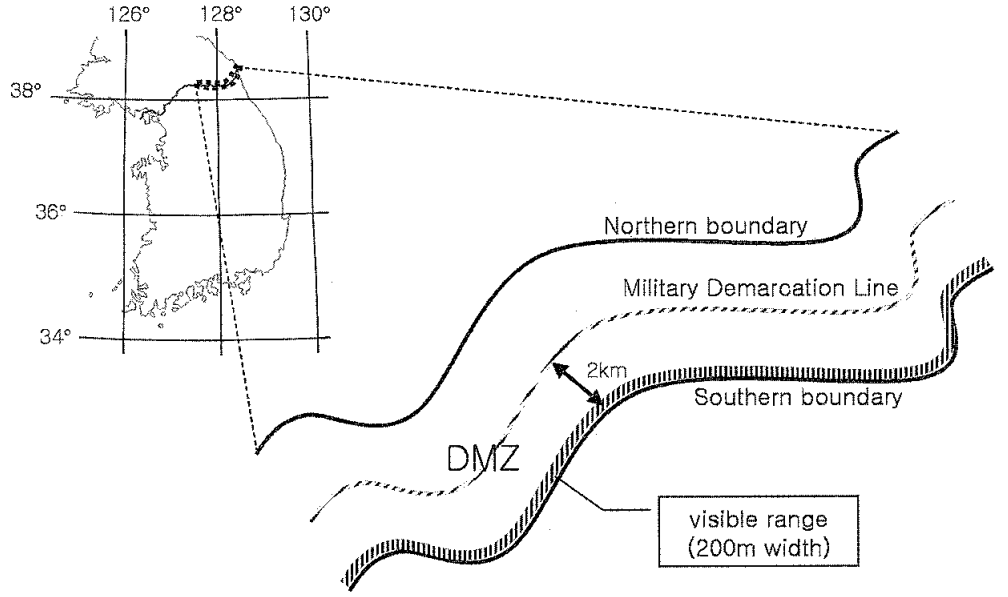

Figure 1. The location of study area in DMZ, Korea.

protected but situation in northern part is unknown. In this study, we used width of DMZ as 2 km. Total size of DMZ of Gangwon Province was calculated as 246 km^2 (①). In this study, maximum visible range was 200 m from border of DMZ. The size of sampling area was 24.6 km^2 (②). Maximum 46 individuals were observed in study area. Density of Amur goral in sampling area is 1.87 ind./km^2 (③). Finally, we can estimated population size of the species as 460 individuals in Gangwon Province (④).

① size of DMZ of Gangwon Province : 123 km×2 km=246 km^2

② sampling area : 123 km×200 m=24.6 km^2

③ population density in sampling area : 46 ind./24.6 km^2=1.87 ind./km^2

④ Estimated population size in DMZ of Gangwon Province : 1.87 ind./km^2×246 km^2=460 ind.

In the repeatedly observation points of Amur goral, dominant tree species of overstory were deciduous trees, such as *Quercus mongolica, Q. serrata, Q. acutissima, Q. variabilis, Juglans mandshurica, Castanea crenata, Fraxinus rhynchophylla* and *Alnus hirsuta*. Also dominant coniferous trees were *Pinus densiflora, P. koraiensis* and *Abies nephrolepis*. In understory, *Lespedeza bicolor, Rhus chinensis, Pueraria thunbergiana, Rhododendron mucronulatum, Lindera obtusiloba* and *Rubus crataegifolius* were dominant species (Table 2).

Deciduous forest was the most dominant land cover types in repeatedly observed points of Amur goral. Also Grassland, Rocky and coniferous areas were dominant. Stony slope area and bare land were subdominant land cover types (Table 3).

In Hwacheon and Goseong areas, deciduous forest was the most dominant land cover types (Figure 2). The Amur goral usually occurred at dense understory vegetation areas composed of deciduous trees with steep slope on high-elevation rocky areas. Especially, grass area was the most dominant land cover types in Inje areas (Figure 1). Most of this mammals were observed at grassland in steep slope area of Inje area.

It is known that Amur goral prefers a forest environment and meadow with rocky cliff or rocky areas nearby bush composed of deciduous trees (Myslenkov and Voloshina, 1989; Cultural Heritage Administration, 1999). This mammal is territorial, sedentary, and small group living animals (Nowak 1999; Rhim and Lee, 2004), and very sensitive to habitat degradation (Sheng *et al.*, 1999).

Table 3. Land cover types in repeatedly observed points of Amur goral in DMZ of Gangwon Province.

Land cover type	Percentage (%)
Deciduous forest	46.1
Grassland	15.0
Rocky area	14.4
Coniferous forest	14.4
Stony slope area	7.2
Bare land	2.7
Total	100.00

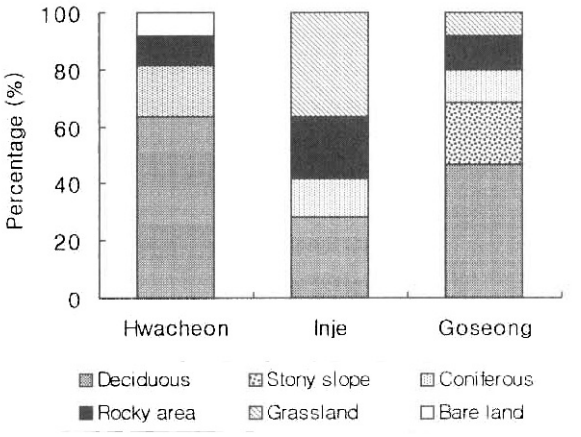

Figure 2. Land cover types in repeatedly observed points of Amur goral within Hwacheon, Inje and Goseong areas, DMZ of Gangwon Province.

For understand of ecology of Amur goral, data on distribution, home range, behavior and habitat using pattern would be needed (Rhim and Lee, 2004). But there are a few data on that. Monitoring system for Amur goral would be needed in DMZ. More detailed informations on ecology and habitats of this species would be possible by developed monitoring system (Lee and Rhim, 2002).

DMZ and its vicinity of Gangwon Province is eastern

Table 2. Dominant species of overstory and understory vegetation in repeatedly observed points of Amur goral in DMZ of Gangwon Province.

		Species
Overstory vegetation	deciduous	*Quercus mongolica, Q. serrata, Q. acutissima, Q. variabilis, Juglans mandshurica, Castanea crenata, Fraxinus rhynchophylla, Alnus hirsuta*
	coniferous	*Pinus densiflora, P. koraiensis, Abies nephrolepis*
Understory vegetation		*Lespedeza bicolor, Rhus chinensis, Pueraria thunbergiana, Rhododendron mucronulatum, Lindera obtusiloba, Rubus crataegifolius*

mountainous areas in DMZ of Korea (Korea Forest Research Institute, 2000; Shin *et al.*, 2004). This area is very important for conservation of Amur goral (Gangwon Province, 2004; Rhim and Lee, 2004). At present, the DMZ of Gangwon Province is protected by military purposes. Also, Amur goral population in DMZ would be isolated from outer areas of DMZ. In the future, foods insufficiency caused by higher population density or inbreeding depression would be possible in DMZ. Management would be needed for gene exchanges between inner and outer areas of DMZ. If there were unification between South and North Korea, land usage would be changed in DMZ. Therefore, action plan for protection and conservation of Amur goral and maintenance of their habitat is needed for habitat management after the unification between South and North Korea.

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