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**CONSERVATION OF LARGE MAMMALS IN BHUTAN WITH SPECIAL
REFERENCE TO TAKIN (*Budorcas taxicolor whitei*)**

KARMA DHENDUP

**With compliments
of**

บัณฑิตวิทยาลัย มหาวิทยาลัยมหิดล

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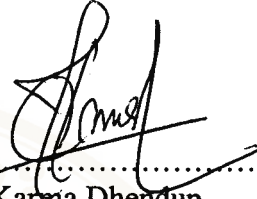
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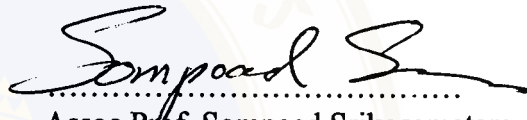
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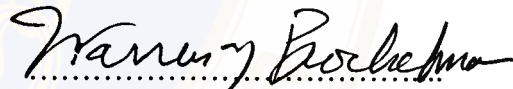
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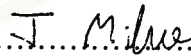
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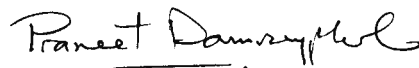
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This study focuses on the status of large mammal conservation in Bhutan, its conservation challenges and the measures that should be taken to conserve large mammals with special reference to Takin, Bhutan's National Animal. With an increasing population, rising economic expectations and economic development gaining importance over environmental concerns, Bhutan's natural base is at risk. To date, only about 3% of its flora and fauna have been described. Since about 85% of the population lives in rural communities and depend on biological resources either directly or indirectly, there is the risk of rare species slowly being extirpated in the near future. As large mammals are amongst the first wild life to be affected by anthropogenic activities.

The present status of large mammal conservation was determined from a detailed analysis of available references and other sources of information. In addition, an ecological and behavioral field study of Takin was conducted in its natural habitat in Damji/Gathana valley of northwestern Bhutan, described as one of the primary winter habitats of the species.

Of 9 threatened mammal species, only Pygmy Hog (*Sus salvanius*) is considered critically endangered in Bhutan, though the statuses of species like Argali (*Ovis ammon*) and Sloth Bear (*Melursus ursinus*) are also very uncertain. They probably have become extinct in the country. Out of 11 species listed as endangered by UNEP-WCMC, 9 are mammals. Similarly, 17 species of mammals in the country are listed as vulnerable, and Takin (*Budorcas taxicolor whitei*) is one of them. Takin is restricted to the north and northwestern part of the country. About 330-410 Takins are estimated to occur throughout their range, of which 2/3 are concentrated within Jigme Dorji National Park in northwestern Bhutan. Herd size in their winter range varies from 1-6 animals with an average of 2.4 (N=13). Their activity begins at dawn, reaches a peak at around 09.00-11.30 a.m. and drops steadily around mid noon. It then rises gradually until dusk. On average, Takins exhibits two cycles of activity during the daytime and spend half of their activity period (47%) on feeding. Other behavioral activities such as resting, grooming, moving and playing cover 35, 8, 5 and 5 percent, respectively. Fecal analysis indicated that 80% of the foraged plant species consists of browsed food plants. Species such as *Elatostema lineolatum*, *Brassaiopsis glomerulata* and *Diplacium esculanta* contributed about 50% of the animal's diet. Tigers are potential predators of Takin. Another mortality factor, i.e, poaching, appears to be having a negative impact on their population size in some Takin areas.

Since the animal requires large areas for their annual migration, conservation efforts for the species, particularly habitat conservation, will also help conserve a wide range of other high altitude fauna.

4138490 SCEB/M: สาขาวิชา: ชีววิทยาสภาวะแวดล้อม; วท.ม. (ชีววิทยาสภาวะแวดล้อม)

คาร์มา เดนดูป: การอนุรักษ์สัตว์เลี้ยงลูกด้วยนมขนาดใหญ่ในประเทศภูฏานโดยเฉพาะทาคิน (CONSERVATION OF LARGE MAMMALS IN BHUTAN WITH SPECIAL REFERENCE TO TAKIN (*Budorcas taxicolor whitei*)). คณะกรรมการควบคุมวิทยานิพนธ์: สมโภชน์ ศรีโกสามาตร, Ph.D., วรเวณ บรอดเคลแมน, Ph.D., จอห์น มิลน์, Ph.D., สุรพล ดวงแข, M.Sc., 108 หน้า. ISBN 974-04-1151-7.

เนื่องจากการเพิ่มขึ้นของประชากรและการเจริญเติบโตทางด้านเศรษฐกิจทำให้การพัฒนาด้านเศรษฐกิจได้รับความสำคัญเหนือความห่วงใยด้านสิ่งแวดล้อม เป็นสาเหตุให้ทรัพยากรธรรมชาติของประเทศภูฏานตกอยู่ในภาวะวิกฤต เพียงร้อยละ 3 ของพรรณพืชและสัตว์ในประเทศนี้ที่ได้รับการศึกษา เนื่องจากประมาณร้อยละ 85 ของประชากรอาศัยอยู่ในชนบทและต้องพึ่งพาทรัพยากรธรรมชาติทั้งทางตรงและทางอ้อม ดังนั้นในอนาคตสิ่งมีชีวิตที่หายากจึงมีความเสี่ยงต่อการสูญพันธุ์ สัตว์เลี้ยงลูกด้วยนมขนาดใหญ่เป็นสัตว์กลุ่มแรกๆ ที่ได้รับผลกระทบจากกิจกรรมของมนุษย์ การศึกษานี้จึงมุ่งเน้นการทบทวนเกี่ยวกับข้อมูลพื้นฐานและการอนุรักษ์สัตว์เลี้ยงลูกด้วยนมขนาดใหญ่ที่อยู่ในประเทศภูฏาน โดยเฉพาะ ทาคิน (Takin) หรือแพะภูฏานซึ่งเป็นสัตว์ประจำชาติ การศึกษานี้เป็นการตรวจสอบเอกสารจากแหล่งต่างๆ รวมทั้งการศึกษภาคสนามเพื่อศึกษาในเขตอุทยานและพฤติกรรมของทาคินที่หุบเขาแดมจี กัตตานา บริเวณตะวันตกเฉียงเหนือของประเทศภูฏาน ทาคินอาศัยในเขตหนาวและเป็นหนึ่งในจำนวน 9 ชนิดของสัตว์เลี้ยงลูกด้วยนมที่ถูกคุกคาม มีเพียงหมูแคระ (Pygmy Hog) เท่านั้นที่ถูกพิจารณาว่าเสี่ยงต่อการสูญพันธุ์อย่างมาก อย่างไรก็ตามสถานะภาพของสัตว์ชนิดนี้ก็ยังไม่เป็นที่ทราบแน่ชัด เช่นเดียวกับแพะอากาศ (Argali) และหมีสลอต (Slot Bear) ซึ่งเป็นสัตว์ที่อาจจะสูญพันธุ์ไปแล้วจากภูฏาน องค์การสหประชาชาติในโครงการสิ่งแวดล้อมและศูนย์ติดตามการอนุรักษ์แห่งโลก (UNEP-WCMC) กำหนดสถานะภาพต่าง ๆ ของสัตว์ในประเทศภูฏานดังต่อไปนี้คือ สัตว์ที่จัดว่าเสี่ยงต่อการสูญพันธุ์ 11 ชนิด เป็นสัตว์เลี้ยงลูกด้วยนม 9 ชนิด นอกจากนี้สัตว์เลี้ยงลูกด้วยนมอีก 17 ชนิด ในประเทศนี้ยังจัดอยู่ในประเภทถูกคุกคาม หนึ่งในจำนวนนั้นคือ ทาคิน การกระจายของทาคินจะพบเฉพาะตอนเหนือและตะวันตกเฉียงเหนือของประเทศ ซึ่งมีประมาณ 330-410 ตัว สองในสามของจำนวนนี้อาศัยอยู่ในอุทยานแห่งชาติจิกมีดอร์จี (Jigme Dorji) ทางตะวันตกเฉียงเหนือของภูฏาน ขนาดของฝูงที่พบในฤดูหนาวมีจำนวนตั้งแต่ 1-6 ตัว โดยมีค่าเฉลี่ยเท่ากับ 2.4 (N=13) พฤติกรรมของทาคินจะเริ่มตั้งแต่รุ่งสาง การหากินและการรวมกลุ่มจะพบมากในช่วงเวลา 9.00-11.30 น. และจะเริ่มลดลงเรื่อยๆ ในกลางวัน จากนั้นจะเริ่มเพิ่มขึ้นอีกในช่วงหัวค่ำ โดยเฉลี่ยกิจกรรมของทาคินจะมี 2 ช่วง ในช่วงกลางวันจะใช้เวลาครึ่งหนึ่งของกิจกรรมเหล่านั้นเพื่อหาอาหาร (47%) ส่วนพฤติกรรมอื่นๆ เช่น การพักผ่อน, การใช้ขน, เคลื่อนไหว และเล่น มีร้อยละ 35, 8, 5 และ 5 ตามลำดับ จากการวิเคราะห์ข้อมูลแสดงให้เห็นว่าร้อยละ 80 ของชนิดพืชอาหารของทาคินประกอบด้วยใบพืช โดยร้อยละ 50 ของอาหารของมันได้แก่ *Elastostema lineolatum*, *Brassaiopsis glomerulata* และ *Diplacium esculanta* นอกจากผู้ล่าเช่น เสือโคร่ง แล้ว การลักลอบล่าสัตว์โดยผิดกฎหมายยังส่งผลกระทบต่อประชากรของทาคินในบางพื้นที่ เนื่องจากสัตว์ชนิดนี้ต้องการพื้นที่เพื่อการอพยพ ดังนั้นการวางแผนทางการอนุรักษ์โดยเฉพาะการอนุรักษ์ถิ่นที่อยู่อาศัยจึงเป็นประเด็นต่อการอนุรักษ์สัตว์ป่าโดยรวม

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LIST OF ABBREVIATIONS

ADB	Asian Development Bank
AZA	American Zoo Association
BWS	Bomdiling Wildlife Sanctuary
BMNP	Black Mountain National Park
CITES	Convention on International Trade of Endangered Species
EIA	Environment Impact Assessment
ICDP	Integrated Conservation and Developmental Programs
ICIMOD	International Centre for Integrated Mountain Development
IUCN	International Union for Conservation of Nature
JDNP	Jigme Dorji National Park
MOA	Ministry of Agriculture
MOP	Ministry of Planning
NEC	National Environment Commission
NCS	Nature Conservation Section
RGoB	Royal Government of Bhutan
RMNP	Royal Manas National Park
RSPN	Royal Society for Protection of Nature
UNCDF	United Nations Capital Development Fund
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNICEF	United Nations International Emergency Fund
WCMC	World Conservation Monitoring Centre

CHAPTER I

GENERAL INTRODUCTION

Conservation is hardly a new concept to the Royal Government of Bhutan. A cultural and religious ethos based on a philosophy that values all life forms. Buddhism, has fashioned a life-style that is very conservation oriented (Buntang and Wangchuk, cited in Palden, 1996).

The country, with a total land area of 46,500 sq. km is known to harbor 7,000 species of vascular plants, more than 800 species of birds, 178 species of mammals, and 197 species of fish (MOA, 1998; Shengji et al., 1998, Inskipp et al., 1999). It lies in the eastern Himalayas with China (Tibet) in the north and the Indian state of Arunachal Pradesh, Assam and Sikkim to the east, north and west respectively (Figure 2.1) The country straddles two biogeographical realms: the Palaeoartic realms of the temperate Euro-Asia and the Indo-Malayan realms of the Indian sub-continent (MOP, 1997). It features extremely diverse geophysical elements: high, rugged mountains interlaced with deep valleys with rich biological diversity at the ecosystem, species and the genetic levels. In addition, considerable altitudinal variation from 200 m in the south to over 7,000 m in the north with dramatic climatic gradients adds to the biological diversity.

Along Bhutan's southern border, the narrow subtropical and tropical forest ecosystem support number of threatened species characteristics of Indo-Malayan origin such as Asian elephant, Greater one-horned rhinoceros, Gaur, Wild water buffalo, hog deer, clouded leopard, and tiger. About 150 m to the north, high

Himalayan fauna include Palaeoartic species such as blue sheep, takin, musk deer, snow leopard, wolf (*Canis lupus*) and lammergeier vulture (*Gypaetus barbatus*). More adaptable species, with habitat extending from tropical to temperate zones, live in between these two extremes. Species such as Himalayan black bear, red panda, barking deer, leopard, wild dog, sambar, serow, wild boar, and langur are common in this region. Except for few species like black-necked crane, tiger and golden langur, knowledge about the condition of the species is still limited and fragmented, never having been put into the context of conservation in Bhutan. In addition, there have been no detailed population surveys or field studies of any of its wildlife (ICIMOD, 1998). Information on the status and population of any wildlife is necessary for understanding the degree of threats posed on the species and also in implementing conservation measures for the species' survival in the wild. Hence, the first part (Chapter II) of this thesis aims to determine the conservation status of large mammals in the country mainly through reviewing available literature on ecology and behavior of large mammals from within the country as well as from the adjoining neighboring countries. It is hoped that the information collected will provide a broader understanding with regard to large mammal conservation in Bhutan, the current threat, and the preventive measures taken for maintaining viable population of mammalian species in the wild.

Of all the mammalian species in the country, takin is a symbolic animal treasured as the national animal of the country. Their distribution is said to be restricted to the northwestern part of the country (Wollenhaupt, 1991). Very little is known about the habits of the animal from the wild. A systematic study on the food habits of the animal during the summer range has been carried out (Wangchuk, 1999).

As with golden takin (Groves, 1995) and Sichuan takin (Schaller, 1986), Bhutan takins are observed to be a generalist browser, foraging on a variety of shrubs, forbs and graminoids during the summer range (Wangchuk, 1999). As a seasonal migrant, ecological information with regard to takin habitats both in their summer as well as in their winter range is crucial for developing management strategies for maintaining viable population of the species in the wild. In Bhutan, such information is limited.

Although there is some ecological information regarding takin in their summer range (Wangchuk, 1999), information with regard to takin habitats in their winter range is non-existent. Proper information on their distribution, ecology and behavior both in their summer and winter range are prerequisites for enhancing the species survival and in implementing management efforts. In addition, their migratory corridor also needs to be investigated in order to assess the presence of threat.

Takin is described as the keystone species of the park (Wangchuk 1999) and their existence is vital to the park's ecosystem and in maintaining the biodiversity as a whole. The park's main threat is competition for land use between the human inhabitants of the park who subsist mainly on yak herding and wildlife (Wangchuk, 1999). Since modification of ecosystem and habitat by local residents can have adverse effects on the mammalian fauna, especially large mammals like takin, a broad range of information is needed about its ecology in a variety of situations. Population numbers and trends are needed for the species and monitoring methods need to be implemented for ecologically sound management of this mammal species. Ecological factors resulting in excessively high or low populations need to be determined. Their conflict with domestic livestock or other anthropogenic activities needs to be examined for proper development of measures to mitigate pressure on wildlife. These

are the basic tenets of an environmentalist and the biologist alike in understanding how organisms respond to environmental changes. Hence, along with reviewing large mammal conservation in the country, this thesis also focuses on investigating ecological aspects of takin. The particular aspects of takin ecology to be covered are as follows.

The distribution of takin in Bhutan has not been documented previously. Distribution of a population in ecological terms, describe its geographical and ecological range that is determined primarily by the presence or absence of suitable habitat. Therefore, depicting the range and distribution of a species will enable us to better understand the environmental conditions necessary for the survival of the species. This will also help in implementing better management plans in order to maintain a viable population of the species in the wild.

The status of Bhutan takin is also very uncertain. Although, the species is not considered as endangered, information on population size and number is essential in monitoring population trends over time or among habitats or to evaluate the success of the species in different habitat in the wild. Such information are non existent and it is hoped that the present information generated will serve as baseline for future research.

Bhutan takin is red-listed in IUCN data book as vulnerable and conservation dependent. Hence, the information on its ecology and behavior in the winter range will highlight critical areas or resources that are important for the species' survival in their winter habitat. This will also enable us to better understand the ecological factors like predation, competition and other ecological changes such as climatic shifts or human activity, that will have adverse effect on the distribution of the species' range. Hence, the study aims to assess the status of large mammal conservation in Bhutan, its current

threat and implementation measures on ground at present. Since, a species is the key in all conservation measures, the study focuses on distribution of takin in Bhutan, their behavior and ecology during the winter range in Jigme Dorji National Park (JDNP). This is meant to fill in the information gap of takin distribution and ecology in Bhutan. This will greatly enhance the species and park management plan for policy adaptation required for protecting critical areas or habitat required for the species and in conserving the biodiversity of the country in general.

The study objectives are to:

- a. Determine the conservation status of large mammals in Bhutan and the most important factors that threaten their conservation and to develop recommendations to ensure their survival.
- b. Compile and map distribution of Bhutan takin in Jigme Dorji National Park and other parts of Bhutan.
- c. Investigate ecology and behavior pattern exhibited by Bhutan takin in their winter range in Gathana/Damji valley, described as the primary winter habitat of the species. This study will complement the existing information on their ecology in the summer range.

CHAPTER II

LARGE MAMMAL AND OTHER BIODIVERSITY CONSERVATION

2.1: Introduction:

Conservation of mammals, something that has been with us in various forms for many centuries, has only really become an area of strong interest during the past 100 years, especially in the U.S.A (Feldhamer et al. 1999). During that time, several waves of interest in conservation related activities have occurred, most notably during the last 25 years. The passage of many new environmental laws, specifically including the U.S. Endangered Species Act, has helped to heighten our awareness of the fragility of our environment and the need for renewed vigilance.

Of the 20 countries with the most threatened mammals of the world, 35% are from Asia (IUCN, 2000). Indonesia has 128 threatened mammal species followed by India and China each with 75 threatened species. These countries in general also have high numbers of mammal species. Indonesia is ranked second in the total number of mammal species, China fifth and India tenth (IUCN, 1998). Factors such as sustained pressure on forest and resulting habitat destruction have contributed considerably to the deteriorating status of the mammalian fauna and the wildlife in general. The identification of the countries with the largest number of threatened species enables countries of their global responsibility to protect and conserve such species. The countries in turn have taken preventive and mitigation measures to save those species by enacting laws and legislation, either national or international and by designating protected areas. Thus, the IUCN- Red Data Book and the red-list play a valuable role

in conservation either by drawing attention to the growing list of threatened species or by stimulating data collection.

Much of the wild life of Bhutan is still little known (MOA, 1998). Surveys of birds and plants are the most complete. A fairly extensive plant inventory was conducted in the 1970s and 10 volumes of the flora of Bhutan covering about half of the total species have been published (Inskipp et al. 2000; Grierson and Long, 1983). In particular, the mammalian fauna has been least studied (MOA, 1998). The National Conservation Plan for Bhutan (Mackinnon, 1991) provides a provisional list of 178 species based on predicted occurrence. This includes 24 internationally threatened species and 64 species that may be nationally endangered. However, recognizing the importance of wildlife conservation, the Nature Conservation Division under the Forestry Department, has carried out wildlife reconnaissance survey in three of the designated parks namely Royal Manas National Park (RMNP), Jigme Dorji National Park (JDNP), and Black Mountain National Park (BMNP). It provides a list of 58, 37 and 57 mammal species confirmed or expected to occur in the three parks respectively (Appendix: 1, 2 and 3). Several species of mammals recorded are globally or regionally threatened and 16 are listed in the schedule I of the Forest and Nature Conservation Act of Bhutan, 1995 (MOA, 2000). These include species that can be considered 'flagship' species such as takin, blue sheep, snow leopard, tiger and red panda. Other species of conservation importance for reasons of their ecological roles as significant predators or prey are the great Indian rhino, Asian elephant, Himalayan black bear, wild dog, musk deer, sambar, barking deer, goral, serow, marmot and pika. However, as stated earlier, there is limited status information available with regard to these mammalian species.

2.2 Ecological Zones and their mammal characteristics:

Bhutan's diversity of ecosystems is attributed partly because of its location between the Indo-Malayan and the Palearctic biogeographical realms, and partly due to the country's great geological relief and climatic heterogeneity (MOA, 1998). Valleys in the inner mountain receive less than 800 mm of precipitation, while rainfall in the lowland is as high as 5,500 mm. The country includes a range of ecosystem from the sub-tropical forest in the south at an elevation of 150 m, to mid elevation temperate forest, to the northern alpine zone above 7,000 m. This provides home to a variety of mammal species. According to the latest land use survey conducted by the Land Use Planning Section (LUPP, 1997), the total land under forest is 29,055 sq. km or 72.5 % of the country. Out of this, 8.1% or 3,258 sq. km have been classified as degraded or natural scrub forest, 26.5% constitute coniferous forest, 34.3% broadleaf forest and 0.2% plantation (MOA, 1998). Based on altitude, forest in the country can be divided into three floristic zones (Table 2.1 and Figure 2.1).

Table 2.1: Floristic/Ecological zones according to the altitude (MOA, 1998).

Floristic zones/Altitude	Forest types
Alpine zone (above 4,000 m)	Natural scrub forest, alpine pasture.
Temperate zone (2,000-4,000 m)	Temperate, conifer and broadleaf forest.
Sub-tropical zone (150-2,000 m)	Tropical and sub-tropical vegetation.

Within the three ecological zones of Bhutan Himalayas, one can distinguish typical mammal species (Table 2.2). Each of these ecological zones consists of an

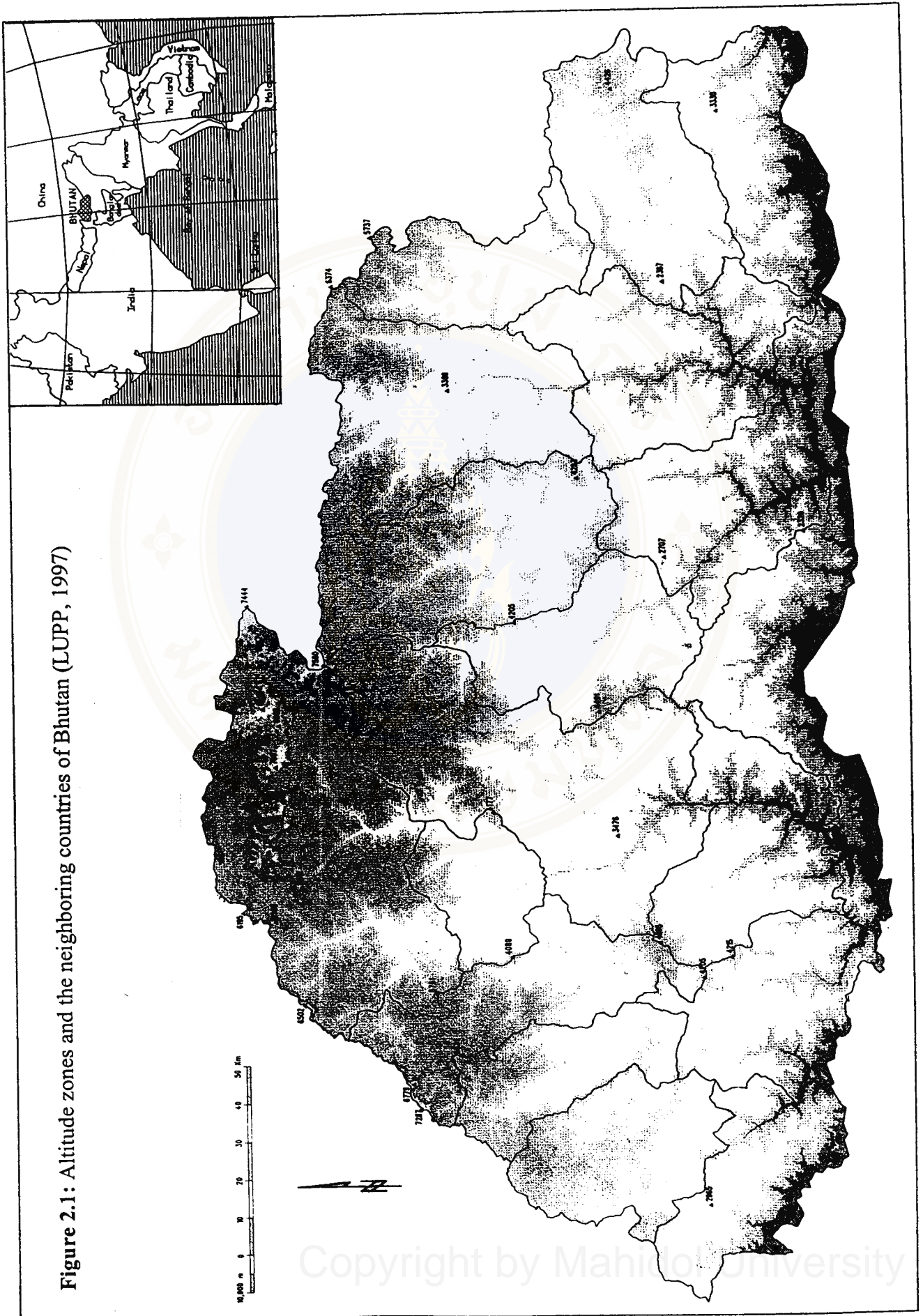


Figure 2.1: Altitude zones and the neighboring countries of Bhutan (LUPP, 1997)

assemblage of interacting mammal species that are interdependent to one another either directly or indirectly.

Table 2.2: Ecological zones with different mammal community. (Source: MOA, 1998)

Ecological zone	Mammal community
Alpine zone (4,000 m and above)	Snow leopard, blue sheep, red panda, takin, marmots, Himalayan musk deer, Tibetan wolf and antelope.
Temperate zone (2,000-4,000 m)	Tiger, common leopard, takin, gray langur and macaques, Himalayan black bear, red panda, squirrels, goral and serow, Sambar, and barking deer.
Sub tropical/tropical (150-2,000 m)	Tiger, clouded leopard, elephant, greater one horned rhinoceros, water buffalo, golden and capped langur, gaur, swamp deer, hog deer, pygmy hog, hispid hare, sloth bear, and in the riverine vegetation lynx and takin are found.

2.2.1: Alpine zone:

The high altitude mammal species is characterized primarily by palearctic species that are globally or regionally threatened (NCS, 1997). “Flagship” species such as snow leopard, red panda, blue sheep and takin are restricted in this zone. The latter, though found in the high altitude venture southward along the major river valleys and are found in the temperate and subtropical zones in winter. The snow leopard and the

Tibetan wolf found in this zone play a significant ecological roles as predators, while species such as marmot, antelope and blue sheep form an important prey base (MOA, 1998).

The distribution of snow leopard in Bhutan is said to be restricted to the higher elevation habitats, such as alpine shrub and meadows (NCS, 1997). Its range is associated with steep terrain broken by cliffs, ridges, gullies and rocky outcrops with arid and semi-arid shrubland, grassland, or steppe vegetation (Massicot, 2001). Elsewhere, it is reported to be generally found at elevations between 3,000 to 4,500 m, although it occasionally goes above 5,500 m in the Himalayas in the summer (Massicot, 2001). In Pakistan and India, the animal is reported to migrate down into, fir or rhododendron forest for the winter (Ahmad, 1994; Fox, 1991 cited in Massicot, 2001).

The geographical model of potential snow leopard habitats by Hunter and Jackson (1997) cited in Massicot (2001) depict a total area of 7,300 sq. km. in Bhutan. Based on the average number of 0.004 individuals/sq. km over their entire range (Fox, 1994), an estimate of 25-30 individuals are expected to occur in Bhutan. However, snow leopard densities vary markedly depending on the available prey densities as well as suitable habitat. For example, an average density of 0.05-0.2; 0.012; 0.043 and 0.007 animals per square km is recorded from Langu Gorge, southeast of Langu Gorge, Nar Phu and Ladakh in Nepal (see Massicot, 2001).

Other endangered mammal of conservation importance in the high altitude is the red panda (*Ailurus fulgens*). As with snow leopard, it is also classified by IUCN as endangered under criteria A2a (UNEP-WCMC, 2001). The species is listed as CITES Appendix I, threatened species, the trade in which is normally prohibited (IUCN,

2000). The American Zoo Association Species Plan (AZA, 1998), reports that the recent field assessment indicates that the population numbers are declining throughout its range. Exact population numbers are not known, but it is estimated that Nepal may have only few hundred individuals, Tibet, around 1,400-1,600 individuals and China, around 5,000-6,000 animals (Roberts, 1998 and Wei et al., 1998, both cited in Massicot, 2001). The takin, Bhutan's national animal, is also found in this zone. But as a seasonal migrant, the animals are known to spend in this zone only a brief period of 2 months from early June to late July during summer (Wangchuk, 1999).

2.2.2: Tropical and subtropical zones:

In the subtropical and tropical zone (150-2,000 m), the mammal species are mostly of Indo-Malayan origin (NCS, 1997) which include species such as Asian elephant, greater one-horned rhino, wild water buffalo, tiger and pygmy hog. Other mammals restricted to lower elevation include gaur, langurs, hispid hare, hog deer, swamp deer, lynx (*Felis lynx*) and takin. These species are likely to form the prey base for important carnivores like tiger, foxes and predatory birds.

Tiger (*Panthera tigris*) in Bhutan is found in a variety of subtropical and temperate as well as sub-alpine coniferous forests ranging from 200 to 4,000 m (McDougal et al., 1998). It is listed as an endangered species by the U.S. Fish and Wildlife Services and the IUCN red book, and is an Appendix I species under CITES (AZA, 1998). It also receives complete protection and is listed in Schedule I of the Forest and Nature Act of Bhutan, 1995 (Table 2.6). The total population of tiger world wide in early 19th century was estimated to be 100,000 individuals (Nowak and Paradiso, 1983; Nowell and Jackson, 1996 cited in Massicot, 2001). Today, only

5,166-7,436 tigers are recorded to exist in the wild (Jackson, 1996, 1998 cited in Massicot, 2001). In Bhutan, the recent nationwide survey using the latest technique gave an approximate number of 100 tigers in the country (McDougal et al., 1998). Their range stretches continuously from west to east from Jigme Dorji National Park (JDNP) to Bomdhiling Wildlife Sanctuary (BWS) and down to the southern foothills adjoining Royal Manas Wildlife Sanctuary (RMNP) (Figure 2.2). The two earlier reports of Jackson, 1993 and 1994 (see Massicot, 2001) yield a total estimate of 20-50 and 50-240 animals respectively indicating a positive trend while its population size has been declining in other parts of its range (Massicot, 2001).

Other mammal species of conservation importance in the tropical and subtropical zone are the Asian Elephant, greater one-horned rhino, water buffalo and the pygmy hog. These species are categorized under different criteria by UNEP-WCMC (2001). At the species level, very little is known about these species in Bhutan. In other range countries, populations of these species are reported to be declining. Rhinoceros is known to have become extinct in Bangladesh and Pakistan (IUCN, 2000). The main reason is attributed to hunting mainly for use of its horn in Oriental medicine. The decline in the populations of Asian elephant and wild water buffalo is mainly due to domestication, hunting for meat, ivory (elephant), competition with domestic cattle and interbreeding with domestic and feral buffalo in case of water buffalo (Massicot, 2001). The pygmy hog is similarly threatened by loss of habitat, overgrazing by domestic livestock and periodic burning of its grassland habitat during the dry season. The species is reported to have become extinct in Bhutan and Nepal (IUCN, 2000). The only remaining populations, a few hundred individuals known to

exist in Manas Wildlife Sanctuary and less than 50 in Barnadi Wildlife Sanctuary, are both in India (Oliver, 1993 cited in Massicot,2001).

2.2.3: Temperate zone:

In the Temperate Zone between 2,000 and 4,000 m in elevation, the mammal community includes species from the subtropical/tropical and the high altitude or the alpine zones. Species such as tiger, common leopard, Himalayan black bear, red panda, serow, sambar and barking deer are found in this zone (MOA, 1998). Except for tiger and red panda which are considered endangered, IUCN (2001) and UNEP-WCMC (2001) categorize the mammal species found in this zone as vulnerable.

2.3: Conservation status of large mammals in Bhutan:

As stated earlier, since many of the mammal species in the country are little known, there is hardly any published information with regard to the specific mammal species within the country. Hence, most of information reported here is the result of reviewing scientific articles and papers published from neighboring countries. Databases of animal species produced by IUCN, UNEP-WCMC, CITES were the main source of information for determining the conservation status of the mammal species within the country. Government reports related to the conservation of wildlife in general were also consulted. The growing threat to the conservation of biodiversity is also discussed with preventive measures taken by the government at present. The gap of action points weaknesses and identifies areas where more emphasis needs to be given to improve conservation of biological diversity, in particular, large mammal species within the country.

Due to limited amount of status information available for the country, Bhutan's full component of the mammalian species cannot be assessed. However, the Forest and Nature Conservation Act of Bhutan, 1995 protects all wild animals and plants and has established a stricter degree of protection for smaller group of species included in Schedule I of the Act. The list includes 16 mammal species (Table 2.3).

The UNEP-WCMC Database, 2001 list Bhutan's full detail of animal species under different category (Table 2.4). Of these, Pygmy hog (*Sus salvanius*) is critically endangered. Its status in Bhutan is quite uncertain. Earlier report from Royal Manas National Park have failed to record its presence (Blower, 1986) although it does occur on the Indian side of the International border. The IUCN red list of threatened species, 2001, report that the species may have occurred in Bhutan till 1994. Out of 11 species listed as endangered, 9 are mammals. Similarly, 17 species listed under category vulnerable are mammals. The status of Argali (*Ovis ammon*) and Sloth bear (*Melursus ursinus*) are also very uncertain. These species are reported to have occurred in Bhutan till 1996 only (IUCN, 2000). They probably have become extinct in the country.

Table 2.3: Totally Protected Mammal of Bhutan (Source: Forest and Nature Conservation Act of Bhutan, 1995s; Referred from Palden, 1996).

Common name	Scientific name	CITES Appendix
Asian Elephant	<i>Elephas maximus</i>	I
Clouded Leopard	<i>Neofelis nebulosa</i>	I
Golden Langu	<i>Presbytis geei</i>	I
Musk deer	<i>Moschus chrysogaster</i>	I
Pangolin	<i>Manis crassicaudata</i>	II
Pygmy hog	<i>Sus salvanius</i>	I
Snow Leopard	<i>Panthera unicia</i>	I
Takin	<i>Budorcas taxicolor</i>	II
Tiger	<i>Panthera tigris</i>	I
Spotted deer	<i>Axis axis</i>	II
Gaur (Bison)	<i>Bos gaurus</i>	I
Leopard	<i>Panthera pardus</i>	I
Leopard cat	<i>Felis bengalensis</i>	II
Himalayan Black Bear	<i>Selenarctus thebatanus</i>	I
Red Panda	<i>Ailurus fulgens</i>	I
Serow	<i>Capricornis sumatraensis</i>	I

Table 2.4. Total number of species under each category with the total number of mammal species in Bhutan [Adapted from UNEP-WCMC, 2001].

Categories	Total no. of species	Total no. of mammal species
i) Critically endangered	1	1
ii) Endangered	11	9
iii) Vulnerable	36	17
iv) Low risk near threatened	47	14
v) Low risk- least concern.	28	28
vi) Data deficient	5	4
vii) Not evaluated	5	0

Table 2.5: List of endangered mammals of Bhutan: [Adapted from UNEP-WCMC, 2001]. CR, EN; Critically endangered and endangered respectively, **Probably extinct in Bhutan.

Mammal species	Common name	IUCN category
1. <i>Sus salvanius</i> **	Pygmy hog	CR- A1c, B1+2cd, E
2. <i>Bubalus bubalis</i>	Water buffalo	EN- A2e, C1
3. <i>Panthera tigris</i>	Tiger	EN- A2cd
4. <i>Uncia uncia</i>	Snow leopard	EN- C2a
5. <i>Ailurus fulgens</i>	Lesser panda	EN- C2a
6. <i>Platanista gangetica</i>	Ganges river dolphin	EN- A1acd
7. <i>Rhinoceros unicornis</i>	Great Indian Rhinoceros	EN- B1+2cde
8. <i>Elephas maximus</i>	Asian Elephant	EN- A1cd
9. <i>Hylopetus alboniger</i>	Particoloured flying squirrel	EN- A1c

2.4: Potential genetic resource of large livestock mammals:

Genetic diversity represents a heritable variation within and between populations of the species. As discussed above, Bhutan has a great number of wildlife species and therefore can be considered to represent a broad genetic diversity. Systematic studies of the wild genetic resources (MOA, 2000) are yet to be conducted. Use of genetic resources by people, however is very apparent. Over 90% of the people live in rural farming communities and practice animal husbandry and cultivation with local varieties and techniques.

Based on the Agro-climatic condition determined by altitude, rainfall and topography, the country can be classified into agro-ecological zones (MOA, 1998). As with faunal characteristics in the three ecological zones, livestock associated differ from one agro-ecological zone to the other. The principal livestock reared in different region of the country are cattle, yak, poultry, pigs, equines and sheep. Geographically, yaks and sheep are reared only in the alpine and the sub alpine area while the buffaloes and goats are reared in the lower altitude. Other livestock breeds such as pig, equines and different breeds of cattle are found in all the regions of the country. Of these, cattle and yak rearing is an important activity in the economy of the rural community. The following breeds and sub breeds of yak and cattle are found in the country (Table:2.6, derived from MOA, 1998, 2000).

Table 2.6: The diversity of livestock breeds (cattle and yak) in Bhutan.

Species	Type	Main breeds	Sub-breeds
Cattle	Local	i) Siri* ii) Mithun** iii) Buffalo iv) Golong***	16
	Exotic	i) Jersey ii) Brown swiss	6
Yak		1	12

Siri* *Bos indicus* cattle; Golong** *Bos taurus* cattle; and Mithun*** domesticated form of Gaur (*Bos frontalis*).

As a result of cross-breeding and back-crossing within and between the breeds and sub-breeds of the same species, there is a wide genetic diversity in case of domestic livestock. For instance, Mithun (*Bos frontalis*), a domestic form of Gaur, is used by local people for cross breeding with Siri (*Bos indicus*). The consecutive filial generations obtained are genetically different and are also named differently (Table 2.7). These species i.e. Mithun and Siri are the basic genetic material for the production of suitable animal for milk and draught (MOA, 1998).

Table 2.7: Genetic diversity of cattle breed from Mithun and Siri. The parental (P) cross was Mithun female with Siri male. Offspring were back crossed with Siri males [MOA, 2000]. *Nublang: Male Siri (*Bos indicus*). F1-F5 are filial generations crossed with Nublang.

Cross	% of Nublang	Name of breed of offspring	
		Female	Male
P - Mithun (F) X *Nublang (M)	-	-	-
F1- Jatsham (F) X Nublang(M)	50.00	Jatsham	Jatsha
F2- Yangkum (F)X Nublang(M)	75.00	Yangkum	Yangka
F3- Dyobum (F) X Nublang(M)	87.50	Dyobum	Dyob
F4- Dyothram(F)X Nublang (M)	93.85	Dyothram	Dyothra
F5- Thrabamin(F)Xnublang (M)	96.90	Thrabamin	Thabazing

Similarly, there is a wide genetic diversity in case of other livestock like yak (*Bos gruniens*). The wild yak (*Bos mutus*), is reported to have become extinct in Bhutan (MOA, 2000; IUCN, 2000). Six hybrids of domestic yaks are produced by cross breeding and back crossing that are genetically different (Table 2.8).

Table 2.8: Genetic diversity of yak using *Golong as male. The parental (P) cross was Yak female with Golong male. Offspring were back crossed with Golong male [MOA, 2000]. F1-F6 are felial generations crossed with Golong.

Cross	% of Golong	Name of breed of offspring	
		Female	Male
P Yak (cow) X *Golong	-	-	-
F1- Zom (F) X Golong	50.0	Zom	Zo
F2- Koi (F) X Golong	75.0	Koi	Koi
F3- Shingolengma(F) X Golong	87.5	Shingolengma	Shingoleng
F4- Tagolengma(F) X Golong	93.8	Tagolengma	Tagoleng
F5- Bagolengma(F) X Golong	96.9	Bagolengma	Bagoleng
F6- Golengma(F) X Golong	98.5	Golengma	Goleng

2.5: Conservation Challenges:

In Bhutan, biodiversity is a matter of everyday necessity. All Bhutanese people, especially in the rural areas, depend on the biological resources in one way or the other. The interdependency is so strong that a break down in one link may create a chain of disorders. Despite every effort directed to nature conservation, the on ground situation is beset with problems. Threats to the ecological integrity of habitat and species stem from several factors. Such threats to Bhutan's biodiversity are also of major importance to the conservation of Bhutan's large mammals. The most important threats are discussed below:

2.5.1: Population pressure:

Bhutan's 3.1 per annum rate of population increase puts ever increasing pressure on the country's fragile ecosystem (NEC, 1997). The population estimated by RGOB was 600,000 in 1996, with 45% of the total in the age group below fifteen (Mop, 1997). The majority (85%) of the population live in rural areas (MOA, 1998). With growth rate of 3.1% per annum, the population is expected to double in 23 years to 1,200,000 in 2019, although the population figure could reach as high as 3.34 million in 2019, if the population in 1996 was 1.67 million as estimated by the UN (UNFPA, 1996 cited in MOA, 1998).

This population will significantly change the population-resource ratio. In Bhutan, since the potential for agriculture expansion is severely limited due to lack of arable land (Smeets et al., 1999), bringing new agricultural land into cultivation cannot modify the population-resource ratio. This population pressure can be expected to give rise to environmental pressures that could undermine the viability of the integrated farming systems and can have serious impact on the nation's biodiversity. The accessible forest areas are already intensively exploited and in some areas, extraction rates of fuel wood and timber are approaching unsustainable levels (NEC, 1997). As agriculture land holdings become smaller and more fragmented, farming will inevitably extend to marginal land and steeper slopes, with greater risk of erosion and accelerated land degradation and land slide. Growing livestock herds will add pressure to forest and to the risk of soil erosion. The progressive removal of vegetation cover, especially in critical watershed areas, is already beginning to affect the hydrological balance, leading to the localized drying up of perennial streams and to flash flooding.

The Royal Government of Bhutan (RGoB) recognize the threats inherent in a continued high rate of population increase and in the Eighth Five Year Plan (starting in 1997), it has made an unequivocal commitment to reducing the rate of growth to 2.56 % by the end of the plan period (Planning Commission, 1997). Population growth is the engine which drives most of the more serious threats to Bhutan's biodiversity. Consequently, reducing the population growth must be the central requirement for achieving biodiversity conservation in the kingdom.

2.5.2: Economic Development:

Threats to the biodiversity conservation arise from a series of human related activities resulting in habitat fragmentation and destruction, and causing the loss of biomes, ecosystem and wildlife species. For centuries Bhutan's isolated location and its self-reliant national character kept the kingdom outside the path of economic development in South Asia. However, by the second half of the 20th century, Bhutan has seen its isolation steadily eroding by the forces of progress and development. NEC (1997), aptly call this progress and development 'a double edge sword', one that can cause undue and unnecessary diminution in national living standards if not properly anticipated and prepared for. Threats to the continued integrity of Bhutan's natural resource base are increasingly being felt from a variety of "developmental" sources, including infrastructure constructions, industrial expansion, increasing urbanization and the growth of foreign tourism (NEC, 1997). The expansion and improvement of the country's infrastructure is having a detrimental effect on the intact ecosystems and the biodiversity resource base. The extensive cutting of soil and rocks and the casual disposal of it downhill facilitate landslides, soil erosion, along with

increased incidence of fires. This is apparent in many part of the country along roadsides. Construction of road networks also have negative impacts on biodiversity conservation in that, it creates “open” access to previously isolated and vulnerable areas (NEC, 1998). It also provide migrant families and loggers access to lands that were previously the sole domain of communities, that have been there, largely undisturbed for many generations.

As stated above, 85% of the total population lives in rural areas (MOA, 1998). They practice self-sustained farming and depend on the biological resource for their general welfare, starting from fuel wood to shingles (roofing material), food and nutrition, farm use, medicine and also for generating income (Namgyel, 1996). Besides, the largest share of land use in the country is attributed to the consumption of wood (25-50%) in the form of fuel wood (Smeets et al., 1999). Shifting cultivation of slash and burn is still practiced in some of the rural communities. These activities pose a serious threat to the biological diversity, in particular large mammals due to habitat degradation and direct attrition or loss of animal species.

Bhutan, however is well aware of these daunting challenges and in May 1990, senior Government officials gathered at Paro to formulate the criteria of Bhutan’s developmental agenda (NEC, 1998). The representatives committed the country to what they termed “The Middle Path”. It focuses on the concept of Sustainable Development i.e. development that meets the needs of the present generation without compromising the ability of the future generations to meet their own needs. The outcome of the forum was “The Paro Resolution on Environment and Sustainable Development”. The key is to find a development path that will allow the country to

meet the pressing needs of the people, particularly in terms of food, health care and education, without undermining the resource base of the country.

The Paro workshop also resulted in formulating a National Environmental Strategy (NES) to monitor developmental activities and their implications on the biological resources of the country. To ensure that environment concerns were made an integral part of the development agenda, an NES task force was also established in December 1993. Their first task was to investigate the environmental implications of the three avenues of development: hydropower, food production and industry. To ensure a sustainable natural resource base, the Royal Government of Bhutan also institutionalized the process of Environment Impact Assessments (EIAs) for all developmental activities (NEC, 1997).

2.5.3: Other factors:

Threats to the biological diversity also stems in parts from the following factors (MOA, 1998):

- Inadequate data and information on biodiversity, its management and use, and inefficient use of the information that exist.
- Extremely limited number of trained personnel in the field of biodiversity conservation represents a major factor limiting the nation's ability to improve and maintain biodiversity conservation.
- Limited institutional capacity to carry out research oriented studies of different species of flora and fauna.

- Threat from outside national borders, which primarily involve trans-border smuggling of medicinal plants and poaching of larger mammals, especially along the southern borders.

2.6: Conservation measures:

2.6.1: Policies of the Royal Government of Bhutan:

Despite the constraints and the threats mentioned above, the country has taken key measures and has implemented policy and legal framework in order to maintain its biological diversity substantially intact. The various sector of the Royal Government of Bhutan (RGoB) has policy objectives and legislation's related to biodiversity. These policies (see MOA, 1998), have the potentials to either have a negative impact or can assist in the biodiversity conservation depending on how much attention is given. The over all policy objective of the RGoB according to MOA (1998) for biodiversity are:

1. Biodiversity issues will be integrated in the economic development plans and programmes.
2. Special attention will be given to support parks, protected areas and effective buffer zone management; and
3. Information on biological diversity will be developed for conservation and sustainable utilization of biodiversity resources. However, the most direct biodiversity legislation falls under the forest legislation.

Bhutan's policy on biodiversity parallel with those of the Convention on Biological Diversity (MOA, 2000), which specify that:

- Conservation of biological diversity is a priority national objective.
- Any use of biodiversity components must be sustainable.

- There should be fair and equitable sharing of benefits arising out of biological resources.

There are master plans for the development of important sectors along with numerous by-laws and acts directed towards biodiversity conservation. The most direct biodiversity legislation falls under the Forest Legislation. The conservation and utilization of its natural resources are governed by the following principal laws and policies (Palden, 1996).

- *Bhutan Forest Act of 1969*: Under this act, all unclaimed natural land was declared government forest reserves. Felling and burning of trees, fishing, and hunting of all large mammals were banned.
- *National Forest Policy of 1974*: To stem the environmental damage caused by uncontrolled logging, the National Forest Policy of 1974 nationalized logging, thereby prohibiting logging by private companies and vesting these activities with the Department of Forestry.
- *Draft National Forest Policy of 1985*: This draft policy accorded higher value to conservation rather than to exploitation of forest.
- *Forest and Nature Conservation Act, 1995* : This act provides long overdue policies for the establishment and management of protected areas and conservation of plants and animal species. The Act covers a wide range of topics from social forestry, forest management, trade and transport of forest resources, soil and water conservation, and conservation of wildlife.

The Government also has launched various activities and programs to ease pressure on wildlife and their products. The most significant ones are: ICDP's in and around protected areas, Agroforestry, Reforestation/Afforestation, Forest Management

/Silviculture, Education and public awareness. Studies in environment are part of the curricula of all the primary schools in Bhutan. In addition, most of the schools in Bhutan also have nature clubs, which promotes environmental awareness among the students through activities such as fieldtrips, environmental camps and publications. These nature clubs have generally been initiated with the help of the Royal Society for Protection of Nature, the country's only non-governmental organization.

Bhutan's conservation effort is also assisted by large number of projects funded by multilateral and bilateral donors, all aimed at conservation and sustainable development of the country (Palden, 1996). The major sources of assistance include: the Asian Development Bank (ADB), UNCDF, UNDP, UNICEF, World Food Program (WFP), World Bank and WWF and government aid organizations of Austria, Denmark, the European Union, Germany (GTZ), India, Japan, the Netherlands and Switzerland (Palden, 1996). The country has signed the Convention of Biological Diversity at the United Nations Conference on Environment and Development, "Earth Summit" (MOA, 1998). The country has accepted its global commitment to preserve the country's wealth of biodiversity. Bhutan has also signed the framework Convention on Climate Change at the Earth Summit (MOA, 1998).

2.6.2: Protected areas:

The Royal Government of Bhutan's policy objective is to maintain 60% of the total land area under forest cover in all times to come (NEC, 1997). Realizing the increasing pressure on wildlife habitats, the Government has set aside protected areas to protect the representative samples of the pristine Himalayan ecosystem. This encompasses 27 % of the total land area of the country. The previous protected area

system has been revised and in 1999, the country with the assistance of WWF has demarcated an additional 9.5 % of the total land as biological corridors (Figure 2.3) linking all the protected areas and declared as a gift to the earth from the Bhutanese people (MOA, 1998). This network of protected areas serves as in-situ conservation of its flora and the fauna including the wild relatives of the domesticated species. Apart from the network of protected area systems, the Government has also set aside a number of protected sites as important conservation areas with special regulations to ensure the protection of local species of conservation importance. Table 2.9 shows some of the important conservation sites with their special value:

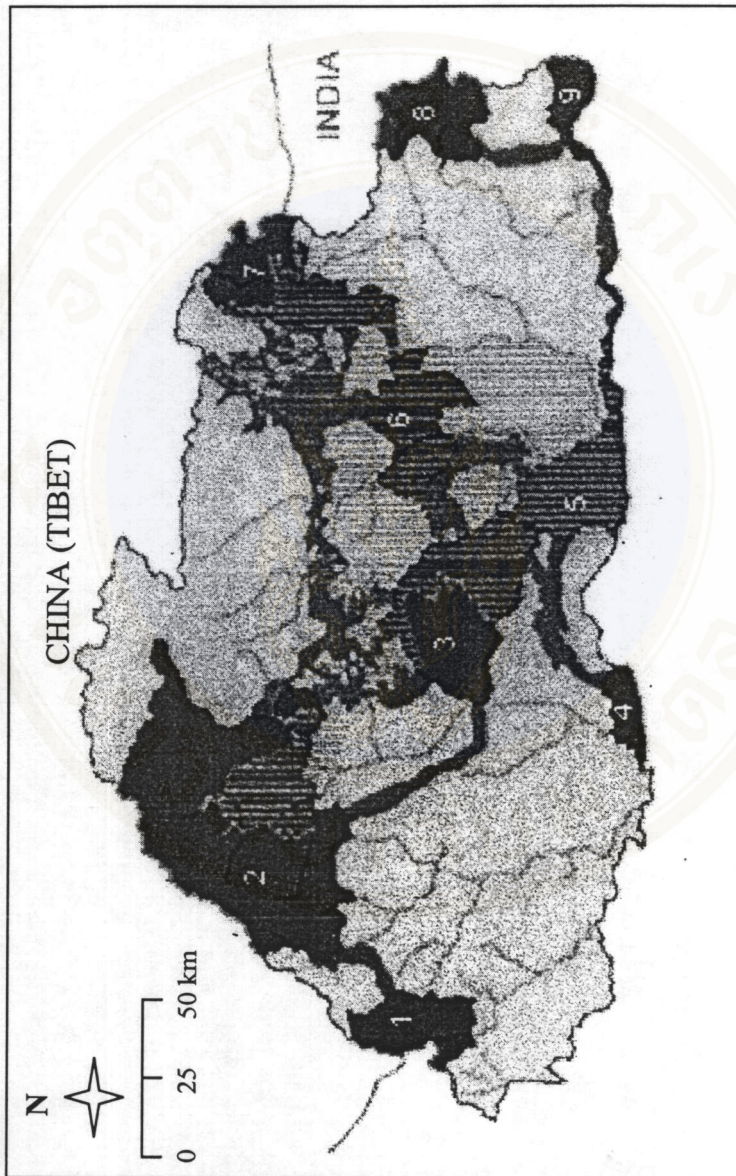
Table 2.9: Important conservation sites besides the network of protected area system with their special values (MOA, 1998).

Name	Dzongkhag (province)	Special values
Dochula	Thimphu	Endemic rhododendron, birds and red panda.
PeleLa	Wangdi	Scenery, langurs, red panda and birds.
Yutongla	Trongsa	Scenery, pine forest and birds
Durtsachu	Bumthang	Hotsprings, geology and scenery.
Phobjikha	Wangdue	Black necked crane habitat
Doga	Paro	Goral habitat

2.6.3: Conservation programs for individual species:

A very limited amount of study has been conducted at the species level. The Royal Society for the Protection of Nature (RSPN) is underway studying the Black

Figure 2.4: Protected areas in Bhutan with Biological corridors.  Protected areas,  Biological corridors and  Potential tiger habitat (McDougal et al., 1998).



- | | |
|---------------------------------|-------------------------------|
| 1. Torsa Strict Nature Reserve | 2. Jigme Dorji National Park |
| 3. Black Mountain National Park | 4. Phibsoo Wildlife Sanctuary |
| 5. Royal Manas National Park | 6. Thrumshingla National Park |
| 7. Bumdelling National Park | 8. Saktien Wildlife Sanctuary |
| 9. Khaling Wildlife Sanctuary | |

necked crane that winters in Bhutan. According to MOA (1998) the Nature Conservation Section (NCS) under the Forestry Division has implemented the Tiger Conservation Programme through its network of territorial units located in tiger habitats. Tiger habitats have been determined and their range and distribution mapped. Workshops are being held to disseminate the information regarding the status of the tiger conservation activities as well as to increase public awareness. Further activities include research to guide and implement scientifically correct tiger conservation and habitat management action and to develop a national conservation action plan based on the results of the tiger survey and data analysis. According to WWF (2000) the tiger population in Bhutan is somewhere between 115-150 individuals. With over 75% forest cover, tiger in Bhutan are not threatened by habitat loss unlike in other parts of the world (WWF, 2000). With regard to other species like takin, the Jigme Dorji National Park staff are underway studying the status and distribution of takin within the park. A detailed study on their diet selection in the summer range has been carried out (Wangchuk, 1999). A limited amount of study on the distribution of snow leopard, golden langur and blue sheep has been documented till date.

In order to assess the status of biodiversity in and outside the protected areas, a nationwide project has been initiated focusing on the non-domesticated areas of the country. It aims in providing policy makers with information which facilitate the decision making process on target settings and measures. At the present moment, a draft framework on the methodology for assessing the biodiversity has been developed and discussed (MOA, 1998). Ecological profiles for the indicator species and the ecosystem are expected to be drawn up and then monitoring process to commence. The project is implemented by the NCS with its co-partner, the National Institute of



Health and Environment in the Netherlands. Patrol monitoring of different habitats for species and site condition is conducted routinely by the respective divisions and the parks (MOA, 1998).

2.7: Discussion:

2.7.1: Status and knowledge of biodiversity conservation:

Bhutan's conservation efforts of its biodiversity are currently constrained by the shortage of basic scientific knowledge about the identity, status and distribution of species and genetic resources in the country. The status and distribution of habitats, the ecological requirements of various species, and the ecological functioning of ecosystems is also unknown. Incomplete survey and poor knowledge of the species requirement limit basic ecological and systematic information on Bhutan's biodiversity. There are no baseline data, which would permit determinations of status and trends in plants and animals, and there are very few data from Bhutan on the ecology and behavior of even the species identified by IUCN and other conservation organizations as endangered. Hence, there is urgent need to collect basic information for species such as red panda, snow leopard, wild water buffalo and Asian elephants in the country to devise suitable environment and management strategies. Survey efforts are also required to determine if species such as Pygmy hog, Argali and Sloth bear have become extinct in the country.

In Bhutan, the number of described plants and vertebrates amounts to about three percent of the total number of species estimated to exist (Reid, 1996 cited in MOA, 1998). Since harvesting of plant species for traditional medicine and for other uses like fuel wood and roofing shingles is immense especially in alpine and rural

areas, there is the fear of over exploiting the rare and endangered species. Hence, it is necessary to identify the population of rare species and their microhabitats in order to protect and monitor them.

2.7.2: Databases:

Database information with regard to the respective protected areas of the country is vital for management purposes as well as for monitoring species distribution and their trends over time. Till date, such database has not surfaced mainly due to lack of expertise and other technical drawbacks. However, the Netherlands co-operation project is developing a biodiversity database for Black Mountain National Park (MOA, 1998). Such databases are needed for other parks like Jigme Dorji and Royal Manas National Park that harbor some of the country's endangered large mammal species such as Snow Leopard, Red panda, one horned Rhino, Asian Elephant and Wild Water Buffaloes.

2.7.3: Staff and capacity building:

At present, the country has limited numbers of trained personnel in the field of biodiversity conservation which presents a major factor limiting the nation's ability to improve and maintain biodiversity conservation (MOA, 1998). Professional and semi-professional manpower in the functional as well as operational level is needed for preparation of scientific management plans and in developing wildlife policy, rules and regulations. Hence, there is the strong need for the recruitment and training of nationals in the field of biodiversity conservation. Bhutan at present doesn't allow foreign scientists to work in the country, but it is strongly felt that such activities can

be monitored in a way that can serve to build the country's own research capacity. International expertise and scientist can be encouraged to help interested national individuals undertaking ecological research within the country.

2.7.4: Ex situ conservation:

Zoos and herbaria play important roles as educational and research institutions. They bring wildlife closer to the general public and also helps in captive breeding. Threatened and endangered species raised and bred outside their natural habitats contribute to captive breeding efforts and therefore to conservation of such species. In Bhutan, except for the national herbarium, there is not yet any national ex situ program for biodiversity. The national herbarium is in its initial stage of establishment and efforts are being made to improve its infrastructure for better preservation of the specimens. It is felt that such initiative can be taken to establish mini zoos in suitable regions of the country for specific species mainly for educative and research purposes. This will also help in bringing about general awareness to the public.

2.7.5: Livestock genetic resources:

The development objectives of livestock have focussed on introduction and adoption of high-yield exotic breeds. Hence much of the agricultural effort is directed towards encouraging farmers to adopt such breeds. Farmers naturally want to get the highest yield possible and therefore there is the fear of losing the indigenous livestock breeds. The high yielding exotics represents monoculture with a relatively narrow genetic base. They are also vulnerable to diseases, parasites and changes in climate and other environmental conditions to which the indigenous breeds are genetically

well adapted. Therefore, conservation effort of the indigenous breeds should be integrated with the overall development plans and programs in order that there is sustainability and effective utilization of the genetic resource.

2.7.6: Economic evaluation of biodiversity:

There has been little attempt to develop an economic valuation of biodiversity in Bhutan. There are economic data on timber, especially on export and some gross figures on tourism with estimates of the number of tourist coming for biodiversity reasons. However, economic valuation of biodiversity in particular, and resource and environmental economics in general remains an area where work is needed. This is considered a particular need in view of the direct reliance of the major proportion of the country's population on biodiversity resource.

CHAPTER III

TAKIN ECOLOGY AND BEHAVIOR

3.1: Introduction:

Bhutan takin (*Budorcas taxicolor whitei*), because of its strong association with the country's religious history and mythology, is treasured as the national animal of Bhutan. Its distribution is said to be restricted to the mountainous regions of Bhutan, Tibetan Chumi valley and Sikkim. Very little is known from the wild about the habits of the animal. Until recent years, most knowledge about takin behavior in the wild was based on few casual observations (Schaller, 1977). Behavioral studies in the wild are important for the effective management of any wildlife. Since behavior is the means by which animals interact with the environment, it can reveal what resources in the environment are important to a species and also how important they are (Dittus and Dittus, 1995). It also reveals how animals organize themselves in space and time to exploit the resources and the amount of space a species require to fulfill its resource requirement. Through behavioral studies, one can also assess the degree of competition within and between species for the same resources, and the importance of predation in a species' life. The IUCN red list of threatened species categorizes takin to be vulnerable and conservation dependent (IUCN, 2000). Hence, proper habitat-specific conservation programme is needed for the species. This can be achieved only through systematic behavioral studies. Besides their status in the wild also needs to be monitored so that any tendency towards numbers can be detected and the population can be saved from extinction. Good information on their population trends and

ecosystem relationship is needed to help takin conservation and to mitigate the takin-human conflict.

Takin populations in Bhutan live in the upper catchment area of Mo Chu, on both eastern and western side (Wollenhaupt, 1991). The summer grazing ground is in Tsarijathang, north east of Lingshi and there is some indication of a second summer grazing ground in Lunanang region. In the upper reaches of the park, takin is the largest ungulate and is identified as the keystone species of the park, the existence of which is an indication of a sound ecosystem (Wangchuk, 1999). Hence their existence is vital to the park in helping to increase habitat quality for an array of other plant and animal species. Being the least studied ungulate, very little is known about its range, distribution, ecology and behavior. Available information focuses mainly on their summer range within the park (Wangckuk, 1999). Hence, this section of the study focuses on distribution of takin in Bhutan, their ecology and behavior during the winter range in Jigme Dorji National Park (JDNP).

3.2: Literature review:

3.2.1: *Takin in mythology*

The Bhutanese name for takin is Drong Gimtsey. Its mythological origin, according to Bhutanese belief, is accredited to the 15th century Buddhist saint and traveling mendicant philosopher, Drukpa Kuenley, commonly known as the divine madman. He is believed to have created takin by giving life to a set of bones from a goat's head and a cow's body (Dowmen, 1980). Takin was formally described by Hodson (1850). Greek mythology tells of the quest of Jason and Argonauts, who sailed the high seas on the ship Argo in search of the magical Golden fleece. They

may well have been seeking the long shaggy coat of the takin, which can be golden in color. There was particular interest in the animal at the beginning of the century and several reports were published (Bailey 1912, Ward 1921, Anderson 1920, Andrews 1922, Copper 1923). Anderson (1920) gives an account of his quest for the golden takin as part of the expedition in central Asia for the American Museum of Natural History.

3.2.2: Taxonomy and classification:

“The takin, which up to a few years ago was thought to be related to the Rocky Mountain goat and serow, is now believed to be nearer to musk ox in classification” (Yin 1967; Pasitschniak Arts et al. 1994). Takin is a Tibeto-Burman name for this animal. Due to its odd combination of features, its true place in the tree of life is still somewhat uncertain. There is only one species of takin (*Budorcas taxicolor*). It belongs to the family Bovidae, subfamily Caprinae, order Artiodactyla. It is an animal of the mountains and prefers thick cover. It is found in the mountainous region of Bhutan Himalayas, northern India (Mishi hills of Assam), eastern Tibet, the Burma-Assam frontier and west central China (Tsinling mountains of Shensi).

There are four recognized subspecies of takin: Bhutan takin (*Budorcas taxicolor whitei*), Shensi/Shaanxi or Golden takin (*Budorcas taxicolor bedfordi*), Sichuan takin (*Budorcas taxicolor tibetana*) and Mishmi or Burmese takin (*Budorcas taxicolor taxicolor*). All the four subspecies are similar in their shape and structure and differ only in their coat coloration. Shensi subspecies, also known as golden takin, is golden in color while that of Bhutan, Sichuan and Mishmi subspecies are dark, brown and straw colored respectively.

The exact limit of the range of each subspecies is difficult to determine because of the paucity of reliable published information. However, Neas et. al (1987) states that Bhutan takin (*B. t. whitei*) occurs in Bhutan, Sikkim, and the Tibetan Chumi valley; Mishmi (Burmese) takin (*B. t. taxicolor*) in the Mishmi hills of Arunachal Pradesh (India), Kanchin state (Burma) and the Bomi-Zayu region of southeastern Tibet; Sichuan takin (*B. t. tibetana*) in southern Daxue Shan (Sichuan province) to the southern Min Shan and the lower drainage basin of the Bailong Jiang province (China); and the Shaanxi (golden) takin (*B. t. bedfordi*) appears to be restricted to the Taibai Shan region of central Shaanxi and the southeastern Gansu province (China). Table 3.1 shows the classification, locality and distribution of different subspecies throughout the entire range.



A



B

Figure 3.1 Bhutan takin (*Budorcas taxicolor whitei*) A: In mini zoo, Thimphu, Bhutan. B: In their natural habitat in study area I (Damji/Gathana valley)

Table: 3.1: Classification and distribution of different subspecies of takin. (Adapted from Neas and Hoffmann, 1987).

Subspecies	Common name	Locality/Distribution.
i) <i>taxicolor</i>	Mishmi or Burmese takin	i) Mishmi hills of Arunachal Pradesh, Kanchin state (Burma) and Bomi-Zayu region of southeastern Tibet.
ii) <i>whitei</i>	Bhutan takin	ii) Bhutan, Sikkim and the Tibetan Chumi valley.
iii) <i>tibetana</i>	Sichuan or gray takin	iii) Southern Daxue Shan to the southern Min Shan and the lower drainage basin of Bailong Jiang province (China).
iv) <i>bedfordi</i>	Shaanxi/Shensi or golden takin	iv) Tai-bai Shan region of Shaanxi province (China), and southeastern Gansu province (China)

3.2.3: Ecology and behavior:

Bhutan takin inhabit the forested mountains of northern Bhutan. Sub populations are presumably separated by mountain ranges running roughly north to south. It is one amongst the 23 totally protected animals under the Forest and Nature Conservation Act of Bhutan, 1995. The IUCN red list of threatened animals list takin under category vulnerable A2cd i.e., a taxon which is conservation dependent, the cessation of which will result in the species to be threatened within a period of five years. Each subspecies in the different range countries has its own ranking: *B. t.*

taxicolor – endangered; *B. t. tibetana* – vulnerable; *B. t. bedfordi* – endangered and *B. t. whitei* – vulnerable.

Takins are seasonal migrants, migrating to an elevation of 3,800-4,000m in summer in the alpine meadows and alpine scrubs. Numerous reports on takin in other regions (Allen, 1940; Lydekker, 1900, 1906, 1907; Sterndale, 1984; Wu and Niu, 1981, cited in Neas and Hoffmann, 1987), place takin in alpine regions, near and above snowline during the period when the takin have migrated vertically upward from their winter range. It is thought that they do this in order to avoid the insect infested area in the lower valleys (Wangchuk, 1999). Besides, this is also the time when the vegetation in the alpine regions is rich in nutrients (Armington, 1998). Groups as often as large as 200 animals can be observed in the open scrub and meadows in summer (Wangchuk, 1999). This is usually the rutting season of the animal that begins from early June to July with calves being born in February and March of the following year (Neas and Hoffmann, 1987). The gestation period is therefore about 8-9 months. Similar claims have been reported for the two sub-species, Shaanxi (*B. t. bedfordi*) and Sichuan (*B. t. tibetana*) takin, to have gestation period of 9-10 months and parturition in February and March respectively (Allen, 1940 and Shou, 1964 cited in Neas and Hoffmann, 1987).

Takin in Bhutan stay in their summer range for a brief period of two months (Wangchuk, 1999). Though they leave their winter habitats in April-May, they arrive in the summer habitat only in June (Wangchuk, 1999). Unlike the quickly migrating caribou or reindeer (*Rangifer tarandus*) of Alaska and north Europe (Skogland 1989), takin migrate in slow stages. They seem to follow the phenological stages of plant growth along their migratory corridor (see Schaller et.al, 1987). Takin in Bhutan have

been observed to take up to 2 months to migrate from their winter habitat to their summer habitat and vice versa. Takin leave for their winter habitats and start their descent down to the sub-alpine and temperate broad leaf forest about mid July (Wangchuk, 1999). Although they start leaving their summer habitats by July, the first takin in one of the winter habitat near Gasa hot spring was seen only at the end of September (Wangchuk, 1999). As they do so, they scatter into smaller herds and most often males are found solitary. Grooves and Jiayan (1991) gives similar statement about Golden takin in the Qinling mountain in Shaanxi province, China and further states that the group size tends to decrease with increasing habitat density.

In most of the range countries, no proper census has been carried out to assess total takin population and status. In particular, the distribution of takin in Bhutan has not been investigated and its status is very uncertain (Wollenhaupt, 1991). Inaccessibility and difficult terrain of its habitat has posed major problems to study this species, and hence very little is known about its ecology and habitat requirement. It still remains one of the unique and least studied ungulate today (Wangchuk, 1999). Of the four subspecies, Bhutan takin has been least studied. Efforts to research Bhutan takin have been made by the park staff and some basic information with regard to their ecology and food requirement during the summer range has been collected. As with Golden takin (Groves and Shield, 1995) and Sichuan subspecies (Schaller et al. 1986), Bhutan takin is described as a generalist mixed feeder foraging on a variety of shrubs, forbs and graminoid species (Wangchuk, 1999). Most of these plants are commonly found in the open meadows and scrub areas in the upper reaches of their summer habitat and therefore it is important to maintain such open areas from being completely taken over by succession into forest stages. Such open areas are

conspicuous above the tree line in the alpine meadows. In contrast to these open meadow areas, the takin being seasonal migrant dwells in the forested areas during the winter range at lower elevation. How then do these animals cope with a different vegetation? Do they exhibit some sort of dietary or habitat preferences in the winter range? If so what is selected and how do they budget their daily activity? Such information on their ecology and behavior are important in understanding animal-food-environment interactions and also to assess the presence of threats to the survival of the species, but is scant for their winter range. For a seasonal migrant like takin, assessment of its winter range in addition to its summer habitat is necessary in order to understand habitat characteristic for maintaining viable population of the species. These parameters are essential prerequisites for good management of conservation programs (Rodger and Panwar 1988, cited in Wollenhaupt, 1991). Bhutan claims to be the last refuge to harbor sizable population of takin in the natural and unspoilt habitat (Thinley 1988). Such claims will not last long if adequate information on its ecology and distribution are not available for better management of the species.

3.3: Study sites:

3.3.1: General description of study sites

The study sites are situated in two areas (Damji /Gathana and Shengana), both inside Jigme Dorji National Park, the largest protected area in Bhutan. Its altitude ranges from about 1,400 to above 7,000 m above sea level. The park is a vital watershed covering almost the whole of northwestern Bhutan and is an important natural conservatory of glaciers, alpine meadows and scrublands, subalpine and

temperate conifer forest, warm and cool temperate broadleaf forest, major rivers and streams, and the flora and fauna that inhabit these ecosystems.

The main study site (Area 1) is located in the southern part of the park where majority of takin herds are known to migrate in winter (Figure 3.2). It is geographically situated between 27° 47' – 27° 52' in latitude and 89° 40' - 89° 45' longitude. The local name of the study area is Damji/ Gathana valley. The area of the study site is about 4,200 ha and the elevation is between 1,800 and 3,000m. Terrain is steep and rugged and virtually all slopes are densely vegetated with mixed broadleaf and evergreen forests. The forest floor is rich in understory vegetation with occasional bamboo. To the east of the area runs Mo Chu river which cuts the valley deep. The riverine vegetation along this valley is the main habitat for takin in winter. On the other side of the river, another valley joins Mo Chu. Local people call the valley Japhulum, and presumably this valley joins Lunanang and serves as the migratory corridor for the sub population leaving for Lunanang in summer.

The second study site (Area 2) is situated in the southeast of the park (Figure 3.2). Presently, a small number of Bhutan takin annually spend their winter season in this area. The local name of the area is Rongrong Karmo and is in the northeast of Shengana. According to the local residents, this sub-population probably has diverted their winter range from Lunanang.

3.3.2: Climate:

Jigme Dorji National Park (JDNP) experiences a considerable seasonal and local variation in climatic conditions mainly because of its latitudinal position, altitudinal range and mountainous terrain. Since the study area is situated in the

Figure 3.2: Jigme Dorji National Park, the primary takin habitat showing study area 1 and 2 (Box).

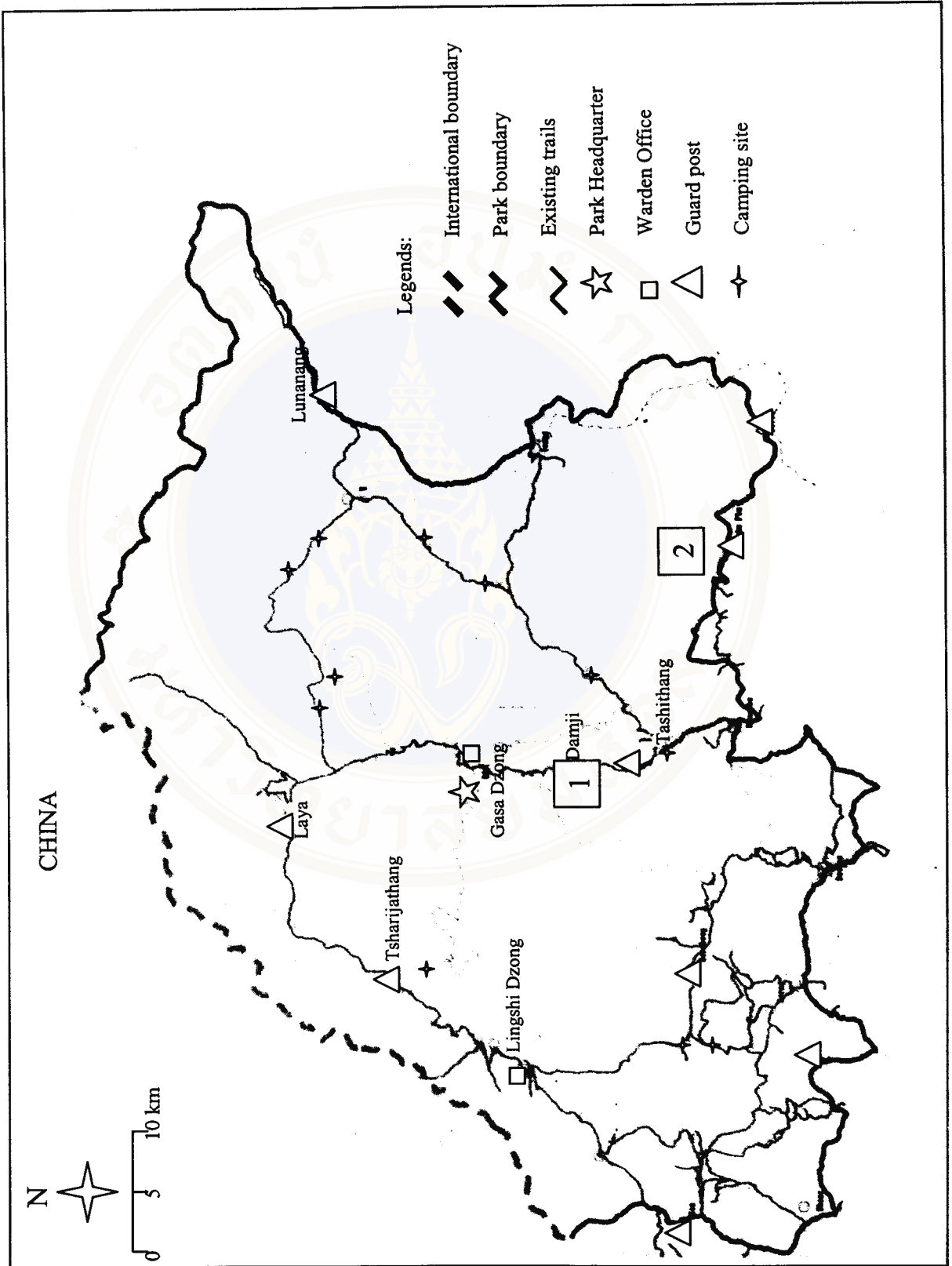
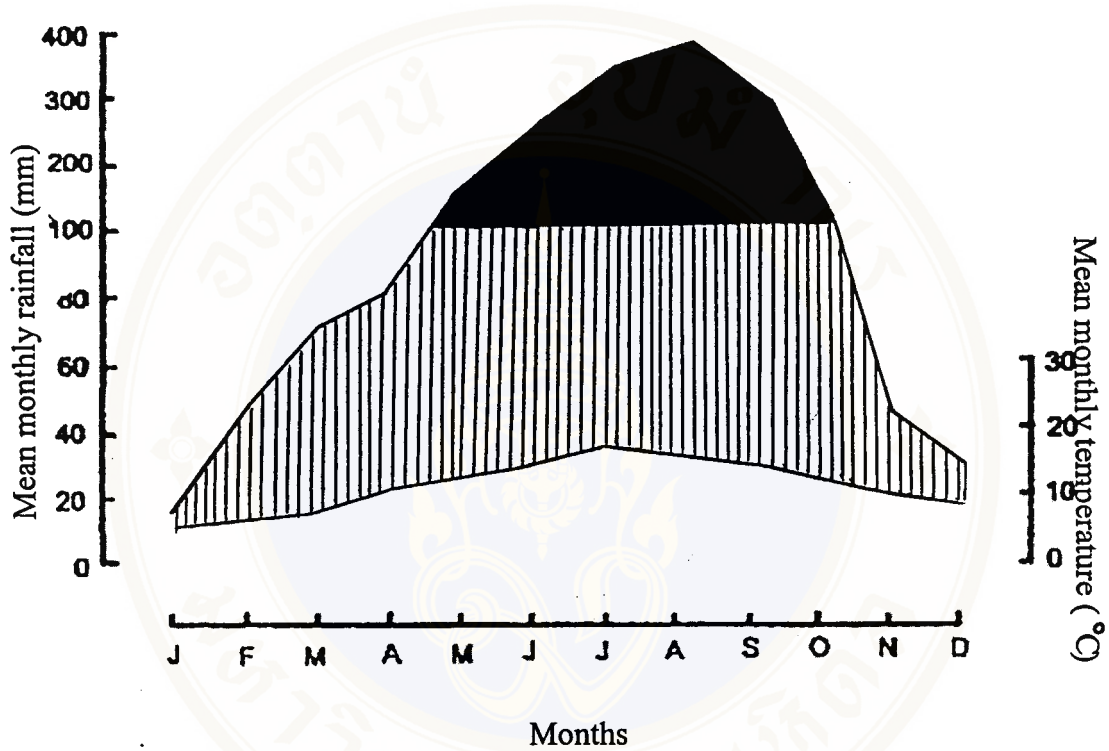


Figure 3.3. Climate diagram (based on Walter's system given in Srikosamatara, 1993) of Khatey showing mean monthly rainfall (Superabundance:Shaded) and mean monthly temperature (Data from NCS, 1997).



southern part of the park along lower Mo Chu valley, the area experiences warm and moist climatic condition almost throughout the year. During the period of the study from late January through May, temperature in the area ranged from high of 17°C to low of 6.5°C. The valley receives rain from March till October and highest in the month of July and August. The coldest month of the year are December, January and February during which months, temperature reads as low as 0°C. Regularly collected and accurate meteorological data of the area are not available, but data exist from a nearby region i.e., Khatey at an altitude of 2,700m. Monthly rainfall and temperature of Khatey is shown in Figure 3.3.

3.3.3: Human activity:

To the west of the main study area is Damji village with the number of household being 33. They are permanent inhabitants with a population of about 300 individuals in the community. The village has a community school, a health clinic and an animal husbandry and agricultural center. The residents there practice subsistence farming, producing just enough for use in the family. Cereals such as paddy, maize and wheat are grown during different times of the year and vegetable crops such as potatoes are also produced. They also rear cattle, sheep and goats, and horses are kept mainly for transportation. In order to foster sustainable use of natural resources, the Nature Conservation Section, with the help of agencies like Royal Society for Protection of Nature (RSPN), WWF and UNDP, have implemented Integrated Conservation and Developmental Programs (ICDP) in and around the park. The local people in the area are also assisted by this program in order to minimize encroachment of forest and wildlife products. Since the village lies within the takin area, such

activities are crucial in order to maintain viable population of this ungulate and other wildlife species in the area.

The human activity in the area does not disturb takin habitat due to lack of road. There are trails for people to travel on foot to the near by takin areas, but is restricted by law. Their livestock are also not allowed to venture into these areas.

3.4: Methods:

3.4.1: Field survey and population estimates:

In order to determine the range of takin distribution and to estimate their population, I corresponded with and interviewed numerous foresters, ex-hunters and other people about the status of the animal in the area known to them. A pre-prepared questionnaire (appendix 5) was used. Trips were also made to various areas, presumed to be inhabited by the animal in winter in order to assess their absence or presence data. Prior to field visit, major secondary information with regard to takin distribution was collected through discussion with park staff, articles and papers. Takin location and distribution was recorded on maps with scale 1:50,000. In general, it was observed that the winter range of takin is characterized by:

- i) Large and relatively undisturbed forest tracts.
- ii) Hilly terrain below an altitude of 2,800 m and
- iii) Availability of free water and an abundance of forage in the form of grasses including bamboo, shrubs and other trees.

Despite every effort, it was not possible to obtain sufficient information to delineate precisely the range of takin distribution mainly because of time and logistic constraints and also due to the remoteness of some of the takin habitats.

3.4.2: Behavioral observation:

For behavioral observation, takin area in the study site 1 was frequented on alternate day from early February till end of May. On most occasions, poor visibility due to fog and mist in the area limited clear observation or sighting. Besides, because they inhabit rugged terrain with dense forest and thick undergrowth, it was very infrequent to observe them for long period. The animal was found to be active during different times of the day, exhibiting various behavioral activities starting from early 0630 hours to 1730 hours. These behavioral activities were quantified and the main sampling procedure used was scan sampling (Martin and Bateson, 1993). The scan was carried at five minutes interval using prepared check sheet (appendix 6) whenever the animal was in view. For each sample, a sweep was made from one side of the herd to the other recording what each visible animal was doing.

After some preliminary observation, five different categories of activities were distinguished. They are feeding, resting and ruminating, moving slowly and browsing occasionally, grooming and standing at gaze. These behavioral activities were found to be relevant in the natural habitat. In the present context, these activities are defined as follows:

- 1) Feeding: An animal was said to be feeding when it was harvesting, that is either grazing or browsing in the same area. It covers only intensive grazing or browsing as compared with the occasional browsing of behavior 3.
- 2) Resting and ruminating: Takins usually prefer open ground while bedding. On clear days around noon, the animals were observed resting with their front legs extended outward resembling that of a sleeping posture of domestic cattle.

Hence this activity covers the time period when the animals were at rest bedding on the ground.

- 3) Moving slowly and browsing occasionally: This is connected mostly with changing from one browsing area to another. This covers the route to the next browsing area while foraging.
- 4) Standing at gaze, interaction and play: are activities that comprise intra-specific behavior pattern. They exclude any browsing activity.
- 5) Grooming, is an important activity in the life of an animal, and it occurs between animals of all ages and both sexes. This activity occurs in takin infrequently between feeding bouts where the animal involves itself in self-grooming by licking different parts of its body or rubbing its body against a rock or a tree trunk.

3.4.3: Activity pattern:

To find out if the species follows some diurnal pattern of activity, I noted how many animals in the undisturbed herds were active or inactive at 5 minutes intervals. The active phase includes all the activities defined above except resting periods when the animals were physically inactive. The six points in each half hour period were lumped together and expressed as the percent of animals active.

All the herd sizes were also recorded on first sight in the field by counting numbers with binoculars and spotting scope. Any number of animals, be it an aggregation or a filial bond of mother and young was classified as a group if the animal acted synchronously. Group composition was recorded as size-age and sex classes based on the physical attributes including horn.

The size-age classes were divided into calves of the year (newly born), yearling (1.5 years), sub-adult male/female (2.5 years) and adult male/female (3 years and +). Sexual dimorphisms were not very distinct and are subjected to biases due to problem of distances between the observer and the animal mainly because of the rugged and difficult terrain in the winter range. Besides, their genitalia characteristics were covered by long thick hairy coat. As a direct comparison, their size was used to classify sex for adult males were comparatively taller and heavier than adult females and besides, the former also possess slightly heavier horns than the latter.

3.4.4: Diet study:

Since the winter habitat of the species is characteristically thick forest, it was not possible to study their diet by direct observation. Site examination was also not possible, as the feeding sites of the species were not accessible. However, local expertise indicated 8 plant species that were foraged by takin. These were collected from the nearby areas. The local experts described these species as the main foraging plants of the takin in their winter range. Collected plant samples were stored in plant press for preparation of reference slides.

3.4.4a: Microhistological analysis of feces:

Microhistological technique for the identification of plant remains in animal faeces has been described by several investigators including Cavender and Hansen (1970), Deardon et al. (1975), Satakopan (1972), Holechek et al. (1982), Schaller and Gu (1994) cited in Berwick and Saharia 1995. It involves identifying plant fragments under a microscope based on the variability of cellular features. An estimate of the

herbivore's diet can be obtained based on the botanical composition found in the excreta. Rentfleish (1998) points out that microhistology technique has various application in the diet study of domestic as well as wildlife herbivores. She states that the application of the results can determine competition between domestic and wildlife herbivores, acquiring food habit knowledge important to any nutrition or competition study, pinpointing agriculture crop and forest damage, animal losses due to poisonous plants, and baseline data for environmental impact, range improvement plans, and surface mined land reclamation, among others. For the present, the main purpose is to investigate and quantify the proportion of various foraging species in the fecal dropping of the animal.

3.4.4b: Sample collection:

Nine fecal samples were collected from various areas within the main study site 1 for laboratory analysis. Since the animals diet in the wild cannot be controlled; attention was not paid to collecting droppings from a single animal or a group of individuals. Pellets of different sizes were collected, mostly semidried and were further air dried and stored in plastic bags with silica gel.

3.4.4c: Reference slide preparation:

Dried and pressed plant specimens were used for preparing food plant reference slides. The technique proposed by Dilcher (1974) was employed where epidermal sheath cells are compared with those of the undigested fragments in the feces. A 1 sq. cm. of the leaf was removed from one edge of the specimen and placed in a bleaching solution of 5% sodium hypochlorite. The color of the specimen became

pale and clear. (This process took about 4-12 hours depending on the characteristic of the leaf). It was then repeatedly washed by placing in distilled water to remove the bleaching solution. The sample was then placed under a dissecting microscope and the two-epidermal layers separated with a dissecting needle and a forceps. The epidermal layers were then placed on the microscopic slide with adhesive gelatin followed by series of alcohol treatments (50, 70, 95, and 100%) for dehydration. The dried layers were then stained with safranin O in absolute ethanol for about 15 seconds or longer depending on the species. Finally alcohol was removed by Xylene-alcohol treatment and the specimen mounted on canada balsam to prepare reference slide. Each slide was then carefully labeled for comparison with those of the fecal slides.

3.4.4d: Fecal sample treatment:

From each dried fecal sample, a fraction of it weighing approximately 100g were initially soaked in formalin acetic acid separately. Following Stewart and Stewart, 1967, Stewart, 1970, a 1 g weight of the original sample was then placed in 4ml of concentrated nitric acid in a round bottomed flask and heated over a water bath for two to three minutes. The treatment clears the epidermal fraction and facilitates identification. The samples were then made up to 200ml with water and then boiled and stirred to complete the cleaning process. The supernatant fluid was then removed by centrifugation followed by washing and centrifuging for a second time. Finally, the residual fragments were stored in 5ml formalin acetic alcohol. From the latter, a sub sample of appropriate size is taken out using a swallow scoop and spread out on slides under 22 X 40 mm cover-slips. Initially, the sub samples were agitated again and centrifugation processed for the third time. This reduces the volume of the sub sample

to about 1ml, which gave sufficient materials for six slides with a suitable density of fragments.

3.4.4e: Analysis:

The slides were marked with parallel grid lines whose distance apart was slightly less than the diameter of the microscopic field of view at a magnification of X100. The slides were also traversed systematically along alternate pairs of lines. Every fragment of leaf epidermis that could be identified using key reference slides and which fell wholly or partly between the lines was recorded. Each slide had 20 point quadrats of which 25% (5 quadrats) were analyzed by counting and measuring the cover area of different species. Initially, the proportion of monocot and dicot in the fecal slides were analyzed based on their cuticular characteristics.

3.5: Results:

3.5.1: Range and Distribution:

At present, the range of takin distribution in summer presumably encompasses three distinct sub-populations extending from Northwest: Lingzhi, Tsjarithang and Lunanang in the north (Figure 3.4). These sub populations disband into smaller herds towards winter as they descend to lower elevation. They inhabit the main river valleys along Pho Chu and Mo Chu within the park. Other herds are found along Wangchu valley above Dodena in Thimphu and along Tonge Rong Chu, northeast of Shengana in Punakha. Winter herds usually range from 1-14 animals in a group, but during the course of the study the largest herd size observed was 6 animals (Figure 3.5). Although, the takin in between Damji and Tashithang area in the north west of Mo




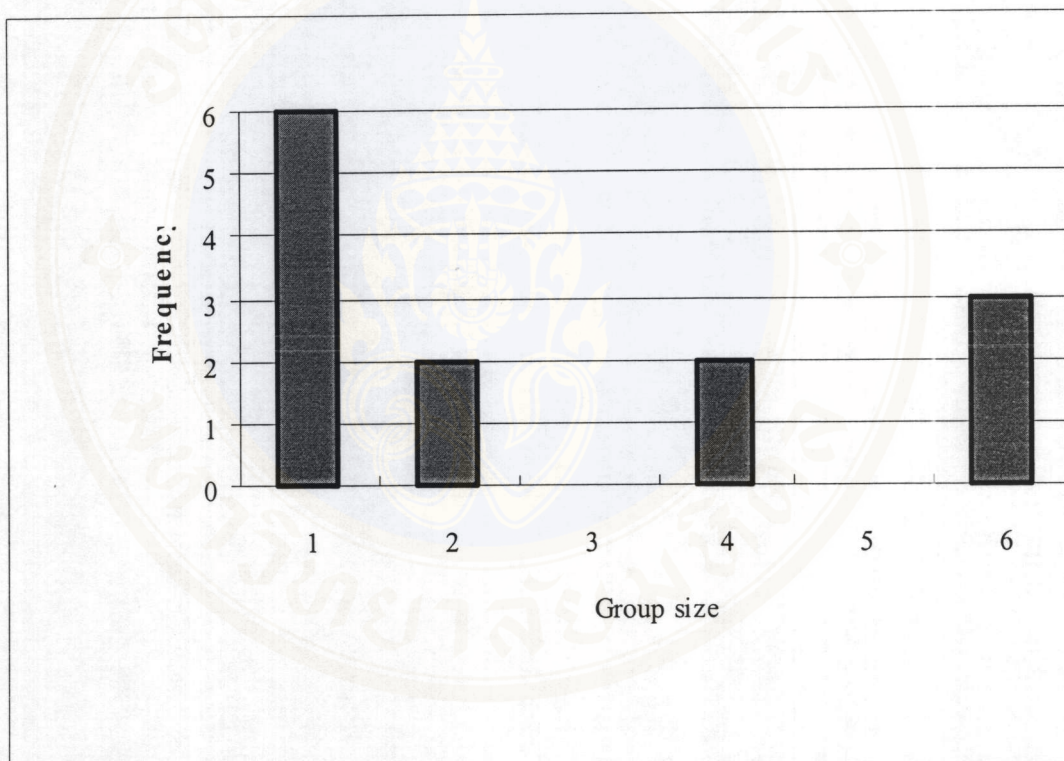
Figure 3.4: Range and distribution of takin in Bhutan.  Summer range (May - September);  Winter range (Oct - May).  Denote the probable migratory route from summer to winter range.



Figure 3.5: Frequency of takin herds from direct observation.



Chu valley are represented on the map as one population, the animals in the area are separated into at least six more or less distinct aggregations. These smaller sub populations have separated from the same herd while migrating from their summer range in Tsajarithang. Majority of these herds along Mo Chu valley leave for Tsarijathang in summer except for fewer sub populations in the lower Damji valley that have their summer feeding ground in Lunanang. These sub-populations leave for Lunanang following Japhulum valley at the base of Damji on the other side of Mo Chu.

Table 3.2: Number of interviewees and reports that support the existence of takin populations in summer range at each location (n=16 people interviewed).

Location	Number of interviewees	Reports
Lingshi	3	NCS, 1997; MOA, 1998 Wangchuk, 1999; MOA, 2000
Tsharijathang	11	NCS, 1997; MOA, 1998 Wangchuk, 1999; MOA, 2000
Lunanang	10	NCS, 1997; MOA, 1998 Wangchuk, 1999; MOA, 2000

Table 3.3: Number of interviewees and reports that support the existence of takin populations in winter range at each location (n=16 people interviewed).

Location	Personal observation	Number of interviewees	Reports
Punakha Dzongkhag			NCS, 1997; MOA, 1998;
- Shengana	✓	0	Wangchuk, 1999
- Kewana	✓	7	
Gasa Dzongkhag	✓	11	MOA, 1998;
Thimphu Dzongkhag			Wangchuk, 1999
- Dodena	✓	6	NCS, 1997; MOA, 1998;
Wangdi Phodrang			Wangchuk, 1999
- North of Sephu	--	3	NCS, 1997; MOA, 1998;
Bumthang			Wangchuk, 1999
- Dhur Tsachu	--	6	NCS, 1997; MOA, 1998;
			Wangchuk, 1999

3.5.2: Population estimates:

Since takin inhabit forested areas with difficult terrain, especially during winter, it was difficult to estimate their population directly by either census technique or by sample count. In addition, their habits also make it impractical for the researcher to study the species during winter. Therefore, to estimate the total population in different takin areas, information was obtained by interviewing individuals either formally or informally with regard to the status of the animal in areas known to them.

A summer count conducted in Tsarijathang valley in 1998 during the summer range numbered 250 animals: 70 large breeding males, 16 calves, 14 one and half year old and 150 females and sub-adults (Wangchuk, 1999). This tallies with the number of animals in between Gasa and Tashithang where the animal is known to migrate in winter and leaves little doubt that the population has not been increasing in the past few years. This may be as a result of smaller sub-populations that were not accounted for during the study or as a result of mortality due to predation or some diseases.

A total of 330-400 animals seem to exist in the wild through out its range (Table 3.4). Of this almost two-thirds of the total population is concentrated in Jigme Dorji National Park within three Dzongkhags, Gasa, Thimphu and Punakha, and the rest are outside the park boundary towards north of Wangdiphodrang and Bumthang (Figure 3.6). Gasa Dzongkhag has the highest population of takin. This may be partly because of less human population with less infrastructure development in contrast to other takin areas as a result of which their natural habitats are still intact and undisturbed.

Figure 3.6: Population estimate of takin in different takin habitats during the winter range





Table 3.4: Population estimates of takin given by interviewees (n=16) in Bhutan for different takin habitats during the winter range (September-May).

Takin areas/ Winter range	Estimated number
<u>Wangdi Phodrang Dzongkhag:</u>	
- North of Sephu	40-50
<u>Bumthang Dzongkhag:</u>	
- around Dhur Tsachu	30-40
<u>Punakha Dzongkhag:</u>	
- North east of Shengana	15-20
- Pho Chu valley, above Kewana	30-40
<u>Gasa Dzongkhag:</u>	
- Tashithang – Damji	20-30
- Damji area	70-80
- Damji – Gasa	30-40
- Gasa area	80-90
<u>Thimphu Dzongkhag:</u>	
- Around Dodena	15-20
TOTAL:	330-410

3.5.3: Herd size and composition:

Sexual identification was difficult as the animals could be observed from a distance of +100 meters. Besides, both sexes possess short horns and their characteristic genitals such as the four teats or the male organ are covered by long thick hairy coat. As a direct comparison, their size was used on some occasions to

identify their sex, for males are comparatively taller and heavier than female cows. Since the observation period coincided with the time of their parturition, calves usually accompanied female cows. From late March till May, herds comprised of animals with newly born calves. The calves in general are darker in color than the adults and their dorsal stripe is also inconspicuous. The size and composition of six takin herds in the valley from March – May showed that young comprised 16 % and the yearlings 16%, sub adults 24% and adult males and females 45%.

Table 3.5: Herd size and composition of takin herds in Damji/Gathana valley from direct sighting and from informant: (* direct sighting, ** from informant)

Adults male/female	Subadults male/female 2-5 yrs.	Yearlings 1.5yrs.	Young/newly born	Total
2	2	2	--	6 *
2	1	1	--	4 *
2	2	1	1	6 *
3	1	--	2	6 **
3	2	1	2	8 **
5	--	1	1	7 **

5.5.4: Activity cycles:

To analyze their activity cycle (Figure 3.7), I noted how many animals in the herds were active or inactive for every 5 minute sampling period. One herd was

observed on each of four days from 07.00 to 17.00 hours (Table 3.6). As can be seen from table 3.6, it was not possible to observe each herd for long hours due to poor visibility and dense habitat they inhabit in winter. The active phase includes all the activities defined in section 3.4.2 except resting periods when the animals were physically inactive. For each herd for each half hour period, the number of active animals for all six 5 minutes sampling period were added together. Inactivity for each herd and half hour period was determined in the same way. Activity was then expressed as the percent of animals active every half-hour. Since observation was carried out on different days, an average of the percent of animals active every half-hour was determined whenever possible.

It was observed that takins were active during different time of the day (Figure 3.7). Their activity presumably starts with the start of dawn and prolonged until dusk. I was able to sight them at the earliest at around 0700 hours during which period at least 1/3 of the animals were at rest. Since social interaction and movement use little of the animal's day especially during winter, the activity curve (Figure 3.7) represents the activity cycle.

It shows that the animals are active at any time during the daylight but that a definite peak of activity exists. The activity starts early morning with the start of dawn where almost all the animal would be active. During daytime, it reaches its peak at around 0900 to 1130 hours and slowly drops down till about 1300 hours in the early afternoon. It then steadily rises and reaches the peak in the late afternoon and prolongs until dusk.

Figure 3.7: % of takin active at half hour intervals between 07.00 to 17.00 hours (n = 4 herds observed)

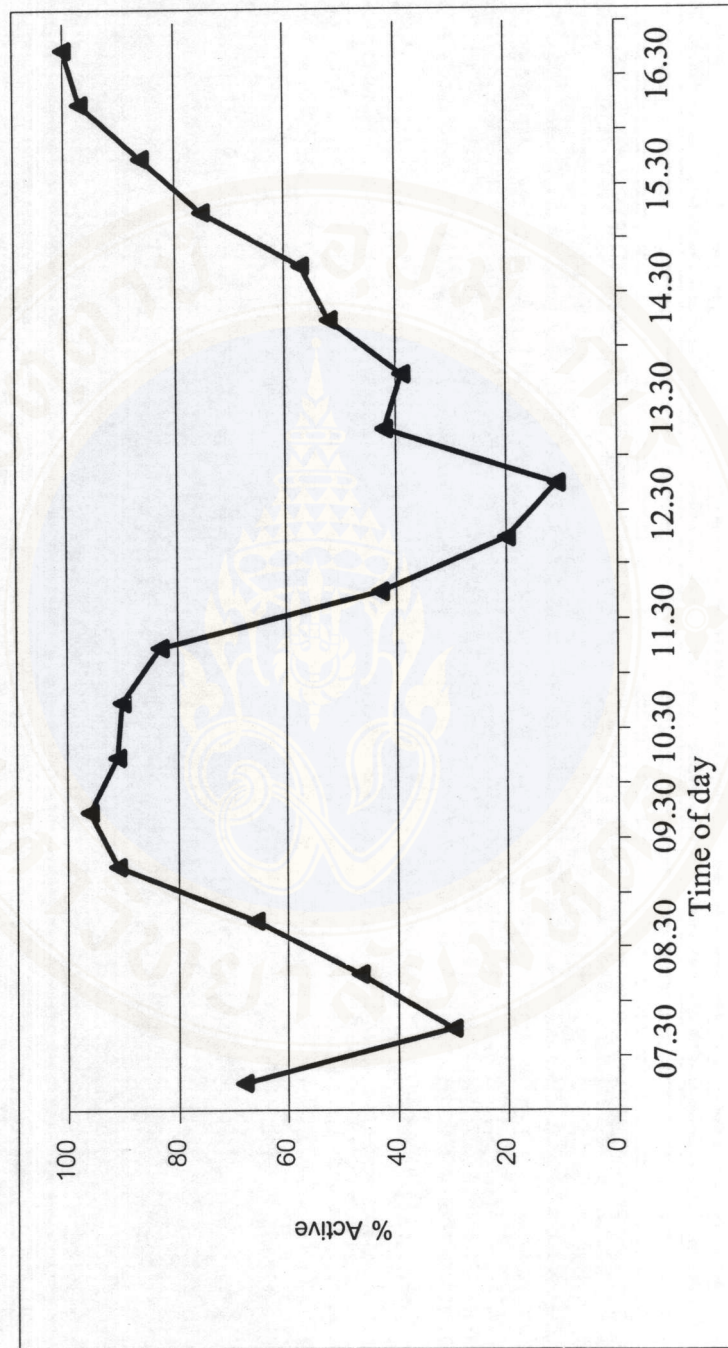


Figure 3.8: Activity budget of takin

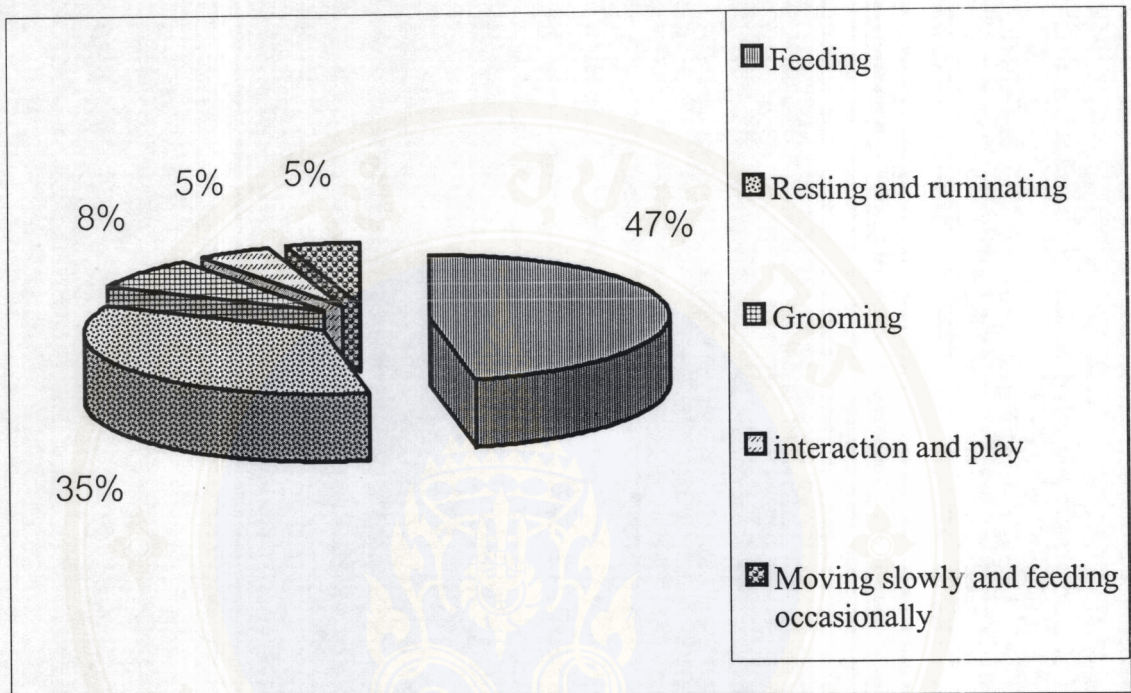


Table 3.6: Percentage of takin active during different time of day.

Time	Observation days and percentage active				Average % active
	1	2	3	4	
07.00-07.30	68	-	-	-	68
07.30-08.00	30	-	-	-	30
08.00-08.30	40	-	55	-	47
08.30-09.00	66	-	67	-	66
09.00-09.30	83	-	100	-	91
09.30-10.00	93	-	100	-	96
10.00-10.30	83	-	100	-	91
10.30-11.00	80	-	100	-	90
11.00-11.30	66	-	100	-	83
11.30-12.00	30	-	37	-	33
12.00-12.30	28	-	12	-	20
12.30-13.00	22	-	-	-	11
13.00-13.30	42	-	-	-	42
13.30-14.00	39	-	-	66	39
14.00-14.30	25	80	-	100	52
14.30-15.00	47	67	-	42	57
15.00-15.30	78	73	-	33	75
15.30-16.00	96	76	-	100	86
16.00-16.30	-	97	-	100	97
16.30-17.00	-	100	-	100	100

3.5.4: Activity budget:

The analysis of activity budget (Figure 3.8) is based on observations of 4 herds, each herd observed on a different day. The number of animals in each behavioral category for each 5 minute period over all herds (observation days) was summed (Appendix 4). These numbers were then used to calculate the proportion of time spent by the animal on each activity. It was observed that the animals in the wild allocate 47% of their diurnal activity on feeding, 35% resting, 8% on grooming, 5% playing and 5% moving slowly and feeding occasionally (Figure 3.8).

3.5.6: Day Range and movement:

Since takins are sedentary, except during their migratory trails, once sighted, they can be observed almost throughout the day foraging or involved in other activities without much movement. The only movement observed during the daylight was connected to the change of feeding site where animals moved slowly and foraged as well. They spent almost 5 percent of the activity on this behavioral act. On the average, the day range during the time of the study was only 112 m (N=3).

3.5.7: Predation and insect harassment:

In both the study areas large mammalian predator like tiger (*Panthera tigris*) and leopard (*Panthera pardus*) were present (Figure 3.8 and 3.9). On several occasions in study area I (Damji), especially at night, the growl of the former was heard. The following day no matter how far we ventured into the study site, we were unable to sight any animal, which further proves that the big cat does prey on takin. Their tracks were also very frequent in the area. Usually, the former frequented the main takin area in the valley bottom along Mo Chu. The latter was known to prey on the livestock in the locality. Asiatic wild dog (*Cuon alpinus*) was also very common and was found in close proximity with the inhabitants there. Although there was no evidence of leopard and the wild dog preying on takin in the area, they were a menace to the animals there. Local people in and around the study area believe that the Himalayan Black Bear (*Selenarctos thibetanus*) also preys on young calves by following pregnant cows and driving her away as soon as she give birth. But this was not evident as we observed a herd of six takins with a newly born calf and a Himalayan black bear just about 50m away from the herd. It was late morning 1105

hours; the herd was foraging at the valley bottom and the bear was resting on a rock next to the riverbed. The herd seemed little bothered and was not distracted by its presence. At around 1315 hours, the bear was on its foot. Sniffing air, it walked upstream and slowly disappeared into the thickets. There was no sign of the latter the whole afternoon and the takin foraged the area without any disturbance. This leaves little doubt that the bear can be one of the potential predators of takin.

Similar observations were made in Shengana (Rongrong Karmoo), north east of Punakha. Tiger is known to be one of the potential predator, their tracks and droppings were encountered during the field visit (Figure 3.9). Leopards too frequented the area, but were found at lower elevations closer to encroached areas. The content of a droppings of tiger from the area revealed about 20 percent takin, 55 percent sambar deer, 25 percent barking deer and other animals. Takin doesn't seem to be the major food item of the big cats in the area. This may be because of the low takin population in the area as narrated by local people and ex-hunters there. The total population estimate in the area is only about 15-20 animals, which accounts for about 5 percent of the whole population. This sub-population must have diverted their winter migration from Lunanang region.

The other nuisance towards end of winter and early spring was the harassment caused by insects. With the advent of the insect emergence season, hordes of blood sucking dipteran flies, leeches, etc. often become a menace to the foraging takin. This season usually last from mid April till early August. The response to this harassment is their ascent up the altitudinal gradient to the summer range. Hence one causative factor which brings about migration in this species is clearly an anti-insect response, although other factors like predation risk and food supply also play role.

Figure 3.9. Topographic map of site 1 (Gathana/Damji valley) showing tracks of takin (●), tiger (■), Leopard (▲) and direct sightings of takins (➤) made during the study period.

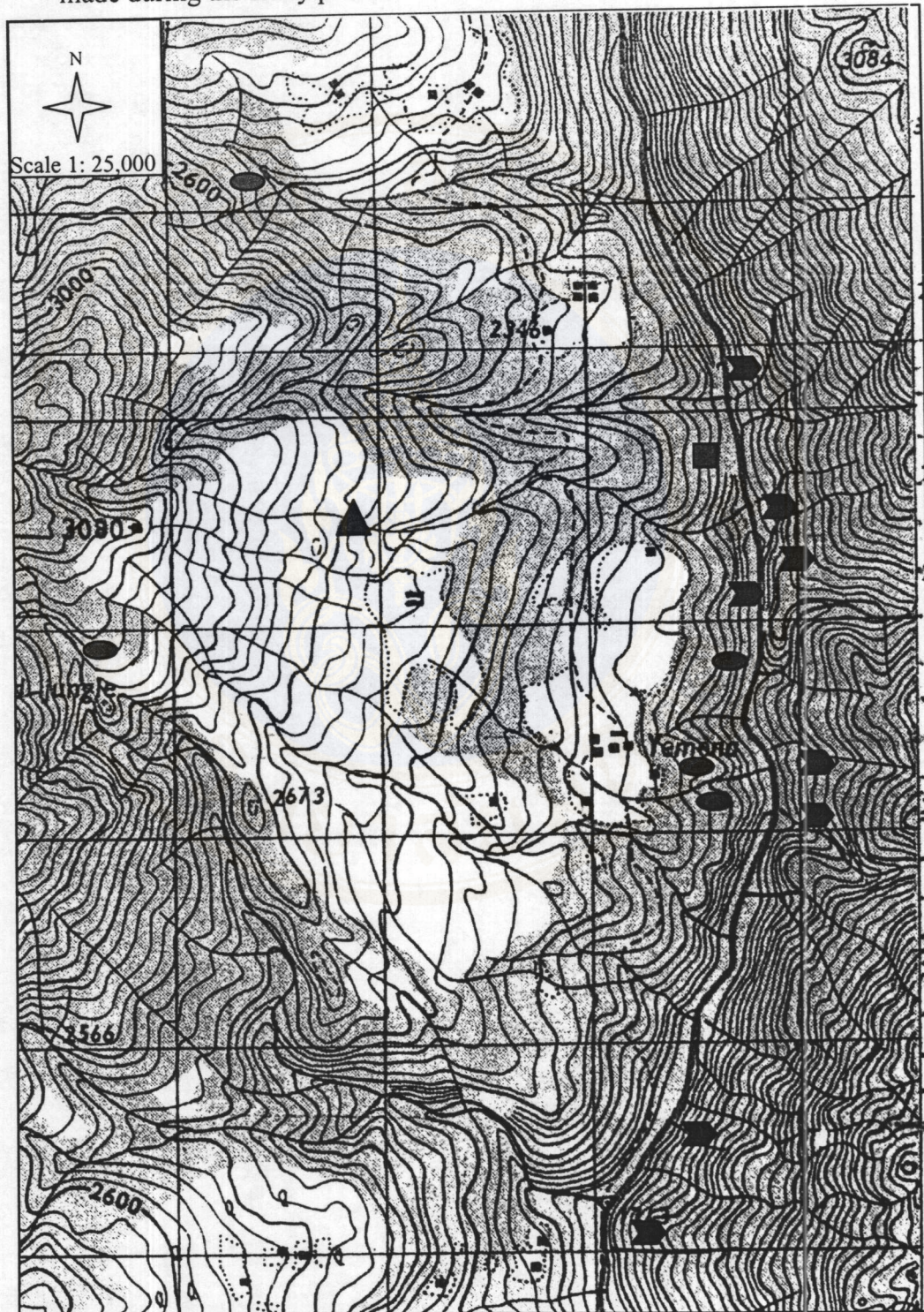
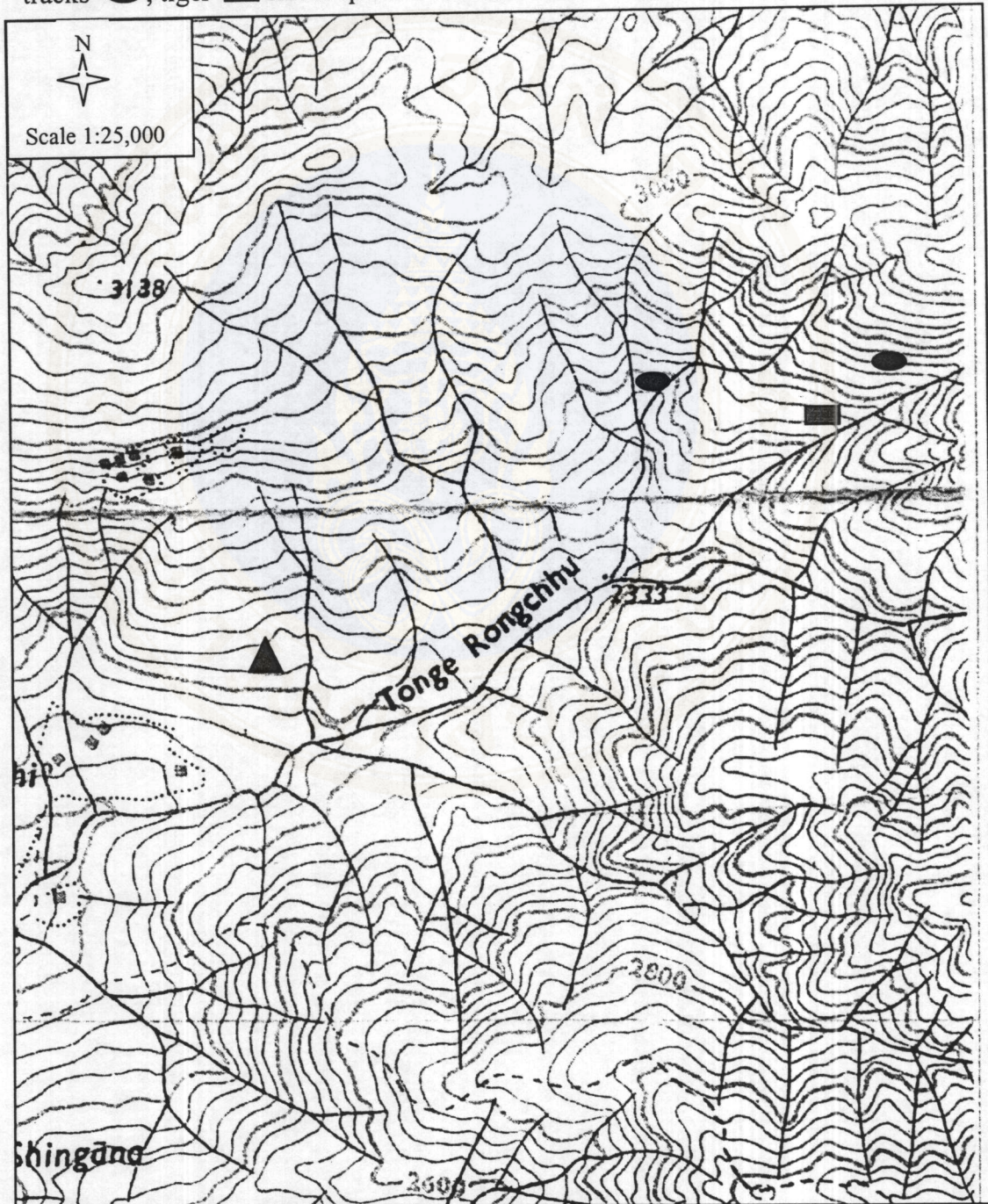


Figure 3.10. Topographic map of site II (Rongrong Karmo, Punakha) showing takin tracks ●, tiger ■ and leopard tracks ▲ encountered during the field visit.



3.5.8: Conflict with wildlife:

There was no evidence of local people hunting takin or any other wildlife species in study area 1. Such activities, though persistent in the past, are no longer carried out by the people. Other wildlife species found in the vicinity of the area include: Tiger (*Panthera tigris*), leopard (*Panthera pardus*), wild dog (*Cuon alpinus*), wild boar (*Sus scrofa*), barking deer (*Muntiacus muntjak*), sambar deer (*Cervus unicolor*), Himalayan black bear (*Selenarctos thibetanus*), red panda (*Ailurus fulgens*), Assamese macaque (*Macaca assamensis*), common langur (*Presbytis entellus*), serow (*Capricornis sumatraensi*), jungle fowl and large number of bird species. The most common ones were Yellow Billed Blue Magpie, Black Drongo, Monal Pheasant, Wedge-tailed green pigeon, Nutcracker and Himalayan tree pie.

Most of the wildlife species listed above, in particular leopard and wild dog, were a menace to the community there. During a brief period of 3-4 months, a total of 18 livestock were lost, either slaughtered or wounded by a leopard or a wild dog. One household (Ap. Tenzin and family) lost 4 cattle and 3 horses. Wild boar, sambar and barking deer are also known to destroy food crops during other time of the year. The residents of the locality have little choice but to bear the losses inflicted by wildlife.

3.5.9: Fecal morphology

The fecal remains in site II resembled that of a Sambar, but were slightly bigger in size. They seem to defecate in the form of pellets, each pellet measuring about 1.5-2.0 cm in length and 1.0-1.5 cm in width. The number of pellets in a pile also varies. On average, each pile consisted of 500-1,000 pellets. Similar observations were made in



Figure 3.11 Fecal dropping of takin in site I collected for fecal analysis

mini takin zoo as reported by Wollenhaupt (1991). Yet, it still remains doubtful if the animal defecate in different forms in the wild as narrated by local people. However, their fecal droppings were slightly different in site I, resembling that a cow's rather than a Sambar's (Figure 3.11). Since, takins in the wild are difficult to observe especially during the winter range, further investigation on their fecal form and structure in different seasons would be helpful in detecting their present/absence information and in studying their feeding ecology.

3.5.10: Fecal analysis

From the fecal samples (n=8), ratio of monocot to dicot species was 1:3.8 indicating that about 80% of their diet consist of browsed species. Based on the cellular characteristics of the epidermis from the reference slide (Figure 3.13), 3 species, *Elatostema lineolatum*, *Brassaiopsis glomerulata*, and *Diplacium esculanta*, were identified in the fecal remnants. These species constitute 40% of their diet: 22, 14 and 4% respectively (Figure 3.14). The former two species form the major food plant of the animals in the area.



A



B

Figure 3.12: Some of takin's foraging species in the area. A: *Elatostema lineolatum* (Major forage); B: *Ligularia mertonii*.

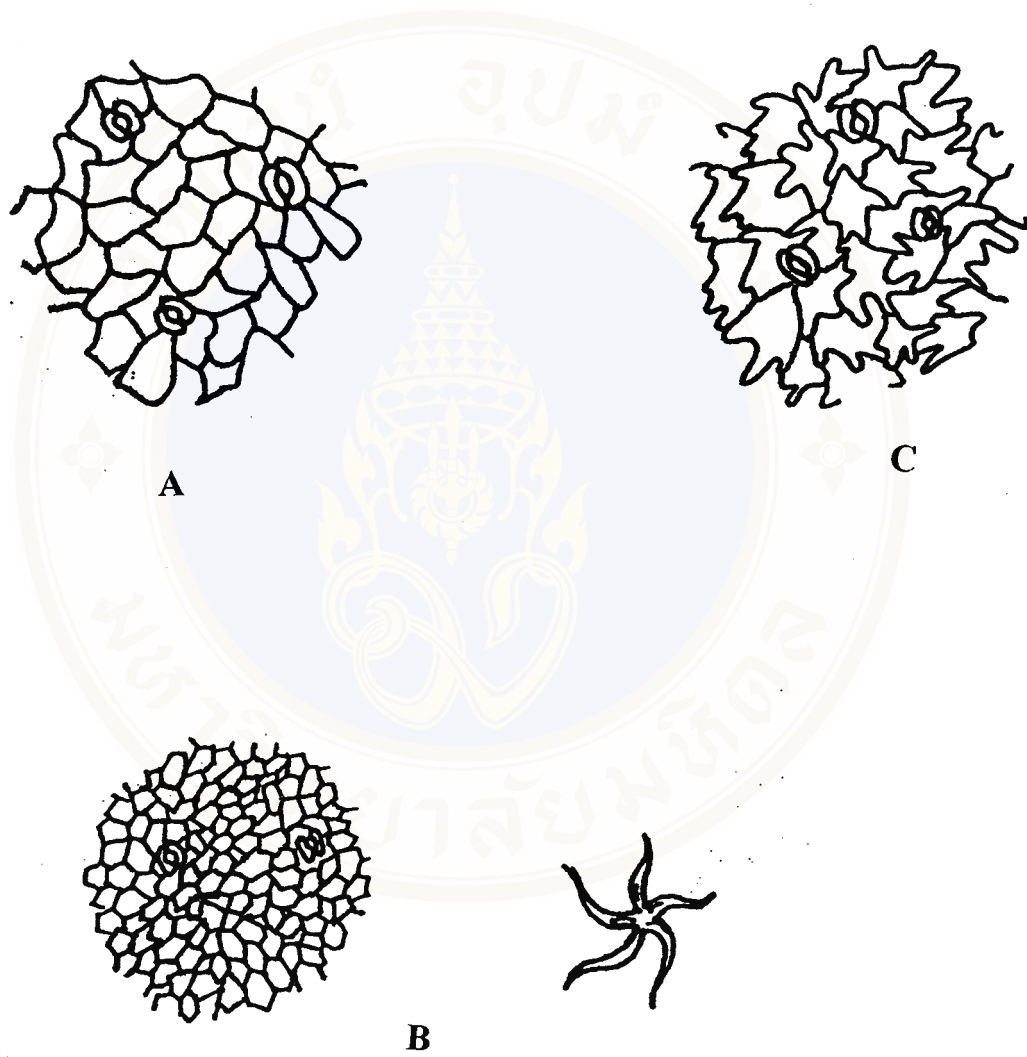
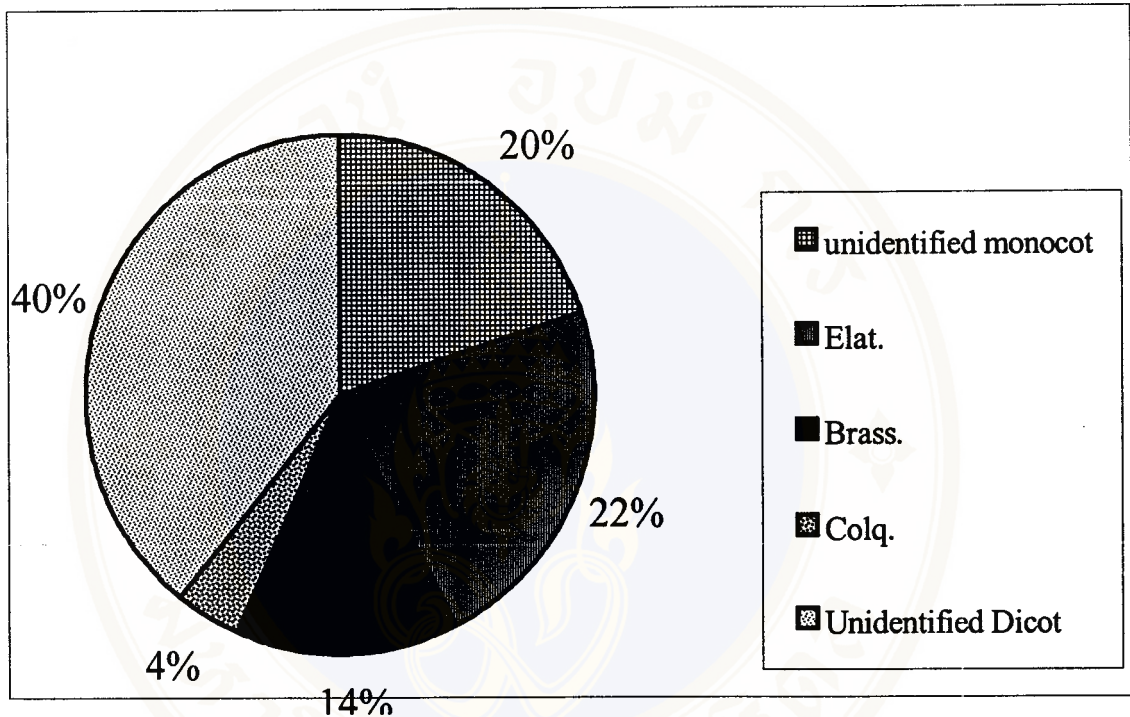


Figure 3.13: Sketch of cuticular sheaths of three browsed food plants from reference slides. **A:** *Elatostema lineolatum*, **B:** *Brassaiopsis glomerulata* with trichome and **C:** *Colquhounia coccinea*

Figure 3.14: Percentage of food plants fed by takin in study area I during winter range as estimated by fecal analysis (n= 8 droppings). Elat. –*Elatostema lineolatum*; Brass.-*Brassaiopsis glomerulata*; Colq.- *Colquhounia coccinea*.



3.6: Discussion:

3.6.1: Herd size and composition:

Some of the earliest account of takin indicates that the animals are solitary or occurs in small herds, except during summer when large herds of cows and young bull are formed (Neas et al., 1987). Shou 1964, cited in Neas et al., 1987 also report of takin herds up to 3 individuals in winter but 10-100 or more in summer. In Bhutan, groups as often as 200 animals are reported in the open scrubs and meadows in the summer range (Wangchuk, 1999). This period is usually the time when females are in estrus and males compete for reproductive success. The average herd size during the time of the study was 2.7 animals (N=13). The smaller herd size during the winter range may be as a result of dense habitat with sparse vegetation outgrowth. Clutton-Brock and Harvey (1977, 1978) (cited in Skogland 1989) suggest that abundance and distribution of food supplies affect dispersion patterns of mammals, and that species differences in group sizes seem best predicted by the disadvantages rather than the advantages of grouping. Besides, tendencies of larger group to be observed in less dense habitat and at higher elevation may also be related to the better visibility as noted by Groves et al, 1997. This is also true with takin since they are known to disband into smaller herds in winter where food is less abundant compared to their summer habitat. Schaller et al. (1986) report that Sichuan takin face a serious threat in winter due to lack of nutritious food and that they often lose weight.

From a total of 13 direct sightings made, 6 of them were solitary, probably lone males driven from leadership of the herd by the younger and more aggressive males. Herds towards end of March usually consisted of newly born young suggesting that



Figure 3.15: Herd of Bhutan takin on route to their summer range in Lingzhi, Bhutan (from UNDP, 1998).

the females gave birth towards late February or early March. The calves on most occasions were inactive and often retired to a cool shady place away from the foraging mother. The percent of newly born, yearling (1.5 years), and sub adultis males and females (2.5 years) during the time of the study was 16,16 and 24 respectively, which gives little doubt that the population had been breeding.

3.6.2: Distribution and migratory pattern:

The extant subspecies of Bhutan takin (*B.t.whitei*) occurs in Sikkim, Bhutan and Tibetan Chumbi valley (Neas et al., 1987). They also state that the exact range of the subspecies is difficult to determine due to paucity of specimen and reliable published data. In Bhutan, their present distribution is restricted to the north and northwestern parts of the country (Figure 3.4). These areas are virtually intact in its natural state with minimum population density. Their summer grazing grounds are in Lingshi, Tsharijithang and in Lunanang, all inside the park. From the former, the animals are known to migrate to lower Mo Chu valley and nearby takin areas in winter as indicated with arrows in Figure 3.4. According to the residents, a small sub-population of takin in the valley diverts from Lunanang in winter following Japhulum valley. Majority of the population from Lunanang migrates for their winter range to upper Phu Chu valley above Kelwana, northeast of Punakha. Other sub-populations outside the park occur in Dhur Tshachu (Bumthang District) and in Wangdi Phodrang district, towards north of Sephu that has also diverted their summer migration from Lunanang.

Takins are known to migrate in slow stages following the phenological stages of vegetation growth. They take up to 2 months to migrate from their winter to the

summer habitat (Namgay 1998, cited in Wangchuk, 1999). Since the study took place during their winter range, February to June, information with regard to their summer habitat was obtained not through a systematic manner and therefore can be biased. As noted by Wangchuk, 1999 radio telemetry and other related study can provide reliable information about their migratory pattern and range.

3.6.3: Population trends:

The total population estimates of takin throughout the range in Bhutan numbers approximately 330-410 animals. Although it is not considered an endangered species, increased human activities in the takin natural range are having a negative impact on their population. For instance, in Shengana, north east of Punakha, poaching is still prevalent and their signs were very pervasive. Besides, the area seems to be heavily encroached by the local livestock. The low population estimate in the area may be attributed mainly for the same reason.

Wangchuk (2000) report of how the populations counted in Tsarijathang (main summer habitat), conducted in a systematic manner have varied considerably from 249 animals in 1998 to 140 in 2000. The difference is too high to attribute to mortality. However, the population estimates in between Gasa/Damji and Tashithang area from the study numbers 160-250 animals. This is the same as the summer count of 1998 in Tsarijathang valley where the animals are known to migrate towards mid of spring (April-May). In general, there is little doubt that the population has been increasing in the area over the past 2-3 years. Study of such population trends in other takin areas was not possible due to lack of reliable information and also because of time and other logistic constraints.

3.6.4: Behavior, daily activity and activity budget:

Since observation of takin during the night was beyond the scope of the study, the activity cycles covers the daylight activities only. As with the captive animals in the zoo, the animals in the wild were observed to be active during different time of the day. Wollenhaupt (1991) state that the animal in captivity shows three complete activity cycles during daylight, each activity cycle covering five different behavioral activities. The results of the study within their natural habitat indicate that the animals have only two complete activity cycles during the day. The reason is attributable to the difference in abundance, availability and distribution of food in the wild and in the captivity. Numerous reports from hunting expedition and from different authors (Schaller, 1967, 1977; Neas et al., 1987; Yaling et al., 1995; Groves et al, 1997), state that the animals feed during early morning and late afternoon. This was true with takins in the study area except on overcast days where the animals were seen foraging even during mid day.

The early morning, mid day from 0900 until about 1130 hours, and late afternoon are the main activity periods of the animal. It shows two major diurnal rest periods, during which less than 40% of the animals are active. The first coincides with sunrise and the second one towards mid noon until early afternoon. The latter is characterized by long bedding time where individuals usually retreated under cover for proper shade to rest. Hence it is probable that temperature or heat has an effect on their activity. Occasionally animals were observed foraging or active on other days when it was cloudy or when the day's heat was not intense.

The main activity of the animal from the study is foraging which overlap with moving slowly and browsing occasionally. These activities together cover more than half of the whole activity period. Hence takin in the winter range allocate a greater proportion of available time and energy on feeding. This may also be accounted for the distribution and availability of food as discussed above. Such information on their behavioral activity in the summer range may shed more light, although they are known to spend a considerable amount of time and energy visiting mineral licks and springs.

3.6.5: Food:

There were three major food plants *Elatostema lineolatum*, *Brassaiopsis glomerulata* and *Colquhounia coccanea* browsed by the animal in the area. These three species form about 40% of their foraging species. Other foraging species grazed by takin in the area couldn't be identified due to lack of reference specimens. However, the animals were observed to feed on every plant species within reach of their broad mouth, feeding on leaves and shoots of bamboo, leaves, plants, and almost all the understory vegetation in the locality. As a generalist, a large amount of food is necessary to maintain its body size (Schaller et al., 1986). Their broad, flexible lips enable takin to forage efficiently and selectively. They are known to rear up on their hind legs to browse on leaves as high as 3 meters above the ground (Schaller et al, 1987; Neas and Hoffman, 1987). On two occasions, a male takin reared on its hind legs to feed on some creeper like plant that grows on tree trunks. They also bite into branches and small saplings, and snap them with a twist of the head, thereby gaining access to the leaves on the top. As noted by many authors (Wangchuk, 1999, Schaller, 1987), they have a large dietary requirement for minerals. This was evident from the

pervasive signs left behind by the animal in chuchub (Gasa) after they had left for their summer range. Their feeding signs were also very prominent with marked de-barkings on tree trunks as a result of the animal feeding on barks and also from rubbing the base of their horns against them.

3.6.6: *Takin conservation:*

In Bhutan, although takin receives full protection as the National animal and law forbids hunting, local people highly esteem the flesh of the animal. They also treasure the horn of the animal for its medicinal value. It is believed that the horn of takin consumed in minute amounts helps pregnant women during difficult childbirth. Hence, this poses a serious threat to the takin population in the wild. Activities such as poaching were evident in study area II. Though the area falls under Jigme Dorji National Park and is close proximity from the park headquarters than site I, the area seems least protected. Unlike area I, there is if at all any patrol monitoring in the area. Therefore, the fewer takin in the area are at greater risk, especially during winter. The low population of the animals in the area may also be accounted for the same reason. Hence, there is the need for site based patrol group to be monitored in winter habitats of the animal, especially in areas that are vulnerable to human activities. In contrast, area I has proportionately greater number of takin than area II. The takin habitat in the former is also intact with least human disturbances. This may be attributed to the strict law enforcement and regular patrol monitoring in the area by the park staff. Although, the winter ranges provide adequate resources with proper habitat for the species, the long-term survival of takin is still under jeopardy. As a seasonal migrant, the survival of the animal will depend on how well their migratory routes and their summer ranges

are protected. Large reserves are obviously required to preserve such mountain ungulates, especially those which require vertical migration between their summer and winter ranges (Schaller, 1977). Jigme Dorji National Park does provide suitable reserve size, but it is important to study their migratory routes to assess the presence of threats. As suggested by Wangchuk (1999), radio telemetry studies should be initiated which will provide information on the migration route, range and activity.

The other major threat the takin face in their summer range is its competition with domestic livestock for food (Wangchuk, 1999). Although, the high altitude herders have signed an agreement with the park authorities to keep away their livestock until the animals have left for their winter range, yet in the absence of core information as to how the livestock affect vegetation growth, their importance cannot be underestimated. Hence, there is the need to assess the degree of threat posed by the livestock and also to investigate its implication on the vegetation growth. The other foreseeable threat to the survival of takin in area I is the present road construction from Tashithang to Damji. The area is one of the primary winter habitats of the animal. According to the local people, there is a decrease in the frequency of encounter rate as compared to the previous years. Takins are reported to be wary of any human presence (Groves et al., 1991; Wangchuk, 1999) and occupy relatively undisturbed forest tracks. Hence, as the area will become accessible, the animal will be subjected to more disturbances and even prone to greater risk of poaching. Therefore, there is the need to investigate the effect of road edges on wildlife in the area in general with further research.

CHAPTER IV

GENERAL DISCUSSION

Bhutan's development is linked to its biological diversity and natural ecosystems. The country to date has paced its economic development at a controlled rate in order to safeguard its natural and cultural heritage. As a result, while most of the Himalayan region has seen its natural resource base severely compromised through deforestation, soil degradation, erosion and pollution, Bhutan's natural patrimony of extensive and varied forest has remained largely intact. Hence, its biodiversity and relatively undisturbed natural ecosystems represent the country's assets. With more than 85% of the country's population living in rural setting and practising self-sustained farming, there is great dependence and depend on the biological resource base for their general welfare. The role and values of biodiversity to the welfare of the Bhutanese citizens can be described as ethical, cultural, aesthetic, utilitarian and ecological.

The country also benefits from its biodiversity conservation in the following ways. Firstly, the existing natural ecosystems provide greater benefits to local population than any alternative uses of most of these lands. They protect the watershed areas and soil, shielding human communities from natural disasters. The alpine ecosystem of Bhutan Himalayas also encompasses the upper watershed areas of the country's major river systems that are vital for the downstream communities in Bhutan as well as India and Bangladesh. Secondly, the nation's biodiversity has the potential of providing significant economic returns through international trade and eco-tourism. Finally, because conservation of forests and biodiversity is of international value even

beyond these domestic benefits, Bhutan stands to benefit from mechanisms for resource and technology transfer established under the Framework Convention on Climate Change and the Convention on Biological Diversity.

With more than 70% forest cover and being in the position of possessing several biogeographical transition zones, the country is in terms of habitat and species diversity, one of the richest in the region (Wollenhaupt, 1989). Different species of wildlife, plant and animal of different origin inhabit the country. Most notably, large mammals such as black bear and snow leopard of Palearctic origin, takin and red panda of Indo-Chinese origin and species such as water buffalo, elephant and rhinoceros of Indo-Malayan origin are found in the country. These species inhabit different ecological zones. At the species level, except for few species like tiger (*Panthera tigris*) and golden langur (*Presbytis geei*), knowledge on the ecology and biology of the country's wildlife is limited as there have been no population surveys or field studies. Hence, there is major lack of information on the status of the country's flora and fauna. Considering priority of species such as takin, snow leopard, Asian elephant and rhinoceros, a detailed study on their ecology and biology should be initiated. A national public awareness programme with regard to these important species and in particular relating it to biodiversity conservation and use should be launched. The capacity to communicate the impact of biodiversity activities to key target audiences is critical to the success of any biodiversity programme. The general public and the people who live in and near protected areas should be made aware of the purpose of national protected areas and biodiversity conservation. In the most positive scenario, involving local people and communities in park management and planning has become an integral part of any biodiversity conservation. Hence in

Bhutan, one issue, which is important to resolve, is the incorporation of local people who live in the vicinity of protected areas into the management planning process. If achieved this could result in sustainable forest management initiatives, which include local people as partners in biodiversity conservation and management. In general, the tropical and subtropical areas in the south are more diversified and also contain proportionately more threatened mammal species as compared to the high altitude and the Temperate Zone. Consequently, threats to wildlife species also seem more severe in these areas especially across the Indo-Bhutan border.

Among the high altitude fauna, takin has been identified as the largest ungulate and the keystone species of Jigme Dorji National Park (Wangchuk, 1999). Hence, their existence is vital for an array of other species within the park. Besides, the species also shares overlapping ranges with other important flagship species such as the snow leopard, lesser panda, tiger and the blue sheep. Other species that share takin's range of habitats include musk deer, goral, serow, Himalayan black bear, sambar, barking deer, wild dog and leopard. Takins being altitudinal migrants, require relatively large tracts of land to support viable populations and therefore, its conservation efforts, particularly habitat conservation on behalf of the species will benefit other species. Hence, preserving their natural habitat will not only enable to support its range of habitats, but a range of other species as well whose spatial distributions are poorly known. Hence, the fate of most of the wildlife, Particularly, high altitude ranging species of the country can be tied to the future of takin, which act as umbrella to shelter the lesser-known inhabitants of the park.

Although takins are not currently considered an endangered species, increased human activity in the takin natural range are having negative effects on their

populations. There are less than 5,000 Sichuan takins, about 1,200 Shaanxi takins and less than 10,000 Mishmi takins remaining in the wild (Nawak et al., 1987). About 300-400 Bhutan takin are estimated to occur in Bhutan, although the population estimate of the subspecies throughout its entire range cannot be estimated due to paucity of information from other range countries. Elsewhere, in other range countries, deforestation caused by logging and agricultural expansion is reducing altogether, habitat required by takin during their seasonal migration (Macdonald, 1993). Poaching for trophy and meat is also having a dramatic effect on their numbers. Srikosamatara and Suteethorn (1994) report of large-scale wildlife trade at Tachilek near Mae Sai, Chiang Rai province. Amongst the wildlife products were horns of takin or goat antelope. Similarly, Davidson (1998) reported takin parts, in total 9 skulls on display, for sale in Thai/Burmese border. Hence, there is the need to regulate such activities to ensure the current status of the different subspecies in the wild.

The Chinese government has given takin full protection and takin is considered a national treasure along with the giant panda and the golden monkey, who also share overlapping ranges with the Sichuan takin. Hunting of the animal has been made illegal in China since 1962 (Song, 1998). In recognition of the threatened condition of takin in the wild, the IUCN currently classifies the status of the subspecies Sichuan takin as indeterminate and the subspecies Shaanxi as rare. All subspecies of takin are also listed as Appendix II animals (not presently threatened with extinction but may become so if their trade is not regulated) by CITES of Wild Fauna and Flora (IUCN, 2000).

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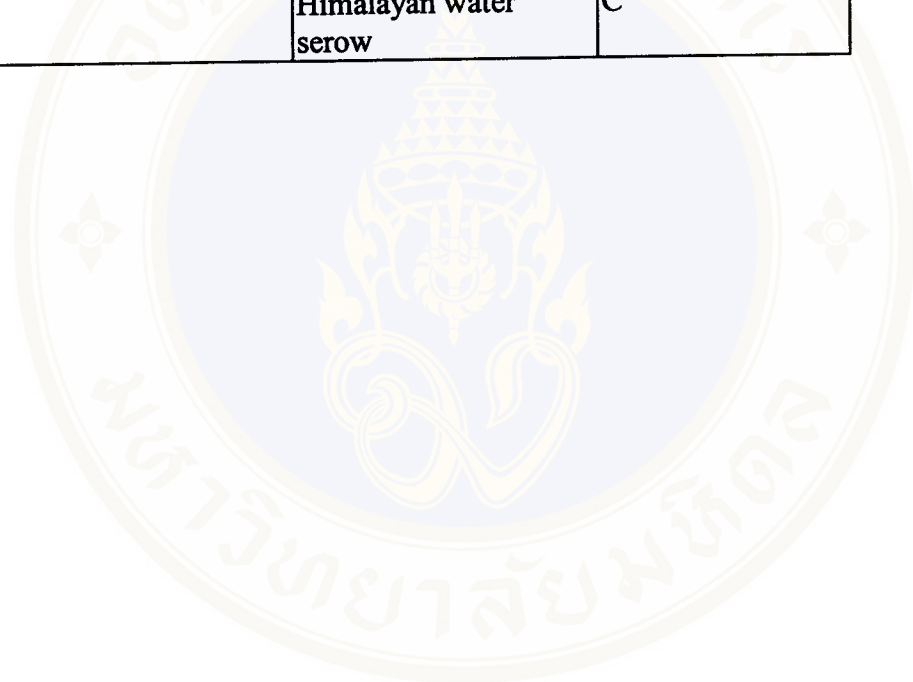
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Appendix 1: Mammal species confirmed or expected to occur in Jigme Dorji National Park. C= confirmed; e= expected; E= endangered; V= vulnerable; I= Schedule I; II= Schedule II of Forest and Nature Conservation Act, 1995.

Species	Common name	status
<i>Budorcas taxicolor</i>	Takin	C, V, I
<i>Pseudovis nayuar</i>	Blue sheep	C
<i>Moschus chrysogaster</i>	Musk deer	C, V, I
<i>Cervus unicolor</i>	Sambar	C
<i>Muntiacus muntjak</i>	Barking deer	C
<i>Capricornis sumatraensi</i>	Serow	C, II
<i>Nemorhaedus goral</i>	Goral	C
<i>Hemitragus jemlahicus</i>	Himalayan Tahr	e
<i>Panthera tigris</i>	Tiger	C, E, I
<i>Panthera unicia</i>	Snow leopard	C, E, I
<i>Panthera pardus</i>	Leopard	C, II
<i>Felis lynx</i>	Lynx	e
<i>Felis manul</i>	Palla's cat	e
<i>Felis bengalensis</i>	Leopard cat	e, II
<i>Cuon alpinus</i>	Wild dog	C, II
<i>Canis vulpes</i>	Red fox	C
<i>Ailurus fulgens</i>	Red panda	C, II
<i>Macaca assamensis</i>	Assamese macaque	C
<i>Presbytis entellus</i>	Common grey langur	C
<i>Selenarctos thibetanus</i>	Himalayan black bear	C, II
<i>Ursus arctos</i>	Brown bear	e
<i>Sus scrofa</i>	Wild boar	C
<i>Hystrix indica</i>	Indian porcupine	C
<i>Mustela sibirica</i>	Himalayan weasel	C
<i>Mustela altaica</i>	Pale weasel	e
<i>Mustela kathiah</i>	Yellow-bellied weasel	e
<i>Mustela flavigula</i>	Yellow-throated marten	e
<i>Lutra lutra</i>	Otter	e

<i>Petaurista magnificus</i>	Himalayan flying squirrel	C
	Hoary bellied squirrel	C
	Himalayan striped squirrel	C
	Orange bellied squirrel	C
<i>Marmota bobak</i>	Marmot	C, II
<i>Ochatona roylei</i>	Pika	C
<i>Alticola roylei</i>	Himalayan vole	C
<i>Pitymys sikkimensis</i>	Sikkim vole	e
	Himalayan water serow	C



Appendix 2: Mammal species confirmed or expected from Black Mountain National Park.
Abundance coding: S= Scarce; O- Occasional; F= Frequent; A= Abundant.

Species	Common name	Status
<i>Macaca mulatta</i>	Rhesus Monkey	O
<i>Presbytis entellus</i>	Grey langur	F
<i>Canis aureus</i>	Jackle	O
<i>Vulpes vulpes</i>	Red fox	O
<i>Cuon alpinus</i>	Dhole/wild dog	S
<i>Selenarctos thibetanus</i>	Himalayan black bear	O
<i>Ailurus fulgens</i>	Red panda	O
<i>Mustela sibirica</i>	Himalayan weasel	O
<i>Mustela altaica</i>	Pale weasel	O
<i>Mustela kathiah</i>	Yellow bellied Weasel	O
<i>Martes favigula</i>	Yellow throated Marten	S
<i>Martes foina</i>	Stone Marten	O
<i>Melogale moschata</i>	Chinese Ferret Badger	O
<i>Melogale personata</i>	Burmese Ferret Badger	O
<i>Lutra lutra</i>	Common otter	F
<i>Aonyx cinerea</i>	Clawless otter	F
<i>Viverricula indica</i>	Small Indian civet	O
<i>Viverra zibetha</i>	Large Indian civet	O
<i>Paradoxurus hermaphroditus</i>	Common palm civet	O
<i>Paguma larvata</i>	Himalayan Palm Civet	O
<i>Herpestes edwardsi</i>	Common Mongoose	O
<i>Herpestes urva</i>	Crab eating Mongoose	O
<i>Felis bengalensis</i>	Leopard cat	O
<i>Felis chaus</i>	Jungle cat	O
<i>Felis temmincki</i>	Golden cat	S
<i>Panthera tigris</i>	Tiger	S
<i>Panthera pardus</i>	Leopard	S
<i>Sus scrofa</i>	Wild boar	F
<i>Moschus chrysogaster</i>	Musk deer	O

<i>Muntiacus muntjak</i>	Barking deer	O
<i>Cervus unicolor</i>	Sambar	O
<i>Nemorhaedus goral</i>	Goral	S
<i>Carpicornis sumatraensis</i>	Serow	O
<i>Ochatona roylei</i>	Mouse hare	O
<i>Hystrix indica</i>	Indian porcupine	O
<i>Cannomys badius</i>	Bay Bamboo rat	F
<i>Alticola roylei</i>	Himalayan vole	A
<i>Pitymys sikkimensis</i>	Sikkim vole	F
<i>Petaurista magnificus</i>	Himalayan flying squirrel	O
<i>Petaurista petaurista</i>	Gaint flying squirrel	F
<i>petaurista elegan</i>	Spotted flying squirrel	O
<i>Demdromys lokriah</i>	Orange bellied squirrel	F
<i>Calloscuiurus macclellandi</i>	Himalayan striped squirrel	F
<i>Marmota bobak</i>	Himalayan marmot	O
<i>Rattus rattus</i>	Black rat	A
<i>Talpa micrura</i>	Short tailed mole	F
<i>Canis lupus</i>	Wolf	S
<i>Suncus etruscus</i>	Common dwarf shrew	A
<i>Sorex bedfordiae</i>	Less striped shrew	A
<i>Sorex minutus</i>	Pygmy shrew	A
<i>Soriculus caudatus</i>	Hodgson's shrew	F
<i>Soriculus nigrescens</i>	Haimlayan shrew	F
<i>Corcidura attenuata</i>	Woodland shrew	A
<i>Crocidura pergrisea</i>	Pale grey shrew	F
<i>Suncus murinus</i>	House shrew	A
<i>Chimmarrogale himalayica</i>	Himalaya water shrew	A
<i>Nectogale elegans</i>	Eleg water shrew	F

Appendix 3: Mammal species confirmed or expected from Royal Manas National Park, Bhutan.

Species	Common Name
<i>Trachypithecus geei</i>	Golden leaf monkey
<i>Canis lupus</i>	Wolf
<i>Panthera tigris</i>	Tiger
<i>Panthera pardus</i>	Leopard
<i>Neofelis nebulosa</i>	Clouded leopard
<i>Felis temmincki</i>	Golden cat
<i>Elephas maximus</i>	Indian Elephant
<i>Rhinoceros unicornis</i>	Indian rhinoceros
<i>Bubalus bubalus</i>	Water buffalo
<i>Bos gaurus</i>	Gaur
<i>Caprolagus hispidus</i>	Hispid hare
<i>Lutra lutra</i>	Otter
<i>Sus scrofa</i>	Wild boar
<i>Muntiacus muntjak</i>	Indian muntjac
<i>Cervus porcinus</i>	Hog deer
<i>Cervus axis</i>	Spotted deer
<i>Cervus unicolor</i>	Sambar
<i>Capricornis sumatraensis</i>	Serow
<i>Platanista gangetica</i>	Ganges dolphin
<i>Sus salvanius**</i>	Pygmy hog
<i>Cuon alpinus</i>	Wild dog
<i>Macaca assamensis</i>	Assamese macaque
<i>Macaca mulatta</i>	Rhesus Monkey
<i>Presbytis pileata</i>	Piliated langur
<i>Canis aureus</i>	Jackal
<i>Vulpes vulpes</i>	Red fox
<i>Vulpes bengalensis</i>	Indian Fox
<i>Selenarctos thibetanus</i>	Himalayan black bear
<i>Martes flavigula</i>	Yellow throated martin

<i>Lutra perspicillata</i>	Smooth Indian otter
<i>Herpestes edwardsi</i>	Common mongoose
<i>Herpestes javanicus</i>	small Indian mongoose
<i>Herpestes urva</i>	Crabeating Mongoose
<i>Felis bengalensis</i>	Leopard cat
<i>Felis chaus</i>	Jungle cat
<i>Felis viverrina</i>	Fishing Cat
<i>Felis marmorata</i>	Marbled Cat
<i>Nemorhardus hispidus</i>	Goral
<i>Lepus Nigricollis</i>	Black-naped hare
<i>Hystrix indica</i>	Indian porcupine
<i>Petaurista magnificus</i>	Himalayan flying squirrel
<i>Ratufa bicolor</i>	Giant squirrel
<i>Hylopetes fimbriatus</i>	Wester Flying Squirrel
<i>Belomys pearsoni</i>	Pearson's Flying Squirrel
<i>Dendromys lokriah</i>	Orange bellied squirrel
<i>Funambulus pennanti</i>	Striped Palm squirrel
<i>Tatera indica</i>	Indian Gerbil
<i>Bandicota bengalensis</i>	Indian Mole rat
<i>Mus booduga</i>	Indian Field mouse
<i>Rattus rattus</i>	Black cat
<i>Vandeleuria oleracca</i>	Long-tail Tree Mouse
<i>Suncas murinus</i>	House Shrew
<i>Talpa micrura</i>	Short Tailed mole
<i>Vivericula indica</i>	Small Indian Civet
<i>Viverra zibetha</i>	Large Indian Civet
<i>Paguma larvata</i>	Common Palm Civet
<i>Arctitis binturong</i>	Binturong

Appendix 4: Breakdown of daily activities of takin in site 1

Observation days	Activities				
	Feeding	Resting	Playing	Grooming	Moving
1	111	57	25	21	18
2	61	21	7	7	8
3	123	56	7	14	8
4	220	249	11	49	25
Total observation	515	383	50	91	59
Percentage	47	35	5	8	5

Appendix 5: Questionnaire used during the field work.

Place.....Date.....Time(Start).....
 Location.....
 Age.....Sex: M/Fe . Occupation.....
 Education: Pri./Sec./Coll. Others (specify).....
 R. status: Permanent/ temporary.

1. How do you value wildlife conservation, in particular 'takin' in JDNP?
 - Very important Less important
 - Threat Others (specify).....
2. Have you come across any takin in the past one year ie. 1999?
 - Yes No
3. If 'yes', how many?
 - Less than 30 30-39
 - 40-49 more than 50
 - Others.....
4. How many takins have you seen in the previous year ie. 1998?
 - Less than 30 30-39
 - 40-49 more than 50
 - Others.....
5. What is your opinion about the number of animals in the past few years?
 - Decreased Increased
 - No change Others.....
6. Give possible reasons for answer in Q.5 above.

7. Have you come across any dead animals in the wild?
 - Yes No
8. If yes, how many individuals (dead) have you encountered last 6 year and the year before?

1999	1998
-----	-----
9. What must have caused the animals to die in Q.7 and 8 above?
 - Predation Disease
 - Age Others (specify).....
10. Name few potential predators of takin.

11. At present, which area in the locality has the highest distribution of takin?

12. Have you noticed any difference with regard to their distribution in the past and the present?
 - Yes No
13. If 'yes' in q. above, please specify reasons.....

14. What is the usual group size of takin that you have seen till date?
 - Less than 3-6

BIOGRAPHY



NAME	Karma Dhendup
NATIONALITY	Bhutanese
DATE OF BIRTH	22nd September 1968
PLACE OF BIRTH	Mongar (Eastern Bhutan)
EDUCATION	B.Ed (Equivalent to B.Sc.) National Institute of education Samchi, Bhutan
SCHOLARSHIP	Thai Government Scholarship (DTEC)
WORK EXPERIENCE	Teacher
1993-1997	Mothithang High School Thimphu, Bhutan
1997-1998	Phuentsholing High School Southern Bhutan.