The Use of Camera Traps for Monitoring the Population of Long-Tailed Gorals

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ABSTRACT

The long-tailed goral (*Nemorhaedus caudatus*) is a rare montane ungulate species with a patchy distribution. In the Sikhote-Alin Reserve, gorals occupy the northern part of their range, concentrated primarily in a small coastal area (6.4 km^2) in Abrek Urochishe. Our pilot study tested the feasibility of individual photo-identification of gorals and population size estimation using the capture–recapture method. We used 10 camera traps spaced 0.6–2 km apart on coastal slopes to monitor the gorals. Four additional cameras were placed at the Reserve boundaries, mainly for law enforcement purposes, such as documenting trespassers. Between June 1 and December 31, 2013, we collected nearly 3000 photographs of gorals, 500 photographs of other wildlife, and 12 images of illegal activities within the Reserve. The total sampling effort was 1870 camera days. Photo data showed that goral horns are reliable biometric identifiers, distinguishable by size, shape, pattern, and the number of rings. The proportion of individually identified gorals in our photos was 0.64 (SE = 0.05). Most individuals (45) were marked (i.e., first detected on camera) in the fall; therefore, preliminary estimates of the goral population size were made between October 11 and December 20, 2013. A closure test confirmed that the population was, in fact, closed (z = −2.670, P = 0.004). The best-fit closed population multiple recapture model for our data was the heterogeneity model M$_h$ (programme CAPTURE), which assumes an unequal capture probability (χ^2 = 112.19; d.f. = 9; P = 0.000). The average goral capture probability was 0.16, and the corresponding population size was estimated at 90 individuals (SE = 6.91; 95% CI: 77–125 individuals). The average goral population density in a 3.5 km^2 effective sampled area (56% of the entire plot area) was 25 individuals/km^2 (SE = 5.62). Extrapolation to locations that lacked data suggests that Abrek Urochishe supports a goral population of 160 individuals. Our results demonstrate that camera trap data can be used for photographic capture–recapture sampling of goral populations. This approach may be more effective than traditional visual surveys of montane ungulates that tend to underestimate the population abundance. The use of camera traps will undoubtedly enhance goral monitoring efforts, aiding in the conservation of this rare species.

Introduction

The long-tailed goral (*Nemorhaedus caudatus*) is a montane ungulate inhabiting rocky areas of the coast of northeastern China, Korea, and the Russian Far East. It is listed in the International Endangered Species List and the Russian Endangered Species List. In

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the Sikhote-Alin Reserve, gorals occupy the northern part of their range, concentrated primarily in a small coastal area in Abrek Urochishe.

Research into the population estimates is a major part of the monitoring systems and programmes for the conservation of rare and endangered species. However, estimating the size of populations of these species is often a serious problem (Gaillard et al., 2003). Goral is one of the least studied species of montane ungulates, and there are no reliable data for their numbers in different habitats (Shackleton, 1997). Population estimates of gorals in the Sikhote-Alin Biosphere Reserve have been conducted annually for 16 years (1979–1994), during winter and spring, when the majority of the population is in open rocky meadow areas. The survey method used is the direct visual counting of animals from a boat and ground observation posts simultaneously (Myslenkov and Voloshina, 1989). The quality of the survey is highly affected by snow depth, which influences the distribution of the gorals, as well as by the number of observers at the ground observation posts. The effective area of the survey was not defined, and estimates of the total number of animals were rather arbitrary. Therefore, information on the goral population size in the Sikhote-Alin Biosphere Reserve must be updated and verified.

The use of digital camera traps is an increasingly popular method in ecological studies (Long et al., 2008). The "capture–recapture" model is widely used to estimate the sizes of populations and has a good statistical database (Karanth and Nichols, 2002; Otis et al., 1978). Photo identification of animals is most often used for species with a unique pattern of bands or spots, and in most cases is not suitable for ungulates (Karanth and Nichols, 1998; O'Connell et al., 2011). However, this approach is also used for species that do not have such pronounced individual differences, such as tigers and leopards. For example, the natural marks for sea otters are the scars on their noses (Gilkinson et al., 2007). For lions, it is the pattern in the growth of whiskers (Tumenta et al., 2010), and for whales and dolphins, the marks and hollows on the edges of the fins are used (Hammond et al., 1990; O'Brien et al., 2009).

Methods for population estimates in which individual recognition is not a prerequisite require a random arrangement of cameras and knowledge of the velocity of the animal, which often leads to a small number of images and requires additional telemetry studies (Rowcliffe et al., 2008). The purpose of this pilot study was to test the possibility of using a photo survey of goral using "capture–recapture" method and to establish a system of video registration to enhance the protection of this rare species in the Sikhote-Alin Biosphere Reserve. In addition, data on the population structure, activity and abundance of predators in the habitat of gorals were collected.

Materials and Methods

The study was conducted in the Sikhote-Alin State Nature Biosphere Reserve located in Primorsky Krai, Russia: 45°02′–45°09′ N and 136°41′–136°46′ E.

Goral inhabits a small coastal area (6.4 km^2) on the rocky southeastern slopes of Abrek Urochische (Fig. 1). The steep slopes at the top of the ridge are covered with xeromorphic Mongolian oak forests, coastal cedar forests with oak and mountain larch forests. The
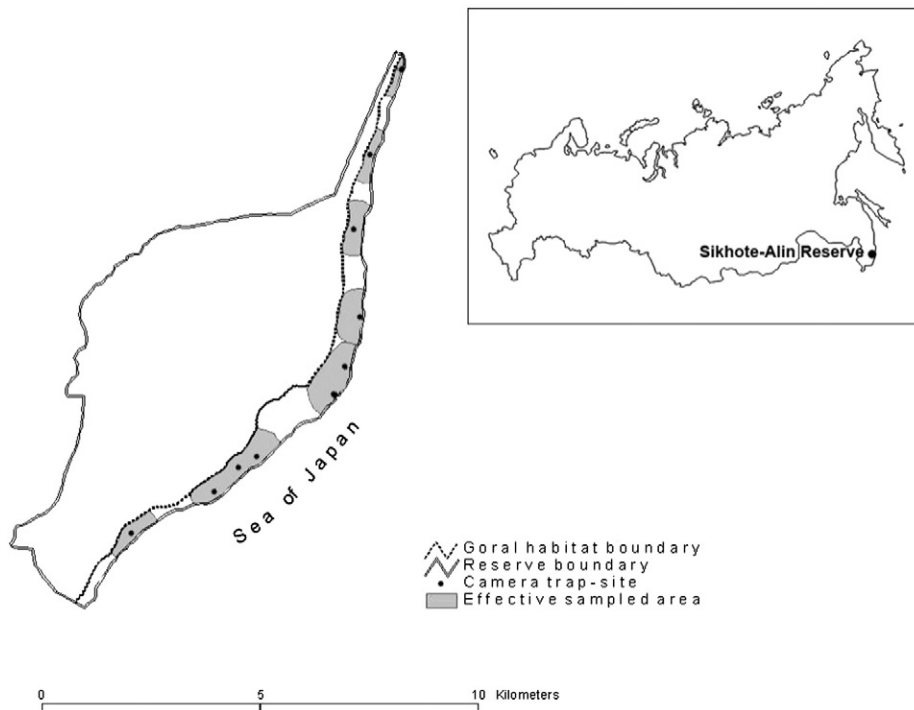

Fig. 1. Location of camera traps and the effective goral survey area in Abrek Urochische, Sikhote-Alin State Nature Biosphere reserve.