



Korean Long-Tailed Gorals (*Naemorhedus caudatus*) are Rare but Successfully Reproducing in Remote Mountains

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Abstract

The long tailed goral (*Naemorhedus caudatus*) is an elusive species with a low and fragmented total population, mostly occurring in remote and elevated areas. In this study we used infrared automated trap cameras within the Seorak Mountain National Park, Republic of Korea. We documented the occurrence of long tailed gorals at the location of each trap camera, and also the presence of two young gorals within the National Park during the summer 2015. This is an important finding for the conservation of the species, emphasizing the success and benefits of large scale, non-fragmented, national parks for conservation.

Keywords: long tailed goral; *Naemorhedus caudatus*; detection; juvenile; Seorak Mountain National Park.

1. Introduction

Mammals, and especially large ones, are among the best known species to science. When it comes to Caprinae, however, general knowledge is still at a miss. The fact that these mountainous species typically occur in remote mountainous areas probably contributes to the paucity of information.

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The wildlife of Seorak Mountain National park has been submitted to strong exploitation over the last century, leading to the extinction of emblematic species such as gray wolves (*Canis lupus*), dholes (*Cuon alpinus*), red foxes (*Vulpes vulpes*), tigers (*Panthera tigris*) and leopards (*P. pardus*) (reviewed by [1]).

Rare species such as bears (*Ursus thibetanus*) or gorals (*Naemorhedus caudatus*) may be sporadically present, but their presence is mostly limited to areas where they have been reintroduced, such as Jiri mountain for bears [2] and the Worak mountain for gorals [3]. Seorak Mountain National Park is consequently poor in mega-fauna and herbivorous species can thrive without fear of predation other than the pest management programs set by the government to prevent over-population. Gorals are not affected by these programs as they are protected as endangered species but also as natural monument species (#217).

A single species of Caprinae, the long-tailed goral (*Naemorhedus caudatus*), is found in the Republic of Korea. The species has been categorized as endangered by the government of the Republic of Korea [4] and as vulnerable by the IUCN [5]. This categorization is based on an estimate of very low population size, bringing the total number of individuals between 864 and 920 [6]. The population in the Republic of Korea is composed of four sub-populations distributed in isolated localities [7]. The distribution of Korean gorals is limited to areas with high altitudes due to the species' preference for rocky regions and timberlands to decrease predation [8].

We documented that the largest population of *N. caudatus* from the Republic of Korea is breeding within Seorak Mountain National Park. This finding is important for the conservation of the species and the designation of breeding grounds of importance.

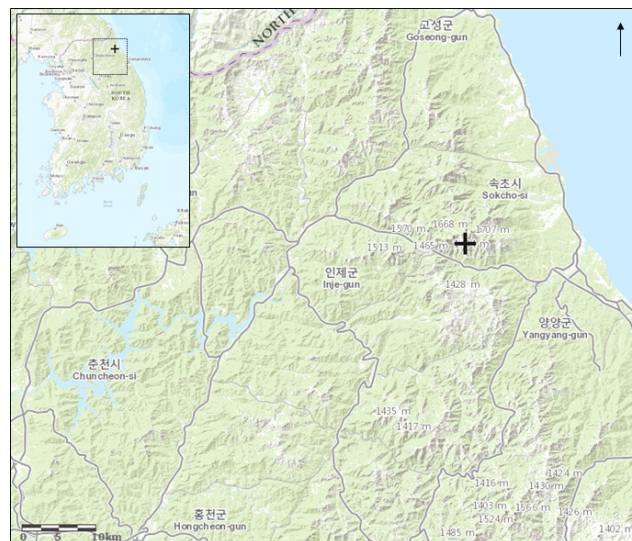


Figure 1: Map representative of the location of the camera-traps. The crosses indicate the location of the camera traps.

2. Material and methods

To detect the presence of breeding Korean gorals in Mont Seorak, we conducted video recordings from February 5 2015 to August 16 2015 (Figure 1). We surveyed 19 localities along a transect between 982 and

1539 m a.s.l. All survey localities were located between the points of coordinates 38.110639°N, 128.451414° E and 38.098658°N, 128.452361°E, in the area above Oseck springs (Table 1). An interval ranging between 120 and 240 m was kept between two adjacent trap cameras. Each locality was recorded for 24 h, using one of six automated, infrared-trap cameras (Moultrie M-990i, Georgia, USA; Hyperfire HC600, Reconyx, Winsconsin, USA; Bushnell 119436, Kansas, USA).

We analyzed the video recordings of *Naemorhedus caudatus* first through a comparison of the number of sites surveyed and the occurrence of young gorals. We then noted the frequency of occurrence of breeding in relation to the occurrence of adults. All computations analyses were carried through SPSS (v. 21.0, SPSS, Inc., Chicago, IL, USA).

3. Results

A large number of rare or endangered mammals were detected, including badgers (*Meles leucurus*), weasels (*Mustela sibirica*), Siberian roe-deer (*Capreolus pygargus*), boars (*Sus scrofa ussuricus*), rabbits (*Lepus coreanus*), and leopard cats (*Prionailurus bengalensis*). The focal species, Korean gorals (*Naemorhedus caudatus*), was detected 14 times in this study. More importantly, we also recorded the presence of young Korean gorals on both 6 April 2015 (38.106117 °N, 128.451892 °E, 1424 m elev.) and 27 July 2015 (38.104056 °N, 128.451722 °E, 1435 m elev.; Figure 2).

Table 1: List of sites and their coordinated were the long tailed gorals (*N. caudatus*) were observed.

Camera ID	Latitude (°N)	Longitude (°E)	Individuals
1	38.099806	128.4525	Adult
2	38.110583	128.451722	Adult
3	38.106556	128.451778	Adult
4	38.100833	128.452528	Adult
5	38.104003	128.451936	Adult
6	38.098658	128.452361	Adult
7	38.108967	128.451461	Adult
8	38.104003	128.451936	Adult
9	38.110639	128.451414	Juvenile + adult
10	38.104056	128.451672	Adult
11	38.109000	128.451361	Adult
12	38.099111	128.451389	Adult
13	38.102861	128.452806	Adult
14	38.104056	128.451722	Juvenile + adult

Adult gorals were detected at 73.7 % of localities and young gorals at 10.5 %. We concluded that the species is

frequently observed at the sites along the transect during the study period. When only the recordings with adult gorals present were selected, the occurrence of young gorals increased to 14.3 % of cases.

The probability of detection for adult gorals along the transect was thus 0.74, and the probability of detection of young gorals within the sites where the species is known to occur was 0.14. More systematic studies are required to better understand the occurrence of the species using video cameras. The videos of both sightings are available online on Youtube at https://youtu.be/kZFt_nyXbFo and <https://youtu.be/jAX7gWKz7Ww>.

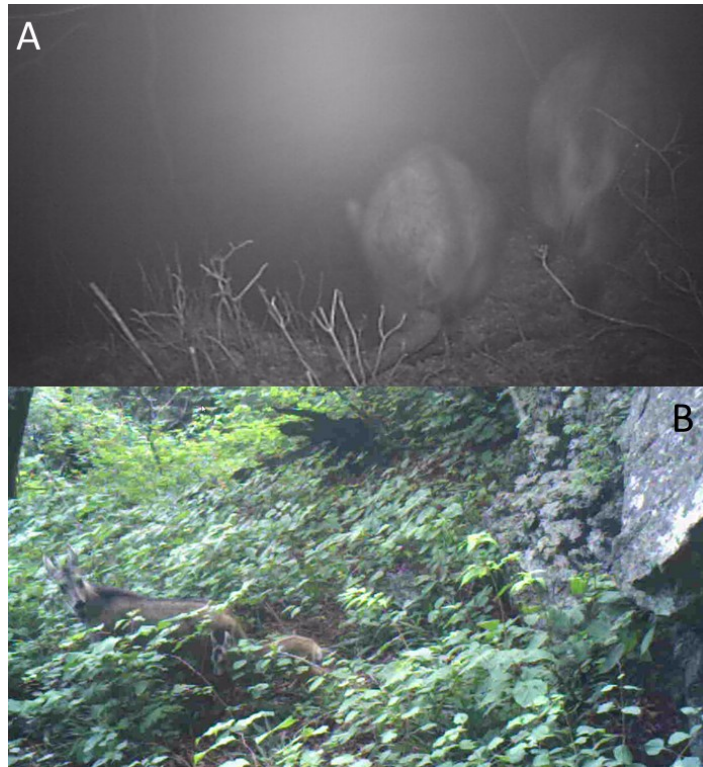


Figure 2: Extracted image from the videos of the young gorals recorded in Mount Seorak. In the infrared still (A) both individuals are seen from the back. In the daytime still (B), the young is maintaining close proximity with its mother. Both juveniles are tailing their mothers.

4. Discussion

Although rare, our results show a frequent appearance of *Naemorhedus caudatus* on the transect surveyed, and to the best of our knowledge, this is the first young gorals reported in the Republic of Korea. This study is of significant importance in the frame of conservation. Adults were mostly recorded while walking, and one individual was seen foraging. In both sightings, the young gorals were accompanied by their mothers. In each sighting, the female was seen foraging, with her offspring behind. The juvenile in the first sighting appeared to be larger than the one in the second sighting. Furthermore, the juvenile in the first sighting was in less close proximity to its mother than the one in the second sighting, suggesting increased independence with age.

Gorals migrate to areas at lower altitudes during winter due to snow, but are consistent in their territory use once established at low or high latitude for the season [9, 10]. We therefore concluded that this area is used for both

over-wintering and breeding by the species. Our results may, however, be specific to the site surveyed and not representative of the behaviour of the species. The known restricted range of females (1.08 ± 0.53 km²), especially during the breeding season [11], makes the area around each sighting of prime importance for the conservation of the species. This is also highlighted by the fact that gorals have preferences for high altitudinal areas and specific diets [11]. Due to habitat fragmentation, it may be difficult for pregnant females to find alternative sites suitable for both over-wintering and breeding.

5. Conclusion

The principal causes of decline for gorals by the IUCN [12] and NIBR [13] are poaching and habitat destruction in relation to deforestation. These two sightings occurred within the largest Korean population of gorals [6], also one of the largest in the world [5]. This finding in this study is a very welcome fact, as all gorals were situated within a protected national park. We recommend the continued protection provided so far to the species at the site. The probabilities of detection presented here could be used for the design of eco-tourism and animal watching programs, enabling managers to estimate the chance of encounters. We also stress that this population should be reconnected to other populations, such as the one in Worak Mountain, to prevent genetic drift and extinction through inbreeding.

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