Original Article

Reintroduction and Behavioral Observations of Chinese Gorals (*Naemorhedus griseus*) in Natural Conditions

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Abstract

The study of the ecology and behavior of gorals (*Naemorhedus griseus*) was conducted in Maelao-Maesae Wildlife Sanctuary, Chiang Mai Province during July 2012 – July 2013. The behavioral patterns of the gorals were observed using focal-scan sampling and descriptive methods. Results showed that the seven most common behavioral patterns were standing, walking, resting, grooming, scratching, feeding (foraging), and ruminating. Twelve plants were recognized as goral food based on direct field observations. Overall land area used by the gorals in this study was 81,124 m^2. The highest number of gorals was found in dipterocarp forests, followed by deciduous forests and the coniferous forests, respectively. Natural condition scores (BCS) of each goral revealed moderate score levels (2.6). Survival rate under soft release conditions was high (50.00%). Female gorals were observed to give birth under soft release conditions. The results from this study provide new knowledge for the reintroduction of gorals into their natural habitat that can be used for conservation management, especially in terms of facilitating and monitoring the increasing goral populations. Effective reintroduction programs can be used as a first important step in conserving gorals in their natural habitats.

Keywords: behavioral patterns, goral, *Naemorhedus griseus,* reintroduction

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Introduction

Effective protection and conservation of native wildlife species are important to ensure that the ecosystem remain intact. Indigenous wildlife is a key component that keeps the ecology in balance. However, in many parts of the world harmful practices such as overhunting and invading wildlife habitats have been done. As a result, many wildlife spacing are extinct and many more are on the verge of extinction (Belovsky, 1987).

Several factors are responsible for biodiversity loss. These include the steady increase in human population, which is positively correlated to the exploitation and consumption of natural resources and habitat encroachment (Jha and Bawa, 2006), the introduction of non-native species to a wide variety of ecosystems, which has disrupted the community structure and ecological functioning of those areas (Scott et al., 2005), and in the change in climate. Continued exploitation of wildlife and subsequent decrease in wildlife population has significantly been compounded by these factors (McLellan et al., 1999). Among the many wildlife species that are at risk of becoming extinct are gorals.

Chinese goral (*Narmorhedus griseus*) is listed as one of Thailand's endangered animal species; Vulnerable in International Union for Conservation of Nature in 2013, and is also listed in a report by the Convention of International Trade on Endangered Species of Wild Fauna and Flora; CITES (IUCN, 2013). In Thailand, Chinese goral can only be found in the northern part of the country. Their population has dramatically decreased due to habitat loss from human activities such as housing development or overhunting for food and animal parts.

In 1993, there was an effort to reestablish a healthy population of goral outside of their natural habitat (*ex situ*) at Om Koi Wildlife Breeding Station in Chiang Mai Province, Thailand. The captive breeding program has been very successful (Kongprempoon, 2003). The next important step for goral conservation is to reestablish a healthy population in their natural habitats (*in situ* conservation).

Our research aimed to provide knowledge that can be used as a guideline for a goral reintroduction program. The research included a study of appropriate landscape habitats as study sites, which are very important for the survival of gorals. The most effective, successful, and efficient way to reintroduce gorals back into their natural habitat is described. This research project will play an important role in the conservation of gorals in the wild for future generations.

Materials and Methods

Study area: Maelao-Maesae Wildlife Sanctuary, Chiang Mai Province was used for the purposes of reintroducing goral back into its natural habitat (geographic coordinate of this area is 4 6 8 9 2 0 , 2 1 2 5 6 6 3). Topography of the area is dominated by rolling hills of low to medium elevation. There are various peaks above 1,000 m asl, and the area includes headwaters of several tributaries of Mae Sa and Mae Teang rivers. This area supports a variety of forest types, including evergreen forests along some watercourses and evergreen forests on hill slopes above c.800 m asl. A deciduous forest is found at lower elevations, with coniferous and evergreen forests found along the ridges.

Behavioral observations: Six healthy gorals (3 adult males and 3 adult females) were selected from Om Koi Wildlife Breeding Centre. Each individual was marked using ear-tags and a radio collar. Direct observations were made from vantage points through binoculars. Indirect observations involved droppings and footprints. The survey was conducted four times per day, including morning (06.00-09.00 am), late morning (09.01 am-12.00 pm), afternoon (12.01- 03.00 pm) and evening (15.01-18.00 pm). For the behavior observation, focal-scan sampling method and/or descriptive method were used to gather information on various aspects of the goral's behavior. The observation period was recorded for about three seconds after the individual was initially sighted, including feeding (foraging), feeding (concentrate), ruminating, drinking, defecating, urinating, standing, walking, running, jumping, climbing, sleeping, resting, sleeping while standing, grooming, scratching, aggressive posturing, guarding, mating, socializing behavior, collar scratching, soil licking, horn rubbing, and milking. The goral's health was determined using Body Condition Score (BCS), described by Mario et al., (2007). Radio collars and at least 2 radio receivers were used to track the gorals. Gorals usually stay in the forest. Forest habitat utilization and feeding were recorded each time a goral was found.

Evaluation of goral's home range: Radio telemetry involved the use of a receiver (TR-4K-VHF) and a radio collar (MOD-401 VHF collar). Location was registered using Global Positioning System (GPS).

Radio telemetry was applied to determine the location and survival rate of gorals by triangulation from three separate points that were located along the study trails or along the road for the purpose of estimating the positions of the gorals using LOAS software. The data was then analyzed and the position was entered into Arcview 9.3 in order to estimate the home range of the animals. Distribution of the goral was estimated according to the observed home range of each animal and the overlap among the home ranges.

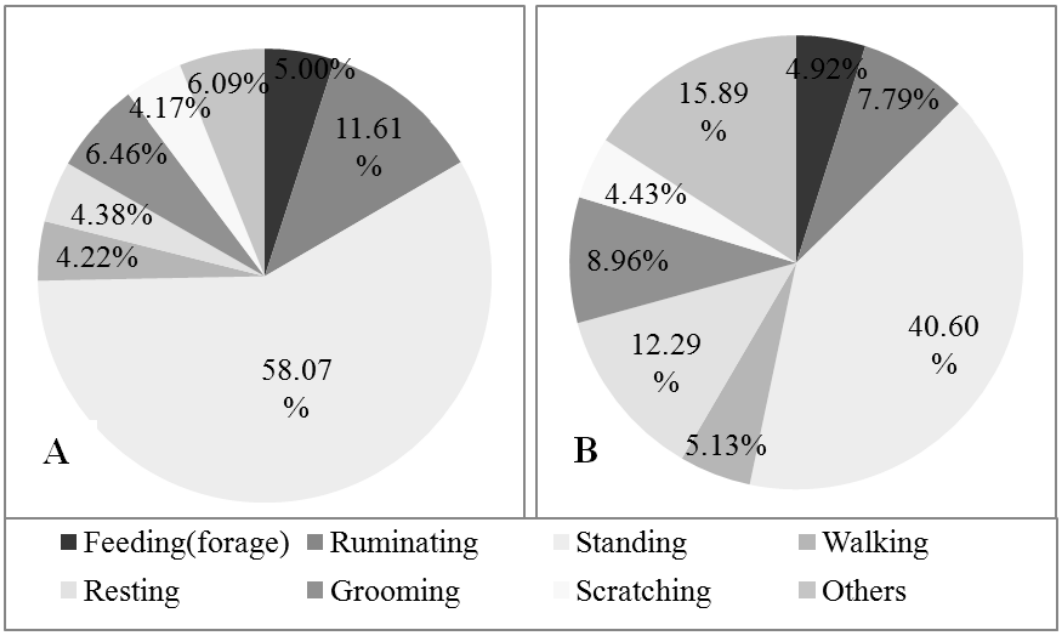

Figure 1 Proportion of male and female goral's behavior in soft release condition (A) male goral, (B) female goral

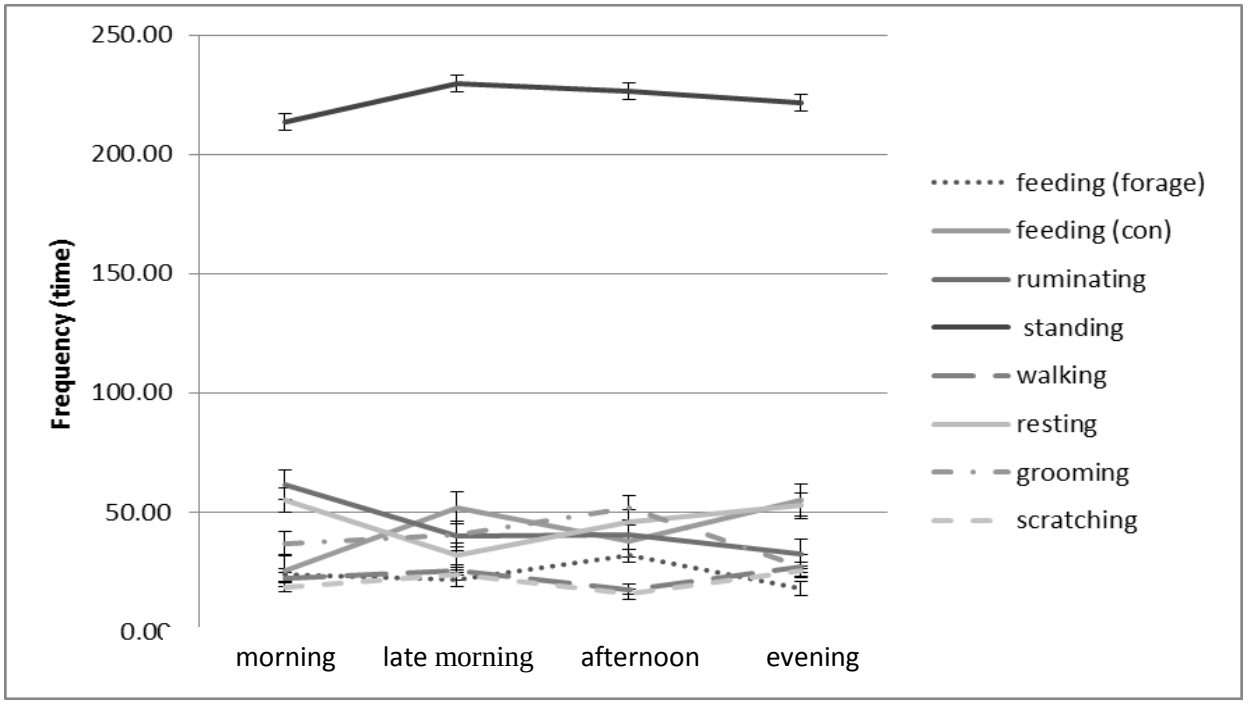

Figure 2 Overview of each main behavioral pattern in each duration

Results

Seven behavioral patterns were labeled as being common for both sexes. These included standing, walking, resting, grooming, scratching, feeding (foraging), and ruminating with 58.07%, 4.22%, 4.38%, 6.46%, 4.17%, 5.00% and 11.61% for male gorals and 40.60%, 5.13%, 12.29%, 8.96%, 4.43%, 4.92%, and 7.79% for female gorals, respectively (Fig 1).

Specifics description of each behavior are explained for a better understanding of the overall goral behavior as follows:

1. Standing: The standing behavior involved having all four hooves on the ground without any other expression of behavior.
2. Walking: This behavioral pattern involved the habit of moving slowly with the use of the front legs followed by the hind legs.

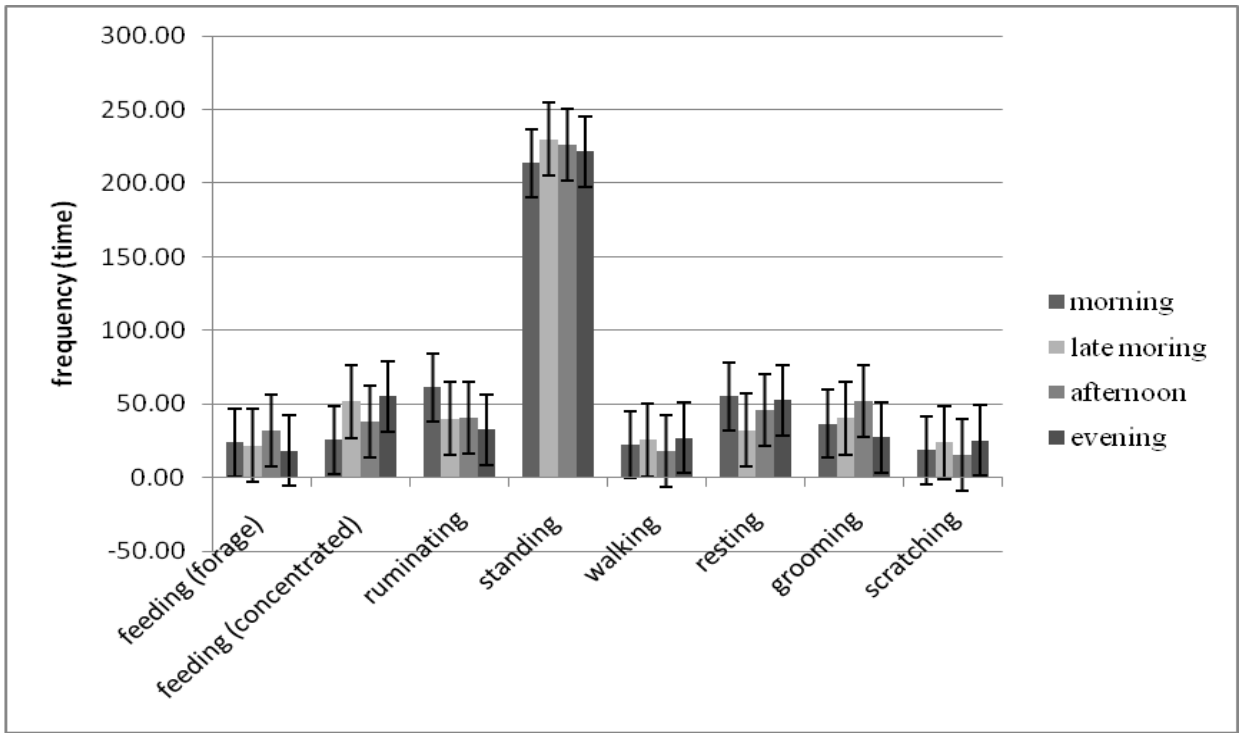

Figure 3 Behavioral observation in each duration in the day

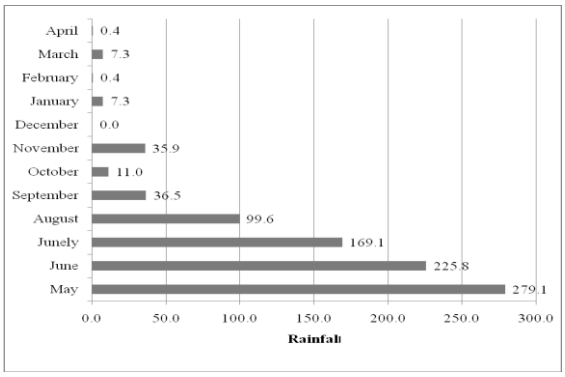

Figure 4 Number of rainfall at Maelao-Maesae Wildlife Sanctuary, Mae Hong Song province from May 2012 – April 2013 (Thai Meteorological Department).

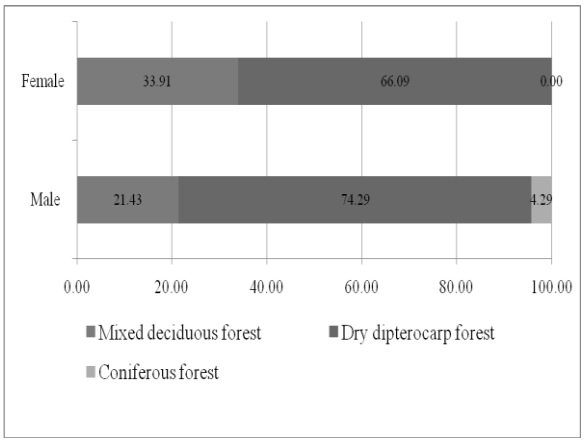

Figure 5 The percentages of male and female gorals in each forest type

3. Resting: The gorals were selected from suitable locations which mostly consisted of shaded areas under trees and other large objects. They used one foot to scratch the ground surface, were back down on their knees and then lied down.

4. Grooming: The gorals typically licked and scratched. They licked themselves by turning their heads to the area to be licked. Then, the tongue was used along the torso, shoulders, back, hips, legs, tail niche beneath the hooves and between the legs to lick the penis. When licking the penis, the hind legs of the male gorals were lifted to one side and extended. The licking behavior could be observed while the gorals were standing or lying. While scratching, the gorals used their hoofs to scratch the face, ears, neck, and shoulders. This behavioral pattern could be observed while the gorals were both standing and resting.

5. Scratching: Scratching could often be observed as being anxious because the goral was disturbed by insects and other ecto-parasites. Moreover, comprehensive materials clinging to parts of the body might be the cause.

6. Feeding (foraging): Foraging involved the head down with the nasal inhalation of food into the goral's mouth with tongue flicks. Then, the goral would look up, chew a little and swallow. After that, it would smell and continue foraging with tongue flicks.

7. Ruminating: Chewing both while standing and lying down. The goral would transfer roughage rumen to the mouth for chewing. Rerumination could be observed as food moved from the throat back to the mouth and into the bulging cheeks, which would then bulge out. Once the rumen was thoroughly chewed, it would be swallowed as food.

The highest demonstrated common behavior was standing (Fig 2), while feeding (foraging), feeding (concentrate), ruminating, walking, resting, grooming, and scratching behaviors were observed at all times with less frequency. Resting and ruminating behaviors were highest in the morning (55.00% and 61.33%). Feeding (foraging), standing and grooming behaviors were demonstrated most frequently in the afternoon (31.67%, 226.33%, and 51.67%, respectively). Feeding (concentrate), walking, and scratching behaviors were highest in the evening (55.00%, 27.00%, and 25.33%), respectively (Fig 3).

Monthly behavior patterns showed that the feeding (foraging), feeding (concentrate), ruminating, standing, walking, resting, grooming, and scratching behaviors occurred with the most frequency in May (20.67%), January (68.00%), January (61.00%), August (59.00%), December (10.33%), May (48.00%), November (13.00%), and June (12.33%), respectively.

Twelve plant species were observed as the goral's food under natural conditions based upon direct field observations. These included *Spondias* axillaris, *Phyllanthus emblica, Eriochloa procera, Terminalia alata, Imperata cylindrica, Ageratum conyzoides, Pouzolzia pentandra, Spilanthes acmella, Centotheca lappacea,* unknown 1 (Family Fagaceae), unknown 2 (Family Leguminoseca), and unknown 3 (Family Sterculiaceae).

The total rainfall of the Maelao-Maesae Wildlife Sanctuary, Chiang Mai Province from May 2012 – April 2013 was 1,300.4 mm. The rainfall was highest in May (232.6 mm) and lowest in February (0.00 mm). The descriptive details of the rainfall that occurred during each month are demonstrated in Figure 4.

Distribution and land usage of gorals: Dry dipterocarp forests were the type of forest where the gorals were most often found, followed by mixed deciduous forests and coniferous forests, respectively (Fig 5). For the land usage analysis, the average land used by six gorals was 81124.50 m² (Fig 6). Out of the six gorals, three were tracked through survival, putting the survival rate at 50.00%. Among the three gorals that were found to be dead, one died from pneumonia.

Body condition score (BCS): The average BCS of each goral was 2.60. BCS data is displayed for all gorals, but the BCS of some female gorals reduced during the process of parturition (Table 1).

Discussion

As a valuable resource to the rural community of Thailand and the environment, Chinese goral (*Naemorhedus griseus*) can be a great natural food source, a source of income, a simple component of the wildlife population, as well as a subject of numerous research studies. Goral has been classified as an endangered species with a declining rate of distribution (Mead, 1989). It has also been listed as being a threatened species by the IUCN

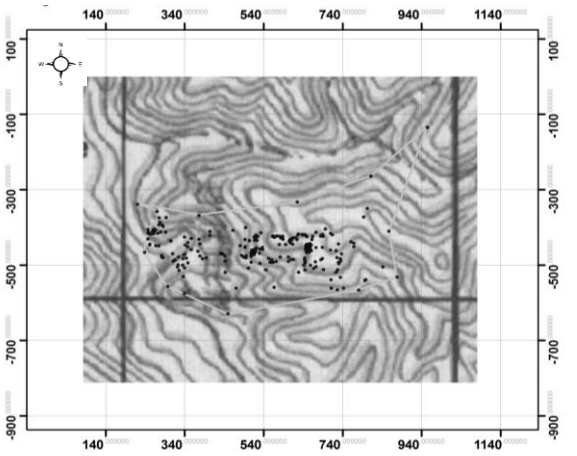

Figure 6 Illustration demonstrating of goral's land used

Table 1 Body condition score of each gorals

Month		Body condition score (1-5)					
		Male			Female		
		M-1	M-2	M-3	F-1	F-2	F-3
captive	07-2011	2.5	2.5	2.5	3.0	3.0	2.5
1 mt	08-2011	Death	2.5	2.5	3.0	3.0	Death
2 mt	09-2011		2.5	2.5	3.0	3.0	
3 mt	10-2011		2.5	2.5	2.5	3.0	
4 mt	11-2011		2.5	2.5	2.5	3.0	
5 mt	12-2011		2.5	2.5	2.5	3.0	
6 mt	01-2012		2.5	2.5	2.5	3.0	
7 mt	02-2012		2.5	2.5	2.5	2.0	
8 mt	03-2012		NF	2.5	2.5	2.0	
9 mt	04-2012		NF	2.5	2.5	2.0	
10 mt	05-2012		2.5	2.5	3.0	2.5	
11 mt	06-2012		Death	2.5	3.0	2.5	
12 mt	07-2012			2.5	3.0	3.0	

(Shackleton, 1997) and assigned as being in a position of vulnerability based on information gathered from different sources (Sheikh and Molur, 2005). Due to a lack of proper education, all hunters and the public do not recognize the biological and behavioral importance of *N. griseus* in nature. Administration and conservation of large herbivores are complex principally due to their large requirements for space. The intensive expansion of land usage of humans is responsible for habitat fragmentation which results in direct and indirect conflicts with wildlife animals over for the remaining semi-natural spaces and resources (Noss et al. 1996; Woodroffe and Ginsberg, 1998). Management of the goral population in Thailand and other countries is important to guarantee long–term survival of their natural conditions.

Standing behavior was observed with the highest frequency in our study. This behavior is used when looking for food and/or avoiding disturbances and dangers from other animals (Grier, 1984). This behavior was most often obseved from December to February because goral's hunger is driven by a form of foraging behavior (Archer, 1979) to find food. Resting behavior was recorded as being the highest in May (rainy season). This was because when it rains, gorals take refuge under trees or huge rocks in the morning hours. This behavior can also occur in the morning after eating, when gorals search for areas for resting which are usually shaded. This area is mainly in dipterocarp forest, which is deciduous during the dry season. The results agree with those published by Kanbunjong (1993), who showed that gorals displayed a high frequency of resting behavior during the same month.

The grooming and scratching behaviors occurred more regularly in the goral's natural environment, where they were disturbed by ecto-parasites, such as ticks other insects and comprehensive materials clinging to parts of the body. These results contrasted with the report by Xie (2006), who determined that when red gorals were kept in captivity, their rutting behavior differed somewhat from those that remained in the wild. Compared to Himalayan goral (*N. goral*), captive red gorals did not show the body/head shaking behavior (Lovari and Apollonio, 1994), which was identified as a behavior of the male goral and was thought to be a display of gentle dominance when used in social interactions. The captive male red gorals in the study mentioned were raised in isolation apart from each other; therefore, this behavior might not yet have been developed. A male Amur goral (*N. caudatus raddeanus*) revealed a typical pattern of stroking a female's head (Myslenkov and Voloshina, 1978).

The twelve species of plants that were observed to be the goral's food are common in northern Thailand. Recent studies have indicated that the population of goral is directly related to an equally small number of plant species, which was determined from direct field observations (Awasthi et al., 2003), indications of general palatability (Anwar and Chapman, 2000), and fecal pellet analysis (Ilyas and Khan, 2003).

Behavioral observations under normal conditions were not easy to be tracked and recorded because the study site with high slopes could not be directly observed, and thus there may not have been enough collected information that could be used to interpret a precise statistic. Furthermore, the gorals were very alert and most of them ran away when they first encountered the researchers. Familiarity with the researchers had to be built up which took about six months.

Furthermore, the gorals were usually found in dry dipterocarp forests rather than mixed deciduous and coniferous forests, respectively. However, the dry dipterocarp forest is more shaded than other forest types in this study area. The gorals' behaviors were observed to be consistent with behavior patterns recently reported by Giotto et al. (2008) on an antelope, *Dorcatragus megalotis*, which was also observed to regularly rest in rock shelters during warmer periods.

In terms of survival rates, during periods of high rainfall, the gorals were more prone to infection, which is thought to be a cause of death for many of them. When they were inflicted with diseases, the diseases tremendously affected their lives. Gorals could not walk to find food and water or participate in other activities which were considered necessary for maintaining a healthy body. Hence, it was impracticable for them to acquire food and water. If they lived through the sickness, it would be very easy to incarcerate and slaughter them because there is a market for gorals even in ill conditions (Parveen and Hasian, 2012). Regarding the natural land usage of gorals, the predicted suitable habitat was located in the environmental setting along walking paths and stone steps. In contrast to Nowicki and Koganezawa (2001), the Japanese serow selected slopes and areas that were close to roads, apparently to avoid other animals, especially Sika deer. This indicated that most mountain goats resided in locations that were less than 150 m from rock outcrops.

IUCN reintroduction strategy calls for the need for an evaluation of the availability of suitable habitats as a key factor in the planning of the reintroduction process (IUCN, 1998). Sophisticated tools have been applied in the identification of suitable release sites, especially Geographic Information Systems (GIS), which are used to represent the distribution of the available habitat locations (Li et al., 2002; Hirzel et al., 2004; McShea et al., 2005). Such assessments have been extended beyond the use of habitat maps that can support the selection of future release areas to reflect patch-specific characteristics as a foundation for enlargement of spatially precise models (Seddon et al., 2007). With regard to the reintroduction of the Eurasian lynx (*Lynx lynx*), the assessment of habitat suitability and distribution (Kramer-Schadt et al., 2002) were fully incorporated with the development of the GIS-based statistical models to quantify the characteristics of the lynx's home range in fragmented areas (Schadt et al., 2002).

In an evaluation of land usage, it is necessary to use GIS to analyze data for studies of the

distribution of goral. In this study, the GIS system was applied to evaluate the land used by each individual goral. The results indicated that the average amount of land used by the goral population was 81124.50 m^2. The results demonstrated that this amount of land was suitable for the survival of the gorals due to the presence of the dipterocarp forests. In addition, this area was an open space, which was appropriated for the daily activities of the gorals. Unlike the main habitat of the serow in other reports, which have been reported to relate their habitat selection with elevation (Mastsumoto et al., 1984), slope (Nowicki and Koganezawa, 2001) and distance to roads (Doko and Chen, 2013), our study indicated that the second plot of the Maelao-Maesae Wildlife Sanctuary, Chiang Mai Province was a suitable location for the reintroduction of gorals.

The body condition score of each goral was considered, which was emitted under soft release conditions. The average BCS of the gorals was 2.6, which is the optimal value of wildlife organisms. This was relevant because the gorals were not too thin (under-conditioned) or too fat (over-conditioned) (Mario, 2007). The evaluation of the BCS of the goral could be observed only from the external morphological appearance because the researchers were unable to get close to the gorals. The BCS of the goral could decrease due to giving birth or from injury, but after about 3-4 months, the BCS of those individuals increased to a moderate score. BCS has been shown to be beneficial in measuring the body conditions of gorals because BCS is the best simple indicator of an available health status that can be used as an indicator of infection by pathogens and as an evaluation instrument to measure the efficiency of goral adaptation to natural environmental conditions.

The reintroduction of the goral to its natural habitat appears to be rather successful. It is quite difficult to understand the biology of the goral in their natural environment due to their complex behavior. This study revealed a moderate rate of survival (50.00%). The adult female gorals were observed to be successful in giving birth during this study. This results indicated that the goral could adapt to soft release conditions as well. The cause of death may be directly related to the forest type. Other forests have higher levels of moisture than deciduous forests and this may account for the predisposition for incidences of pneumonia and death among the goral population. Therefore, the reintroduction of gorals back into their natural surroundings should take place in higher areas of deciduous forests. Moreover, the adult female gorals were observed to successfully give birth in this study. However, the mating behavior rarely occurred and was not found in observed durations.

Our study on the behavior and reintroduction methods of gorals back into the wild provides information that can be useful to conservation management officers for the planning and monitoring an increase in goral populations in the future. This includes protocols used before, during, and after the reintroduction program that could be adjusted and applied to the reintroduction of other species in the future.

Acknowledgments

We thankfully acknowledge the Omkoi Wildlife Breeding Station, the Maelao-Maesae Wildlife Sanctuary, Chiang Mai Zoo and the Bureau Conservation Research and Education, Zoological Park Organization Thailand for granting us access to their facilities. We would like to thank Dr. R.K. Hollis for editing our manuscript. Finally, we acknowledge the National Research Council of Thailand for partly funding this research.

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บทคัดย่อ

การปล่อยคืนสู่ธรรมชาติและการสังเกตพฤติกรรมของกวางผา (*Naemorhedus griseus*) ในสภาพธรรมชาติ

นิธิดล บูรณพิมพ์[1,2*] นริทธิ์ สีตะสุวรรณ[2] อดิสรณ์ กองเพิ่มพูน[3] คีตะ ก่อกุศล[4]
บริพัตร ศิริอรุณรัตน์[4] สุเมธ กมลนรนาถ[4]

การศึกษานิเวศวิทยา และพฤติกรรมของกวางผา (*Naemorhedus griseus*) ได้ดำเนินการ ในเขตรักษาพันธุ์สัตว์ป่าแม่เลา-แม่แสะ จังหวัดเชียงใหม่ ในช่วงเดือนกรกฎาคม 2555 ถึง กรกฎาคม 2556 โดยการสำรวจรูปแบบพฤติกรรมของกวางผาโดยวิธี focal-scan sampling method และ descriptive method พบว่ามี 7 รูปแบบพฤติกรรมที่สามรถพบเห็นได้บ่อย คือ การยืน การเดิน การนอนพัก การเลียตัวเอง การเกา การกินพืชอาหาร และการเคี้ยวเอื้อง นอกจากนี้จากการสำรวจโดยตรงพบว่ามีพืช 12 ตัวอย่างที่เป็นอาหารของกวางผาใน สภาพธรรมชาติ โดยกวางผามีพื้นที่ใช้สอยทั้งหมดเท่ากับ 81,124 ตารางเมตรซึ่งส่วนใหญ่มักเป็นป่าเต็งรัง ฝ่าผลัดใบ และป่าสนตามลำดับ ค่าความสมบูรณ์ของร่างกาย (BCS) ของกวางผา มีค่าปานกลาง (2.6) อัตราการอยู่รอดของกวางผาในสภาพ soft release มีค่าสูงเท่ากับร้อยละ 50.00 จากการศึกษาในครั้งนี้ให้ข้อมูลใหม่สำหรับการปล่อยกวางผาสู่ธรรมชาติซึ่งสามารถใช้ในการจัดการการอนุรักษ์โดยเฉพาะอย่างยิ่งในการติดตามจำนวนประชากรกวางผา นอกจากนี้แผนการปล่อยสัตว์คืนสู่ธรรมชาติอย่างมีประสิทธิภาพสามารถนำมาใช้ในการอนุรักษ์กวางผาในสภาพธรรมชาติได้เป็นอย่างดี

คำสำคัญ: รูปแบบพฤติกรรม กวางผา *Naemorhedus griseus* การปล่อยสัตว์สู่ธรรมชาติ

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