Chapter 2

Literature Review

2.1 General Information

Goral was originally found in Himalaya mountain range in Nepal in 1825. It was considered close to Antelope or Blackbuck of India. It was then classified and named, *Antilope goral* (Hardwicke, 1825). Later, it was analyzed to be different from the Blackbuck completely, so it was classified to be a new genus in 1827, namely *Nemorhaedus* (Smith, 1827). At present, Goral is taxonomically classified as follows (IUCN, 2008):

Phylum Chordata
Class Mammalia
Infraclass Eutheria
Cohort Ferungulata
Order Artiodactyla
Suborder Ruminantia
Family Bovidae
Genus *Nemorhaedus*

(currently spelled as *Naemorhedus*)

Hence, Goral scientific name was *Nemorhaedus goral* (Hardwicke, 1825), which could be classified into 7 subspecies, as follows:

1) *Nemorhaedus goral goral*
2) *N. goral caudatus*
3) *N. goral griseus*
4) *N. goral amouxianus*
5) *N. goral raddeanus*
6). *N. goral hodgsoni*

7) *N. goral baileyi*

Based on the taxonomy above, Goral is classified into Family Bovidae, Sub-family Caprinae (Graham and Round, 1994; Wongthirawat, 1996). It is considered as an Even-toed ungulate, and shares the same family with cattle and water buffalo. Goral has shared the same sub-family with Serow, but smaller which adult's height reaches a little more than 50 centimeter (cm.). In general, each adult Goral weighs around 30 kilogram (kg.). Its hair is mostly brown or grayish brown. A black line along the back reaches its tail. Belly's color is lighter than the back. Short tail is black. Black horn has rings pointing towards the back. Both male and female Goral have horns which are empty inside. Goral's stomach is developed to have 4 parts, including digestive stomach which they can spit out the food eaten earlier and ruminate until the food is edible (Wongthirawat, 1996).

Figure 2: Goral (*Naemorhedus caudatus* Milne-Edwards, 1867) (source: Ecological Research Division, 1997; Wongthirawat, 1996)

In Thailand, Goral's length from head and body is around 82 - 120 cm., tail is 7.6 – 20.3 cm, ear is 10 – 14 cm., hind leg is 26.5 – 28.5 cm., height from shoulder to the ground is 50 - 70 cm. and weight is around 22 - 32 kg. (Lekagul and McNeely, 1988). Goral's horn has a hard skin over the horn axis which is an axial bone attached to its forehead skull (see figure 3, 4 and 5 below). There is only one pair of horn throughout Goral life which size is growing by age.

Figure 3: Goral's head (source: Lekagul and McNeely, 1988)

Figure 4: Inside Goral's head (source: Lekagul and McNeely, 1988)

Figure 5: Lateral side of Goral's head (source: Lekagul and McNeely, 1988)

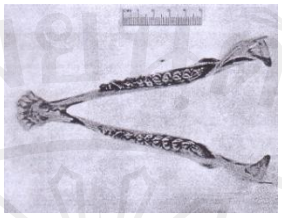


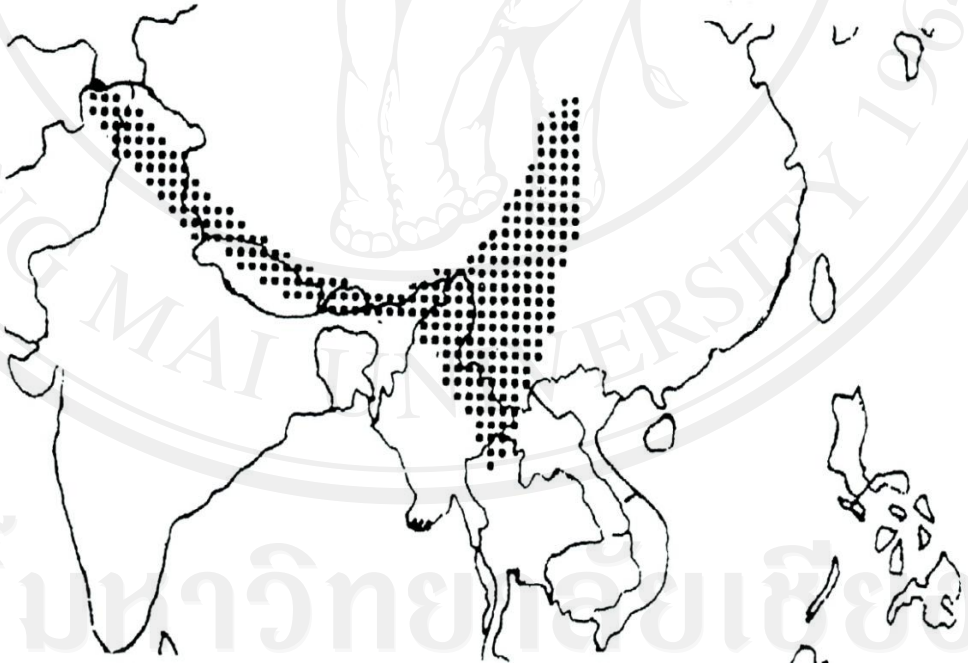
Figure 6: Goral's teeth arrangement (source: Lekagul and McNeely, 1988)

Goral was re-discovered and classified several times during the past 200 years. It was classified by characteristics, behavior and distribution. Original Goral (*Naemorhedus goral* Hardwicke, 1825) was found in 1825 in the Himalaya mountain range as mentioned, and its distribution range was from Siberia southwards to Northern Thailand. Wongthirawat (1996) proposed a revision and a new taxonomy of Goral, which resulted in a new species of Goral in Thailand, namely *Naemorhedus caudatus* (Milne-Edwards, 1867). Its common name is Goral or Chinese Goral. However, the Reserved wildlife species list according to the 1992 Wildlife Reserve and Protection Act used another scientific name, *Naemorhedus griseus* (Milne-Edwards, 1872), following an identification of a specimen from Sechuan province, P.R. China in 1872. After its verification, *Naemorhedus griseus* (Milne-Edwards, 1872) was found to be similar to the Chinese Goral, implying that the name was a synonym of the original name. This research therefore uses the correct name, *Naemorhedus caudatus* (Milne-Edwards, 1867) throughout.

In Thailand, "Kwang Pha" is finalized as a common Thai name. There are several local or ethnic names according to the ethnic minorities, such as, Maa Tewada or Yeong Mhon or Puu Mhon by Khon Muang (Northerners) in the upper Northern region, Yeong Mhon Noi by Tai of Mae Hong Son province, Ta Klae by Karen of Mae Hong Son province, Zai Kloe by Hmong of Mae Chaem district, Chiang Mai province and Aachi by Lahu of Omkoi district, Chiang Mai province.

2.2 Distribution of Goral

Goral has a species distribution range from Himalaya mountain range, southwards to Kashmir and Assam provinces in India, then Myanmar, Southern China and the lowest latitude in Northern Thailand. Goral in the upper North of Thailand is the southern-most distribution which is highly sensitive to threats at present. There were reports about Goral distribution in the high mountains of Thailand, such as, Doi Mon Chong in Omkoi Wildlife Sanctuary, Doi Mon Liam, Doi Mhoe Ka Do in Chiang Mai district (it was clear in this study that Doi Mhoe Ka Do is in Mae Hong Son province, while Doi Pa Ti Do is in Chiang Mai province), and riparian zones along the Ping river in Mae Ping National Park (Ecological Research Division, 1997; Lekagul and McNeely, 1988).



Map 1: Goral distribution in the world (source: Lekagul and McNeely, 1988)

2.3 Goral Ecology

Wildlife ecology comprises 6 components (Lakanavichian, 2010), as follows:

(1) Ecological niche. It is divided into 2 characteristics: wildlife function and specific habitat,

(2) Wildlife habitat. It is an area which wildlife uses for expression and carrying out its activities. It includes forest, grassland, limestone cliff, open space and water source.

(3) Welfare factors. It comprises food, water, coverage and areas for specific activities, such as, salt-lick area, mud pond, powdered soil, mating area, nursery area.

(4) Distribution of biotic community, in relation to the targeted wildlife species.

(5) Wildlife distribution in the country and neighboring countries.

(6) Species distribution range. It relates directly to the habitat and basic needs for wildlife ecology of the species.

Each wildlife species has different ecological tolerance. Some species need the habitats in very narrow ecological tolerance as they cannot adapt themselves for other ecological conditions. For example, some wildlife species select very specific habitat with special ecosystems, such as, Serow, Goral, and they hold onto such very narrow ecological tolerance allowing them to live in only steep and high mountains. On the other hand, some species are able to select various types of habitats as they have a wide range of ecological tolerance. Wildlife habitat selection is a consequence of evolution and adaptation to utilization of the areas (Lakanavichian, 2010). Nevertheless, Goral have adapted to their environment relatively, such as, their color similar to their physical environment – grayish black as same as the rock's color or

brown color, as same as the dry grasses in the dry season (Worawan, 1996; Lakanavichian, 2010).

There was a research on endangered or rare wildlife species in Thailand focusing on the fact that Goral habitats were only the high mountains with steep cliffs in Northern region, with particular to the watershed forests of the Ping river (Nakasathien, 1991). In the late1970s, Goral was not observed in nature by anyone and it was somehow concluded that Goral was extinct (Nakasathien, 1991; Lakanavichian, 2010). Until 1985, Seub Nakasathien and his team went to investigate Doi Mon Chong which peak's height was 1,929 m. amsl. in Om Koi Wildlife Sanctuary and discovered Goral in that area. Early 1986, the investigation team led again by Seub Nakasathien found about 20 Goral in that area of Doi Mon Chong (Nakasathien, 1991). Due to forest destruction and forest-area decrease during the past 5 decades totaling 63.65 million rai (10.18 million hectares), some forest ecosystems have been fragmented and become fragmented forests according to the Island Biogeography principle (Lakanavichian, 2010), indicating weaken relationships between the species and relevant areas. It is obviously that large forest areas have tendency to have the high number of species than small areas, which are risky for wildlife extinction (Bolen and Robinson, 2003).

Goral study in Om Koi Wildlife Sanctuary by Chairat (1997), particularly the west of Doi Mon Chong which was the Granite-mountain habitat of Goral, was found that the habitat being selected for most Goral utilization was grassland, followed by rock cropping areas, and lowland forests between the mountains. In the rainy season, Goral use the areas at elevation 1,400-1,500 m. amsl., while using the areas at elevation 1,500-1,600 m. amsl. in the dry season. There were 12 plant species as food of Goral, mostly grass species. The age ratio between adult and newly-born Goral showed a stable trend of population. Goral behavior could be divided into 2 categories: (1) individual behavior, including eating, walking, standing, running, resting, rumination, drinking, urinating and excretion, climbing, scratching and body licking, and yelling, and (2) social behavior, such as, territory protection, aggression, horn sharpening, scent marking, defeat, greeting, fertilization and calf nurturing. The

relationships between Goral and other wildlife species are various, e.g., competition with Serow, cattle and water buffalo; symbiosis with White-headed Bulbul and Lesser Coucal. Predator in the Goral habitat is likely to be tiger. Relationship between Goral and human beings can be either positive (assistance) or negative (destruction), yielding difficult livelihood of Goral and likely to put Goral in a risk of extinction. It is thus necessary to set up appropriate measures for Goral conservation.

In addition, Goral distribution was also discovered in other legal conservation areas. There were 7 legal conservation areas (both wildlife sanctuary and national park), for instance, Mae Lao – Mae Sae Wildlife Sanctuary which Goral were found at Doi Mon Liam, Chiang Dao Wildlife Sanctuary which Goral were found at Doi Luang, Lum Nam Pai Wildlife Sanctuary which Goral were found at Baan (village) Nam Kad, Muang district, Mae Hong Son province, Mae Tuen Wildlife Sanctuary which Goral were found at Doi Poh Luang, Mae Ping National Park which Goral were found at Haad (beach) Pha Lhek, Doi Inthanon National Park (N.P.) which Goral were found at Kiew Mae Paan, and Om Koi Wildlife Sanctuary (W.S.) which Goral were found at Doi Mon Chong as mentioned (Chairat, 1997; Chayutagul, 2006).

A study on application of Global Information System (GIS) and remote sensing for assessing Goral habitat in Om Koi W.S., Chiang Mai province by Deeprasai (2006) found significant factors for habitat selection by Goral, including distance from roads, elevation, rock type, water source and aspect respectively. The results showed special habitat of Goral that were grassland on high cliffs with western aspect, and far from human activities. Suitable areas for Goral livelihood was 71,592.25 rai or 9.58% of the total land area of Om Koi W.S., while other less suitable area was 679,786.25 rai or 90.42% of the total Om Koi W.S. area. Suitability of Goral habitat and factors related to Goral presence were useful to Goral habitat management for conservation. Weakness of Goral habitat was the high cliffs with grassland causing limiting number of Goral population in the habitat (Graham and Round, 1994), along with hunting for oil, horn and meat to fulfill a belief that Goral

oil could cure bone problems, Rheumatoid and Arthritis, resulting in high risk of Goral population (Kekule, 2004).

Goral habitat exploration by GIS in Om Koi Wildlife Sanctuary, Chiang Mai province, Chayutagul (2006) studied Goral behavior in semi-natural captives at Om Koi Wildlife Breeding Station and found 2 categories of behavior: individual behavior and social behavior, including eating, rumination, excretion, mobility, scratching, body licking, stretching and courtship. The behavioral information is utilized as an approach to explore Goral habitats at Doi Mon Chong, comprising three methods: roadside survey, random sampling survey, and interview. The results showed that Goral mostly grazed in the grassland and they liked to eat grasses between the rock crops, rest and ruminate on rock yards at high slopes. Pine forest scattered on the mountains were utilized the least by Goral. Analysis of suitable habitat for Goral by applying the GIS program, namely Arc View 3.3, was based on the inventory data including factors which affect Goral livelihood, i.e., food source, water source, geography, distance from human activities and distance from wildlife competitors. The results of suitable habitats are presented in map forms and expected to be useful for Goral habitat management, with particular to an approach of eliminating human disturbances.

A study of Goral behavior in captive was conducted at Choeng Doi Suthep Wildlife Conservation Development and Promotion Station, Muang district, Chiang Mai province by Karnbanchong (1993) (at that time, the Station's name was Choeng Doi Suthep Nature and Wildlife Study Center). The behavioral study by observation and recording around the captives included eating, excretion, mobility, resting and ability for comfort. The results were that frequency of Goral individual behavior changed over time, during the day and months. Male and female Goral did not stay near each other, and males showed aggressive behavior more than females, particularly during the reproduction period which was once a year during mid October – end January. Pregnancy was 6-8 months. Kekule (2004) found that Goral fertilized during November to December in nature, and produced only one offspring per year.

Nakasathien (1987) studied Fea's Muntjac (*Muntiacus feae* Thomsa and Daria, 1889) which has been a reserved species of Thailand. Fea's Muntjac were mostly found in Tanaosri mountain range and Southern region of Thailand, so the study was carried out near Klong Saeng Wildlife Sanctuary in Surat Thani province. Its weight was around 20 kg., so its size was close to Goral and several behavioral types were similar. It was found that habitat size for food foraging and escape was around 10 km^2. Since habitat size of Goral has yet been studied, it may be feasible to compare habitat size of Goral and Fea's Muntjac for further estimation of habitat characteristics of Goral aiming for future conservation of these two reserved species in Thailand.

2.4 Goral Population

Based on literature review, none of the documents pinpoint an exact number of Goral population in Thailand, only various statements about a small number of population were presented (Lakanavichian, 2010). Although there are currently some breeding Goral in captives by various agencies, such as, 80 Goral at Om Koi Wildlife Breeding Station in Om Koi district, Chiang Mai province which Goral are in semi-natural captives (Nimitsilp, 2012); 26 Goral at Chiang Mai Night Safari which are in captives (Thongmee, 2011); 3 Goral in Chiang Mai Zoo which are in captives (Thongmee, January 2013 – personal communication). There are currently 109 Goral from artificial breeding in captives.

Goral population in nature is not yet available from any studies. Systematic methodology is needed for population assessment. It is thus difficult to estimate the exact population in the entire country, whether in the legal protected areas or the real nature, outside the protected areas. Nevertheless, a wildlife ecologist-cum-photographer whom has explored most forests in Thailand, including wildlife sanctuaries which were for wildlife study to some extent, has estimated that there should be a maximum of 60 Goral in the wild of Thailand (Kekule, 2004).

2.5 Goral Conservation

Effective wildlife conservation needs to practice in-situ conservation, such as, protection of reserved wildlife status, enactment of wildlife sanctuaries and non-hunting areas, and ex-situ conservation, if necessary. Conservation of wildlife species depends very much on the status of Reserved Wildlife and Protected Wildlife species under the Wildlife Reserve and Protection Act, as well as, participatory conservation by relevant stakeholders, including local villagers and other interested organizations, besides the government officials of the Department of National Parks, Wildlife and Plant Protection (DNP). Moreover, academic and research-related conservation which is considered as an ex-situ conservation is also necessary, i.e. establishment of Wildlife Research Station and Wildlife Breeding Station. Finally, it is important to protect and enforce the laws upon wrongdoers in illicit wildlife hunting in natural forests, inclusive of the wildlife sanctuary or national park status (Lakanavichian, 2010).

Goral is classified as one of fifteen Reserved Wildlife species which is endangered, according to the 1992 Wildlife Reservation and Protection Act. Goral species is therefore required to be conserved in all types of legal protected areas. It should be noted that Goral habitat conservation is to conserve forests, requiring clear border demarcation between the conservation forests and agricultural areas in nearby or surrounding villages. In addition, it is necessary to encourage community participation in every step of wildlife conservation. Government technocrats involving in wildlife conservation and personnel of the protected areas, i.e. wildlife sanctuary, non-hunting area, national park, must disseminate data and information regarding Goral ecology to all interested villagers, with particular to communities within or surrounding the protected areas.

A study on community participation in an approach for Goral conservation in Doi Inthanon National Park had objectives to explore Goral status and conservation practices at Kiew Mae Paan forest and its four surrounding villages: Baan Pa Tueng, Baan Teen Pha, Baan Pa Pong Piang, and Baan Mae Ming in Chang Koeng sub-

district, Mae Chaem district, Chiang Mai province. There were impacts of economic development on Goral. Goral population in the studied areas was very low, while residing over high-slope mountains which were difficult to access. The researchers suggested that study of Goral in depth and width of all age-classes and all groups would be significant and it would be more than necessary to expand research results to other involved communities in the relevant areas for building awareness in Goral conservation (Sirisaiyas *et al.*, 2005).

Goral habitat has been limited and decreased in size so it is worrisome that Goral will be reproduced within its family and clan yielding high blood aligned rate which tends to weaken the particular Goral clan and accentuate risk for extinction (Lakanavichian, 2010). Wongsisom (2007) studied blood aligned rate and genetic parameter of newly born Goral's weight. The study aimed to assess blood aligned rate and genetic parameter by using genetic history and weight of 47 newly born Goral from Om Koi Wildlife Breeding Station, Chiang Mai province. The study showed 16 blood aligned Goral, with the blood aligned rate of 0.19 or equaling to 0.06 of the group average. The average weight of newly born Goral was 2,057.8 grams. Genetic rate and standard error of the newly born Goral, based on regression analysis of a calf within father's characteristics and a calf within mother's characteristics, were 0.15 ± 0.58 and 0.46 ± 0.48 respectively, which were considered low to medium. It indicated that newly born weight highly depended on environmental influence. Genetic rate and standard error of the newly born Goral, based on regression analysis of a calf within average value of father's and mother's characteristics was 0.61 ± 0.34, implying high genetic variation. It was thus suggested a need to adapt the circumstance to suitable environment along with genetic selection within a group. Assessment of fertilization of 45 Goral by Best Linear Unbiased Prediction (BLUP) founded that fertilization value of Goral in newly born weight by using genetic rate yielded 3 values, $h^2 = 0.15$, 0.46 and 0.61 respectively, implying genetic variation from 0.15 to 0.61. Goral fertilization according to newly born weight showed the three highest values: 61.83, 183.03 and 253.77 gram respectively. Fertilization pattern used group arrangements by considering blood aligned rate and number of offspring per sires. It must be noted that nil clan

relationship was allowed within mating partners. Mating was per rotational sires and produce sires in replacement of each group in order to avoid blood aligned cases. It was suggested that the results should be replicated in a larger population to reduce variation. Afterwards, the result would be used as an approach for fertilization and species improvement of Goral prior to release into the forests so as to prevent the Goral from blood ties.

Endangered wildlife management for restoration and population increase must take 5 factors into consideration (Deal, 1998), i.e., 1) habitat protection, 2) scientific research, 3) captive breeding, 4) reintroduction into the wild and 5) special habitat allotment or wildlife management technique. Several wildlife studies by various researchers and wildlife protection by the government agencies have not fulfilled the five factors mentioned. The Royal Thai Government (RTG) through the Department of National Parks (DNP), Wildlife and Plant Conservation of the Ministry of Natural Resources and Environment followed the factors number 1 and 3, according to the 1992 Wildlife Reservation and Protection Act. Recently, the DNP began undertaking the factor number 4, wildlife reintroduction into the wild but without support of scientific data yet. In practice, restoration and conservation of Goral in Thailand have been far from the main goal: ceasing of natural Goral population decrease. It is definitely necessary to increase Goral population and set up an approach for Goral survival in a long term. Several researchers and involved DNP technocrats cannot figure out the total population of Goral in the nature at present which is one of the most significant weaknesses in Goral conservation in Thailand. The author may conclude that it is necessary to study habitat and behavior of Goral in nature, as well as, to assess Goral population in the case-study area, which is considered outside the protection areas as of the 1992 Wildlife Reservation and Protection Act. It is thus important for the author to study ecology and population of Goral, in order to develop approaches for conservation of the remaining Goral population with local people in the target area.

2.5.1 **Goral Conservation, based on the Wildlife Ecology**

Wildlife ecology is a study of relationship between wildlife and its environment, including biological and physical factors. The main components of wildlife ecology, as mentioned, are: (1) ecological niche, (2) wildlife habitat, (3) welfare factors, (4) distribution of biotic community, and (5) wildlife species distribution. Goral conservation requires its habitat conservation and welfare factors, plus space for special activities, such as, salt-lick area, rest area, mating area. In addition, Goral is sensitive to environmental variation, according to its highly specific habitat, and group behavior which is similar to cattle and water buffalo. Most importantly, Goral like to excrete at the same places causing its proneness to illegal hunting. For example, local people near San Pan Daen Wildlife Sanctuary, Pang Mapha district, Mae Hong Son province, hunted 5 Goral at once as they were in a group (Rungreong Pothi, November 2012 – personal communication). In fact, the Goral at San Pan Daen W.S. was firstly discovered by the research team and the San Pan Daen W.S. officers.

Forest conservation as Goral habitat protection has not yet been successful. Forest habitats of Goral in Thailand have been encroached and destroyed furthermore in the past decade, so it has been difficult for Goral survival. Both legal protected forests and forests outside designation of the legality have been encroached continuously. Welfare factors and special areas for specific activities of Goral were consequently destroyed. The risk of Goral extinction is therefore high, due to habitat destruction and conversion for human utilization (Lakanavichian, 2010).

2.5.2 **Goral Conservation and Ecotourism**

Ecotourism is a type of tourism with concerns of environment. If there is a management of tourists and visited areas according to the principles of ecotourism, it will be feasible to reduce environmental impacts. A selected definition of ecotourism covering a wide range of factors is that ecotourism means tourism with responsibility over natural resources which identities are native and cultural sources, by participatory learning processes under environmental management, and participatory

tourism by local people aiming to build awareness of sustainable ecosystem protection (Science and Technology Research Institute, 1997).

Tourism development in any areas in Thailand needs collaboration from all stakeholders, including the state, academics and the private sector from national level to local level. Local cooperation is the main component and plays the important role in tourism development. It is thus necessary to induce local participation at every step so as to build up an ecotourism approach. In fact, it implies the rights to control and oversee tourism processes inclusive of local participation, from exploration, to planning, and management/implementation. It is not for only profits to local level, but it also indicates the importance of local people and leaning process building according to capacity building approach for local community sustenance. Ecotourism development will be benevolent to ecosystem and local people, particularly the people from nearby areas needing to participate in the ecotourism approach. Development of areas for sustainable tourism must include understanding of relevant natural resources and tourism resource which are likely to provide economic benefits to local communities. In the past, tourism promotion in Thailand was rush according to the economic development acceleration policy, yielding destructive natural resources of the areas. The government tourism agencies were without planning about pollution, environmental problems, problem of deteriorated tourism areas and social problems caused by tourism. Besides, there were very few studies on carrying capacity of the tourism areas. Thus local benefits from tourism were unsustainable. It tended to be a rush since local tourism business was popular in a short period of time and became degraded resulting in loss of tourism finally (Science and Technology Research Institute, 1997).

People living around the case-study area, Doi Pa Ti Do and Doi Mhoe Ka Do, arranged for tourists to travel to the two mountains recently. The villagers have good intention to conserve Goral habitat, but they lack information and knowledge about ecotourism, life cycle of Goral and Goral ecology, such as, habitat, mating season, pregnancy, distribution range. If the local villagers know about Goral ecology and its risks, then use the information for ecotourism planning, it will be feasible to

set up such tourism which is friendly to ecosystem and Goral in the area. Thus it is possible to promote ecotourism in the habitats of Goral, yielding positive outcome in Goral conservation for sustainability.