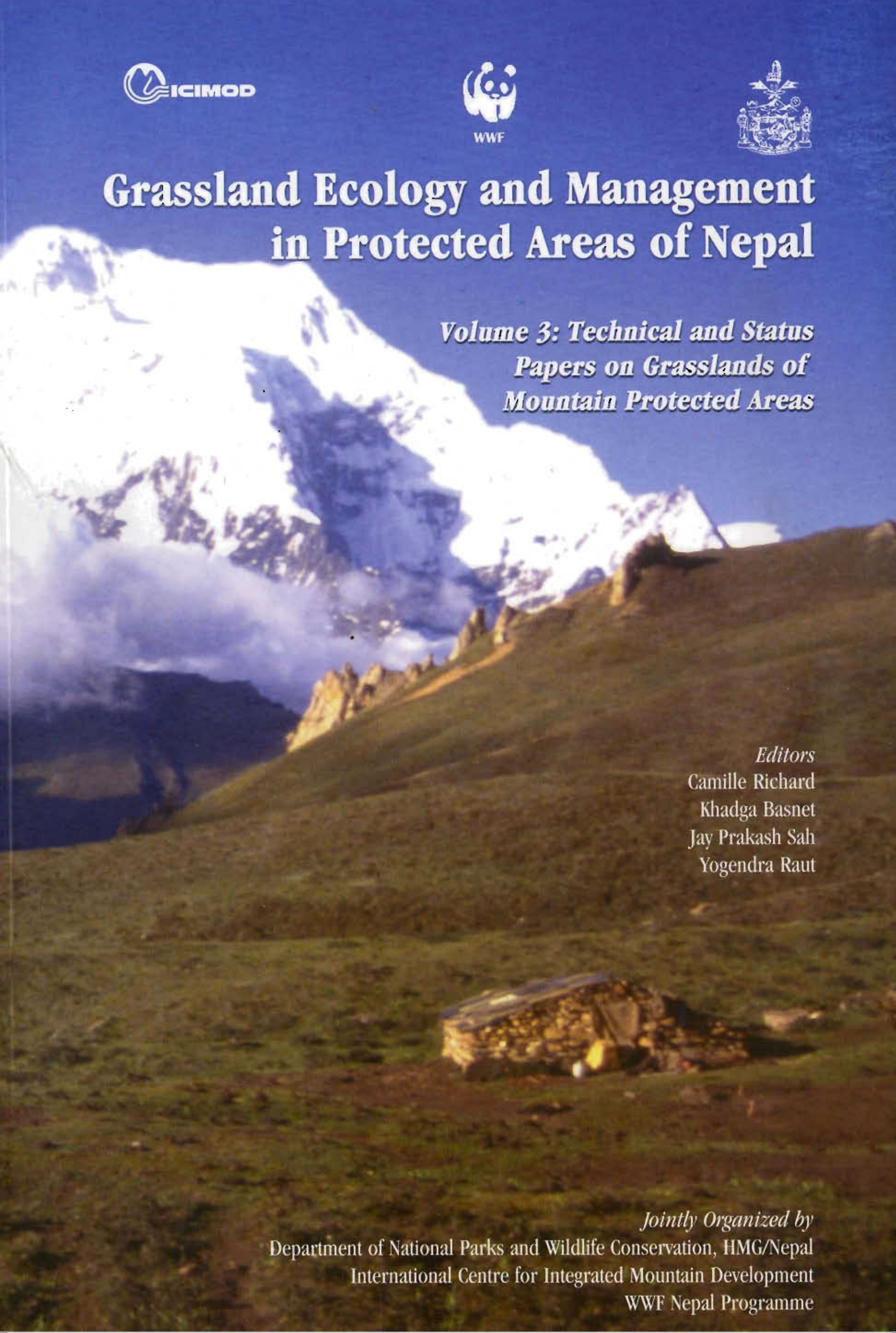

Grassland Ecology and Management in Protected Areas of Nepal

Volume 3: Technical and Status Papers on Grasslands of Mountain Protected Areas

Editors
Camille Richard
Khadga Basnet
Jay Prakash Sah
Yogendra Raut

Jointly Organized by
Department of National Parks and Wildlife Conservation, HMG/Nepal
International Centre for Integrated Mountain Development
WWF Nepal Programme

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Proceedings of a Workshop

Royal Bardia National Park
Thakurdwara, Bardia, Nepal
March 15-19, 1999

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In Praise of Grass

Grass is the forgiveness of nature – her constant benediction. Fields trampled with battle, saturated with blood, torn with the ruts of cannon, grow green again with grass and carnage is forgotten. Streets abandoned by traffic become grass-grown like rural lanes, and are obliterated. Forests decay, harvests perish, flowers vanish, but grass is immortal. Beleaguered by the sullen gusts of winter, it withdraws into the impregnable fortress of the subterranean vitality and emerges upon the first solicitation of spring. Sown by the winds, by wandering birds, propagated by the subtle horticulture of elements, which are its servants and masters, it softens the rude outline of the world. It invades the solitude of the forests, climbs the inaccessible slopes and forbidding pinnacles of the mountains, modifies climates and determines history, character and destiny of nations.

J. Ingals

Foreword

Globally, grasslands and rangelands occur in polar, temperate, sub-tropical, and tropical latitudes, from low to high elevations. In total, they cover 45 million square kilometres or one quarter of the earth's surface. In the Hindu Kush-Himalayan Tibet-Qinghai Plateau, rangelands and pastures cover some 60 per cent of the total area. They vary from sub-tropical savannas to alpine meadows in the eastern, central, and western Himalayas and steppe formations on the Plateau. As such, they contain a wide diversity of grasses and other plant species on which a number of endangered wildlife species depend. This diversity is matched by the cultural diversity of the people who have adapted their lifestyles to the harsh environment.

It is ICIMOD's, World Wide Fund for Nature's (WWF), and the Department of National Parks and Wildlife Conservation's (DNPWC) concern about the relationship between the people and their rangelands, between environment and development, and between nature and culture, that has brought together the scientists and managers represented here in these volumes. These proceedings provide valuable information on grassland ecology and management, not only for protected area managers here in Nepal, but also for scientists and managers working in other countries with similar ecological conditions.

It was only in 1995, when the first four-year Regional Collaborative Programme for the Sustainable Development of the Hindu Kush-Himalayas started, that ICIMOD could appoint its first rangeland management specialist and allocate some modest resources to a programme addressing rangeland issues. In ICIMOD's Second Regional Collaborative Programme (RCP-II), which covers the period from 1999-2002, rangelands have become an important focus of work on the mountain commons. We are very fortunate that the Government of Austria is funding the three-year Regional Rangeland Programme that allows us to carry out a comprehensive programme of research, capacity building, and extension, continuing until the end of 2001. The primary focus of the programme is to develop approaches that involve the local custodians of the rangeland resource – the communities themselves – in conservation and development of the rangelands upon which they so heavily depend. It is vital that collaborative management be the focus of future conservation efforts, both in Nepal and abroad, to ensure sustainable and equitable management of biological resources during this period of rapid change. This has been the approach of both WWF Nepal Programme and the DNPWC, who have pioneered work in collaborative management in the region.

Important issues that affect the grasslands and rangelands in protected areas of the Hindu Kush-Himalayas are the following:

- how to maintain biological diversity and multiple use of rangelands to promote co-existence of domestic and wild grazing ungulates and predators within and outside protected areas;

- how to find technical and institutional mechanisms to accommodate the needs of local communities to continue to access protected area resources while simultaneously promoting conservation;

- how to save and use the indigenous knowledge regarding use and management of rangeland resources; and,

- how do changing patterns of rangeland use and conservation affect the local communities, considering differential effects among diverse ethnic groups, on gender relations, and eventually on policy.

This compilation of working group outputs and research is a vital step in beginning to answer these important questions and provides working guidelines for protected area managers to help them prioritise future activities. The grasslands of the Himalayas are not only vital to the livelihood of many poor mountain families but to the sustainability of the varied and beautiful ecosystems that are in our trust. This work, and the innovative and committed people who have contributed to it as authors and editors, will help to conserve our mountain future.

J. Gabriel Campbell PhD.
Director General, ICIMOD

Acknowledgements

First we would like to offer our thanks to the Department of National Parks and Wildlife Conservation (DNPWC), the International Centre for Integrated Mountain Development (ICIMOD), and WWF Nepal Programme for the support provided for organizing and conducting this workshop on "Grassland Ecology and Management in Protected Areas of Nepal.' Staff from the organizations working in the Royal Bardia National Park (RBNP), the Bardia Integrated Conservation Project (BICP), WWF Nepal Programme, Care Nepal, and The King Mahendra Trust for Nature Conservation (KMTNC) were instrumental in making this workshop successful on the ground. In particular we would like to thank Mr. Shiva Raj Bhatta (Chief Warden and BICP manager) for taking on all the responsibility for local management and facilities; Dr. Shanta Raj Jnawali (Director, KMTNC, Bardia) for supporting local management; Ms. Sushila Nepali (Assistant Manager, BICP) for her active role in public relations and logistics; Mrs. Sarita Jnawali for her management of food and beverages; Mr. C. P. Bhandari (Finance and Administration Assistant, BICP) for financial matters and logistics; Mr. Ramesh Thapa (Ranger, RBNP) for taking care of the workshop complex; Mr. Bhusal (Health Assistant) for providing first aid services; Mr. Ramji Shivakoti (RBNP/CARE Nepal), Mr. Naresh Subedi (Park and People Project), Ashok Bhandari, and the senior game Scouts for their logistical support, and the drivers of RBNP for their invaluable assistance transporting participants.

We are also grateful to the following people for their direct and indirect support in helping to make the workshop run effectively: Mr. Sushil Bhattarai, Joint Secretary, Ministry of Forest and Soil Conservation (MoFSC) for inaugurating the workshop; Mr. D. D. Bhatta (Director, Regional Forest Directorate), Mr. Shyam Bajimaya (Conservation Officer, DNPWC), Mr. Sawarkar (Scientist, Wildlife Institute of India), and Mr. Krishna Man Shrestha (former Chief Warden of RBNP) for chairing various sessions of the workshop; and Basant Subba for serving as rapporteur. Special thanks are due to the editorial committee for their hard work in bringing this document into its present shape.

Finally, we would like to thank Dr. T.M. Maskey (Director General, DNPWC), Dr. U.R.Sharma (Joint Secretary, MoFSC), Mr. Egbert Pelinck (Former Director General, ICIMOD), and Mr. Mingma N. Sherpa (Country Representative, WWF Nepal Programme) for their continuing support to conservation efforts in Nepal.

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Abbreviations and Acronyms

ACA	Annapurna Conservation Area
ACAP	Annapurna Conservation Area Project
AGB	above ground biomass
APPA	appreciative participatory planning and action
BZ	buffer zone
CS	camping sites
CAMC	Conservation Area Management Committee
DHR	Dhorpatan Hunting Reserve
DNP	Dudwa National Park
DNPWC	Department of National Parks and Wildlife Conservation
ERBC	ecoregion-based conservation
GIS	geographical information system
HKH	Hindu Kush-Himalayas/Himalayan
HMG/N	His Majesty's Government of Nepal
HP	Himachal Pradesh
ICIMOD	International Centre for Integrated Mountain Development
J&K	Jammu and Kashmir
KCA	Kanchenjunga Conservation Area
KMTNC	King Mahendra Trust for Nature Conservation
KNP	Khaptad National Park
KWR	Koshi Tappu Wildlife Reserve
LNP	Langtang National Park
masl	metres above sea level
MBNP	Makalu Barun National Park
MCA	Manaslu Conservation Area
NACFP	Nepal Australia Community Forestry Project
NGO	non-government organization
NTFP	non-timber forest product
PA	protected area
PAN	Protected Area Network
PAR	participatory action research
PPP	Plants and People Project (WWF)
PRA	participatory rural appraisal
PWR	Parsa Wildlife Reserve
QNP	Qomolangma Nature Preserve

RBNP	Royal Bardia National Park
RCNP	Royal Chitwan National Park
RNP	Rara National Park
RRA	rapid rural appraisal
RS	remote sensing
RSWR	Royal Shukla Phanta Wildlife Reserve
SNP	Sagarmatha National Park
SPNP	Shey Phoksundo National Park
SRV	species richness value
SS	steep slopes
TAR	Tibetan Autonomous Region
ULM	undulating landmass
UNDP	United Nations Development Programme
UP	Uttar Pradesh
WWF	Worldwide Fund for Nature

Glossary

Physiographic Regions of Nepal (Carson 1992[1])

- ***Terai*** — Alluvial piedmont plain occurring at the base of the Himalayan range, from 60-300 masl. This is an extension of the broad Gangetic plains including the Bhabar region and the alluvial fans of the Siwaliks. The region is heavily traversed by the major river systems of Nepal. It exhibits a tropical type of climate. *Dalbergia sissoo, Shorea robusta,* and *Eucalyptus* are the major vegetation types of forest, interspersed with riverine savanna grassland. Much of the forests and savannas of the *Terai* have been converted to agriculture.

- ***Churia Hills (Siwaliks)***— The outermost Himalayan foothills are classified as the Siwaliks, ranging from 300-1,000m, and they represent the most recent zone of uplift. The soils are shallow, erodible, and drought prone, originating primarily from highly erodible sedimentary rock composed of previous piedmont plain alluvial sediments. The climate and vegetation of this region are mainly sub-tropical depending on the elevation, but forests are dominated by sal (*Shorea robusta*). Due to the fragility of the landscape, land-use pressures are not severe.

- ***Middle Hills*** — Landscape between 1,000 and 2,000m occurs throughout the Mahabharat range. Slopes are more gentle than in the Siwaliks and a significant portion of the sloping hills is cultivated under relatively sophisticated terrace systems in the form of low (irrigated) and upland (dry). The forests of the middle hills are heavily exploited for fodder, firewood, litter, and timber collection.

- ***High Mountains*** — The landscape ranges between 2,000 and 3,000m, however, a range of sub-tropical to cool temperate conditions can occur within the same valley. Bedrock is predominantly highly metamorphosed sedimentary rocks, thus landscapes are steeper than in the middle hills because rocks are relatively more resistant to weathering. Deep 'V'-shaped valleys are common throughout the region. Forests in the high mountains tend to be in better condition than in the middle hills due to lower population densities.

- ***High Himalayas*** — Landscapes are usually >3,000m in altitude. Most of the area below 4,300m is natural forest with alpine zone above the treeline. Bedrock is predominantly more competent and forms very steep and rugged terrain. Dry forest types and grassland steppes occur in the rainshadow behind the main mountain ranges. The area has a very low population density because of lack of cultivable land and cold winter conditions.

[1] Carson, B. (1992) *The Land, The Farmer, and The Future: A Soil Fertility Management Strategy for Nepal*, ICIMOD Occasional Paper No. 21.Kathmandu: ICIMOD.

Seral — Early to mid-stage in ecological succession.

Climax —Final stage of a succession where a given assemblage of species is in equilibrium with the prevailing natural environment.

Phanta(s) — Grasslands dominated by short perennial grasses, such as *Imperata cylindrica*, which have originated following human intervention (forest clearing, burning, domestic stock grazing, and cultivation); they occur on more or less stabilised soils.

Tall (Riverine) Grassland — Riverine grassland dominated by tall grass species' assemblages maintained by inundation during the monsoon and/or by fire and grazing. These grass species range from *Typha elephantina, Phragmites karka,* and *Saccharum spontaneum* assemblages that colonise new alluvial deposits in floodplains to assemblages on drier and better developed soils dominated by *Narenga porphyrocoma, Saccharum bengalense,* and *Themeda arundinacea*. These herbaceous species eventually give way to dominance by non-flooded climax deciduous forest which is predominantly composed of sal (*Shorea robusta*).

Himalayan Alpine Shrub/Meadow — Mesic herbaceous and scrubby meadows that occur above the treeline on the south facing Himalayan range, dominated by herbaceous grassy genera such as *Kobresia, Poa, Deyeuxia, Agrostis,* and *Festuca* and shrubby species such as *Rhododendron* and *Juniperus*. These regions contain a rich floral and faunal diversity.

Trans-Himalayan Rangelands — Vegetation communities dominated by desert steppe vegetation such as *Caragana, Lonicera,* and xeriphitic grass genera such as *Stipa*. Although relatively low in floral species' diversity, these rangelands support large herds of ungulates and wild predators.

Buffer Zone — Areas adjacent to or within a PA in which land use is partially restricted and which are managed to provide an added layer of protection to the PA itself while providing valued benefits to the neighbouring rural communities (MacKinnon *et al.* 1986[2]).

Eco-development — A site-specific package of measures, developed through peoples' participation, with the objective of promoting sustainable use of land and other resources, as well as farm and off-farm income-generating activities, not deleterious to protected area values (Panwar 1992[3]).

Eco-development area — (used in India, similar to a Buffer Zone in Nepal) a conservation designation in the Indian Wildlife Act for areas adjacent to core Protected Areas. The area is managed so as to reduce or eliminate human pressure on core protected areas using eco-development measures.

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[2] MacKinnon, J.; MacKinnon, K.; Child, G.; and Thorsell, J. (1986) *Managing Protected Areas in the Tropics*. Gland, Switzerland: IUCN

[3] Panwar, H.S. (1992) *Ecodevelopment: An Integrated Approach to Sustainable Development for People and Protected Areas in India*. Paper presented at the IV World Congress on National Parks and Protected Areas, 10-21 February 1992, Caracas, Venezuela.

Workshop Summary

Natural grasslands cover approximately 14% of Nepal and are important areas in terms of biodiversity and sources of forage for wild ungulates and domestic livestock. In the plains of Nepal (the *Terai*), natural grasslands occur along flood plains and terraces. As a result of increasing population pressures in this region, these grasslands only exist in their natural state within protected areas (PAs) as neighbouring grassland and sub-tropical forest habitats have been rapidly converted into agricultural land and grazing commons. At higher altitudes, trans-Himalayan and alpine rangelands are home to a diverse array of wildlife and are grazed by livestock, which are an integral part of the livelihood of several different ethnic groups. While there is a general assumption that these high elevation areas are being overgrazed, little is known about the ecology and sustainability of prevailing land-use practices.

To address these issues, a workshop on Grassland Ecology and Management in Protected Areas of Nepal was organized jointly by HMG/Ns Department of National Parks and Wildlife Conservation (DNPWC), the International Centre for Integrated Mountain Development (ICIMOD), and WWF Nepal Programme, from March 15-19, 1999, at Royal Bardia National Park, Nepal. The idea for the workshop arose from discussions on protected area (PA) management during the Wardens' Seminar in 1998, in the Annapurna Conservation Area. The DNPWC endorsed the recommendation of the Wardens' seminar, and ICIMOD and WWF pledged financial and technical support. The goal of the workshop was to summarise the major grassland ecological research work conducted to date and devise effective research and management strategies for grasslands in PAs in the mountain and Terai areas of Nepal. Participants included representatives from the Ministry of Forest and Soil Conservation, protected area managers from Nepal, independent researchers from Nepal and abroad, and guest scientists from India who have worked in similar environments in their own country. Some invited papers from research workers who were unable to attend the workshop were included in the background papers (and will be published in the proceedings) to ensure completeness in the coverage of technical information.

A series of technical and status papers were presented summarising research for both Terai and Himalayan grassland ecosystems. Working groups were formed to prioritise issues, to identify research and management gaps, and to devise research and management guidelines for both grassland ecosystems. The Terai working group sessions revealed that while much research on grasslands has been conducted to date, the results have not been incorporated into grassland management practice. The participants of the Terai working group outlined a number of management strategies to address these gaps, primarily focussing on maintenance of grassland habitats for key wildlife species. The mountain group sessions indicated a significant absence of research related to high elevation rangelands. Thus these participants focussed on developing research strategies to address the high priority issues of wildlife-livestock competition, crop and livestock depredation, medicinal plant extraction, stakeholder involvement, and transboundary protection. Research and management committees have been recommended to follow up and refine these guidelines. The proceedings from the "Workshop on Grassland Ecology and Management in Protected Areas of Nepal" are divided into three volumes. Volume I is the Workshop Action Summary and contains a brief summary of the papers presented in Vols. II and III, as well as a summary and synthesis of the workshop findings and recommendations; Volume II presents status and research papers from the Terai protected areas of Nepal and India; and Volume III presents status and research papers from mountain protected areas.

Volume I. Action Summary

Volume II. Technical and Status Papers on Grasslands of *Terai* Protected Areas

A. Technical Papers on *Terai* Protected Areas

A Landscape Approach to Managing the Indian *Terai* Ecosystem with Reference to Uttar Pradesh, India
Vishwas B. Sawarkar

Status of Research and Monitoring in Protected Areas of the Indian *Terai*: An Overview
Pradeep Kumar Mathur

Managing the *Terai* Grasslands in Nepal: Recent Research and Future Priorities
Nic Peet, Diana J. Bell and *Andrew R. Watkinson*

The Organization and Human Use of *Terai* Riverine Grasslands in Royal Chitwan National Park, Nepal
John F. Lehmkuhl

Grasslands and Large Mammal Conservation in the Lowland *Terai*: A Preliminary Synthesis Based on Field Research Conducted in Royal Bardia National Park, Nepal
Per Wegge, Shant Raj Jnawali, Torstein Storaas and *Morten Odden*

Koshi Tappu's Treasure: Grasslands or Wetlands?
Jay Prakash Sah

Effects of Management Practices on the Grassland Vegetation and Their Use by Ungulates in Dudwa National Park, Uttar Pradesh, India
Harish Kumar

Importance of Tall Grasslands in Megaherbivore Conservation
Shanta Raj Jnawali and *Per Wegge*

Grassland Management Impacts on Small Mammals
Tika Ram Adhikary

Impact of Grassland Management on Avian Fauna
Hem Sagar Baral

B. Status of Grasslands in *Terai* Protected Areas: Management Issues and Gaps

Parsa Wildlife Reserve (PWR)
Surya Bahadur Pandey

Royal Bardia National Park (RBNP)
Shiv Raj Bhatta

Royal Shukla Phanta Wildlife Reserve (RSWR)
Ram Prit Yadav, Sher Singh Thagunna and *Jay Prakash Sah*

Volume III. Technical and Status Papers on Grasslands of Mountain Protected Areas

A. Technical Papers on Mountain Protected Areas

Indigenous Livestock Management Systems on the Upper Slopes of Central Nepal
Santosh Rayamajhi, Don Messerschmidt and *Bill Jackson*

Alpine Vegetation of North Western India: An Ecological Review
Gopal S. Rawat

Rangeland, Animal Husbandry and Wildlife in Annapurna, Nepal: A Case Study
Som B. Ale

Grasslands in the Damodar Kunda Region of Upper Mustang, Nepal
Rita Arjel Koirala, Rinjan Shrestha and *Per Wegge*

Ecological Separation between Ibex and Resident Livestock in a Trans-Himalayan Protected Area
Yashveer Bhatnagar, Gopal S. Rawat, A.J. Thomas Johnsingh and *Michael Stüwe*

A Participatory Approach to Rangeland Research and Management: Developing an Action Plan for Rangeland Conservation in Mountain Protected Areas
Camille Richard and *Colleen McVeigh*

Managing People-Wildlife Conflict on Alpine Pastures in the Himalayas
Rodney Jackson

B. Status of Grasslands in Mountain Protected Areas: Management Issues and Gaps

Langtang National Park (LNP)
Jhamak Karki and *Colleen McVeigh*

Kanchenjunga Conservation Area (KCA)
Fanindra R. Kharel

Dhorpatan Hunting Reserve (DHR)
Ramchandra Kandel

Khaptad National Park (KNP)
Nilamber Mishra

Rara National Park (RNP)
Gopal Ghimire

Shey Phoksundo National Park (SPNP)
Tulsi Ram Sharma

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Technical Papers on Mountain Protected Areas

Indigenous Livestock Grazing and Management Impacts in Upper-Slope Forests of Nepal

Santosh Rayamajhi, Don Messerschmidt and William Jackson

Abstract

The central Himalayan 'upper-slopes' are defined as an area lying between 2,300 and 4,000 masl, which possess a rich wealth of forest, shrub and grassland resources. The upper-slope area is capable of sustaining sizeable populations of livestock as well as other forms of resource utilisation such as extraction of bamboo and timber, collection of *Daphne* spp bark for making Nepali paper and collection of various medicinal plants. Herding livestock is an important means of livelihood among the people living in and near upper-slope areas. This paper on indigenous knowledge is based on research carried out to examine traditional use of upper-slope mountain resources with special attention given to intense forest use by livestock grazers in the east-central districts of Sindhupalchok and Kabhrepalanchok in Nepal.

Three styles of livestock management have been identified in the study area: 1) full transhumance, 2) semi-transhumance, and 3) stall-fed livestock management (non-transhumance). These indigenous systems have recently been influenced by several factors like the construction of new roads into formerly remote locales; the opening of new markets for agricultural, livestock and forest products, and employment; greater access to schooling and health facilities and supplies of clean water; and, new opportunities for migrant labour and small business investment in and outside of Nepal. In response to some of these impacts, use of forest resources on high upper-slopes is changing. Yet, despite the various social and political constraints, traditional livestock systems are still prevalent in some areas, though local authorities have begun to rationalise the use of resources by means of extra-legal restrictive measures under community or communal pasture management systems.

In this study, we examine the traditional and contemporary adaptation of users of upper-slope resources, especially livestock herders, and their impact on high-altitude forest resources.

Introduction

Herding livestock is an important means of livelihood among the people living in north central Nepal, on the Himalayan 'upper-slopes'. About 43% of Nepal's landmass is classified as 'high Himal' and 'high mountainous'. Grassland, shrubland, and forested land account for 53% of the land area in these physiographic zones. Thus, the upper-slopes possess a rich wealth of forest and grassland resources, capable of sustaining sizeable populations of livestock as well as other forms of resource use such as extraction of bamboo (*ningaalo, baans*) and timber (*kaath*), making of paper from *Daphne* spp bark (*lokta*), and collection of medicinal plants (*jaributi*). Nepal's livestock production system alone contributes significantly to the national economy, accounting for about 25% of total agricultural GDP (MPFS 1989); the upper-slopes are among the main areas of the country used for livestock grazing.

The forest environment of the upper-slopes is regarded as a distinct and fragile ecosystem. This is the result of a combination of climatic and topographical conditions, rich biodiversity, and a variety of human influences (Schmidt-Vogt 1988, Jackson *et al.* 1993, BPP 1995b). However, the overall value of natural resources in the forests of the upper-slopes of the Himalayas has been little explored by scientists and developers, except in the recently protected areas of Annapurna, Solokhumbu, and Makalu-Barun. Until now, His Majesty's Government of Nepal (HMG/N) has focused its management efforts on areas of the *Terai* (lowlands) and the mid-hills. Research on the upper-slopes, while not entirely neglected, has received considerably less attention. There is an urgent need to collect information related to issues and knowledge that can be used to develop approaches to the sustainable management and conservation of resources from the upper-slopes.

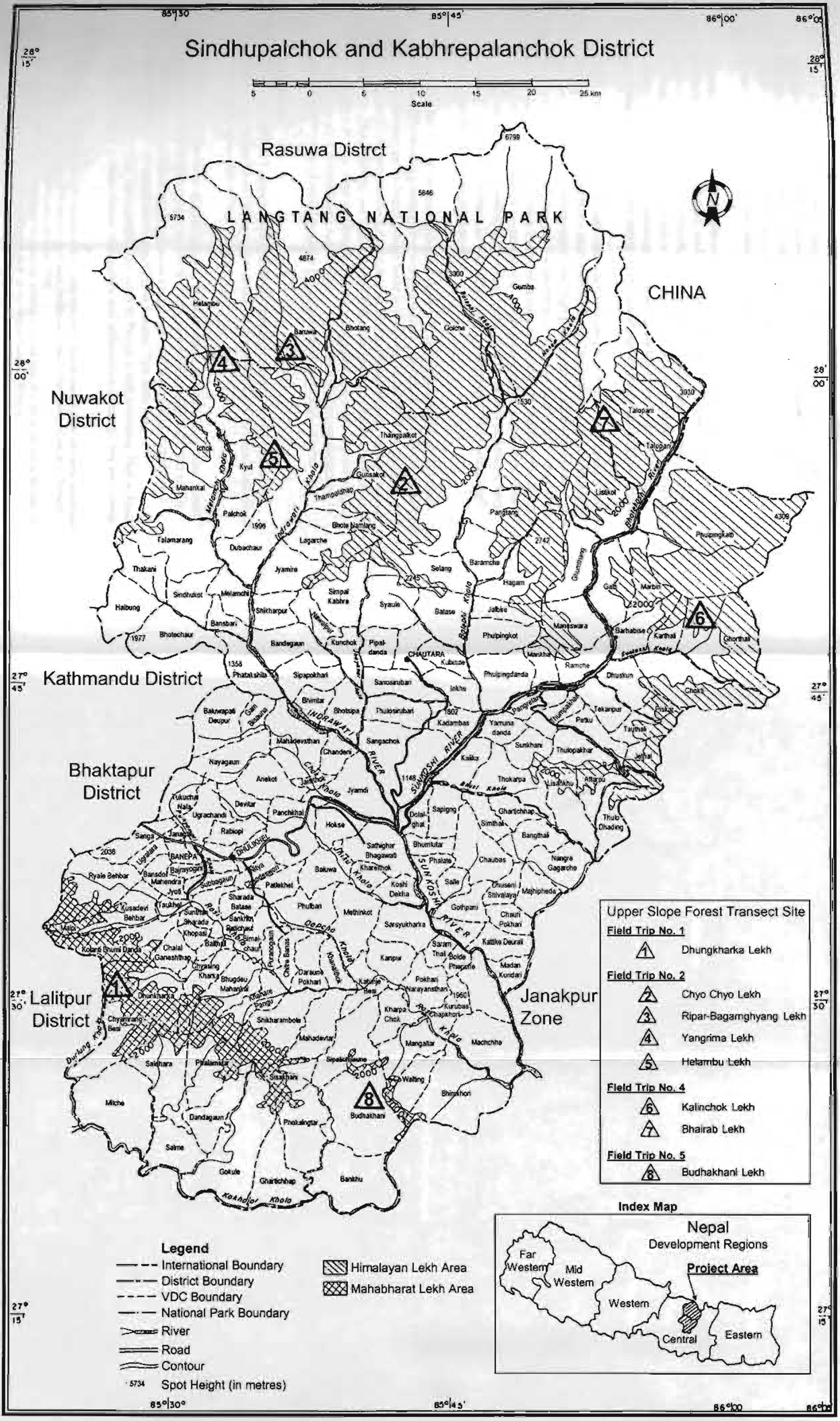
This paper explores the knowledge and practices of communities occupying the upper-slopes in terms of indigenous livestock management and knowledge and use of forest resources. It deals specifically with the demographic, socioeconomic, and biophysical settings of the upper-slopes, the impact of livestock herding, and emerging strategies of livestock management in response to the changing demographic, socioeconomic, and biophysical setting of the upper-slopes. It raises questions about how upper-slope forest resources can be managed sustainably in future and, in particular, the role of community-based management initiatives over traditional private management schemes.

Methodology

The study was conducted over a four-month period, January–May 1996, by a multi-disciplinary team of researchers on behalf of the Nepal Australia Community Forestry Project (NACFP) in the two central districts of Sindhupalchok and Kabhrepalanchok.[1] The team identified and analysed the status of, and issues related to, resource management and conservation of the upper-slope forests. The authors' experiences in other upper-slope areas of the Himalayas are also incorporated in this paper.

A series of investigative field trips was undertaken into the high altitude areas of Sindhupalchok and Kabhrepalanchok districts to survey the condition of the forest and grassland resources. For basic data collection, a methodology for a

[1] The study on the upper-slopes was supported by the Australian Agency for International Development (AusAID) as part of planning for the proposed Nepal Australia Community Resource Management and Conservation Project (NACRMCP), implemented from 1996-2001.
The research was carried out from January to May 1996 by a team led by Don Messerschmidt (Anthropologist, Social Forester), with Santosh Rayamajhi (Forester, Protected Area Specialist), Tulsi B. Prajapati (Social Forester), R.M. Tamrakar (Land Use Specialist), and Anita Manandhar (Gender Specialist). In addition, Bill Jackson, Ram B. Chhetri, and Sameer Karki, all of the Nepal-Australia Community Forestry Project, also participated in parts of the fieldwork and in the subsequent workshop and data analysis (Messerschmidt and Rayamajhi 1996). The authors thank all involved for their participation.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Rasuwa Distrct
LANGTANG NATIONAL PARK
CHINA
Nuwakot District
Kathmandu District
Bhaktapur District
Lalitpur District
Janakpur Zone
CHAUTARA
DHULIKHEL
BANEPA
INDRAWATI RIVER
SUNKOSHI RIVER
SUN KOSHI RIVER
Bhotekoshi River
Upper Slope Forest Transect Site
Field Trip No. 1
1 Dhungkharka Lekh
Field Trip No. 2
2 Chyo Chyo Lekh
3 Ripar-Bagamghyang Lekh
4 Yangrima Lekh
5 Helambu Lekh
Field Trip No. 4
6 Kalinchok Lekh
7 Bhairab Lekh
Field Trip No. 5
8 Budhakhani Lekh
Index Map
Nepal
Development Regions
Project Area
Far Western
Mid Western
Western
Central
Eastern
Legend
International Boundary
District Boundary
VDC Boundary
National Park Boundary
River
Road
Contour
5734 Spot Height (in metres)
Himalayan Lekh Area
Mahabharat Lekh Area
85°30
85°45'
86°00'
28° 15'
28° 00'
27° 45'
27° 30'
27° 15'

'Forest Profile by Rapid Assessment' developed for the Nepal-Australia project by Jackson and Ingles (1996)[2] was used and both key informant interviews and focus group discussions with villagers and forest resource users were used following standard Rapid Appraisal tools and methods (Messerschmidt 1995, Grandstaff and Messerschmidt 1995, Jackson and Ingles 1996). These and other rapid appraisal field methods were used to investigate land-use change, gender issues, and environmental management issues.[3]

A series of interviews were also conducted with specialists in forestry and protected area development; and these include officers of HMG/N and professional staff from community forestry and protected area development projects. The team also carried out an extensive literature review, held a series of briefings, and held a workshop on upper-slope forest management issues involving participants from many government agencies and projects in Nepal.

During the field work, 71 high-altitude forest profile surveys were undertaken. In addition, we held discussions and interviews with key informants (especially with resource users encountered in the high pastures and forests) and made first-hand observations. Perhaps most important of all, sources of information from among the local people were the local guides who were engaged by the team to travel with us through the upper-slopes – which are locally called '*lekh*'. These guides were highly knowledgeable informants, able to discuss in detail a wide range of seasonal activities and lore (the basis of indigenous knowledge and practices) about natural resources.

Because the use of the upper-slope forests and pastures is seasonal, meeting people while actually engaged in some seasonal activities was difficult. Livestock grazing on the upper-slopes occurs later in the year from April into the summer monsoon. Cutting of fuelwood and timber also tend to be done after the snow has gone. Nonetheless, we encountered and interviewed some individuals and family groups who were herding cattle and yak, collecting *lokta* and *jaributi,* and cutting wood in several high forest areas. Our individual, prior professional experience on use of resouces from the upper-slopes was also helpful.

Study Area

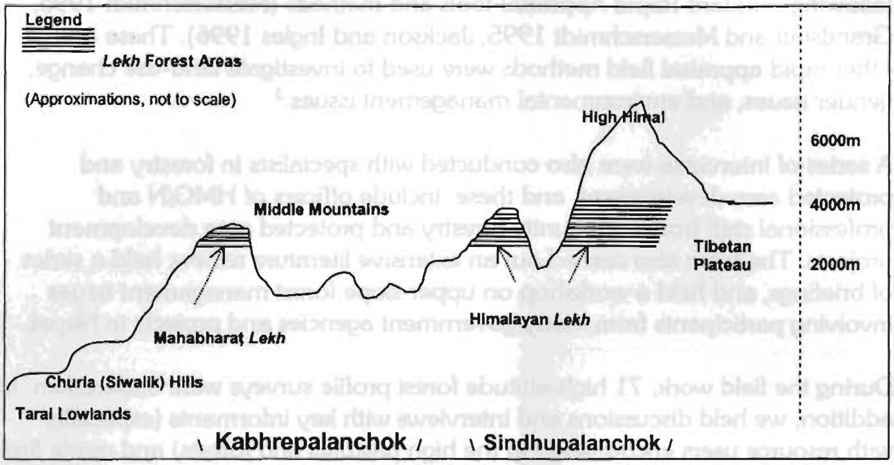
The study area is located in the middle and high mountain zones of central Nepal; i.e., in the Mahabharat *Lekh* of Kabhrepalanchok District and Himalayan *Lekh* of Sindhupalchok District (Figure 1).

The NACFP has been operating since 1978 in these districts, in an area which together covers 3,886 sq.km, or 2.6% of Nepal's total area of 147,181 sq.km. The *lekh* area of Sindhupalchok rises to the high altitude pastures and even extends into Tibet across the Nepal/China border. The *lekh* area of Kabhrepalanchok is the culmination point in Nepal's mid-montane Mahabharat range. There are some major similarities and differences between the two areas

[2] A revised and expanded version of the *Forest Profile by Rapid Assessment* has been developed for the Third Forestry Development Project in Bhutan. See Nurse 2000; Nurse and Wangdi 2000; Nurse and Messerschmidt *et al.* 1998.

[3] Our work on these topics was not entirely unique, but was part of a set of on-going studies on these topics being conducted by the staff of the Nepal-Australia Project.

Figure 1. **Profile of Nepal Showing the Aproximate Vertical location of Lekh Areas**
(adapted with modifications from Jackson 1999:7, Figure 1-2)



Note that lekh occur on the smaller peaks of the Middle Hills and the mid-levels of the High Mountains

in terms of the people, their culture, forest and pasture resources, and patterns of resource use.[4]

The upper-slopes are distinctive; they are located far from urban centres and they are difficult to reach. They differ in many ways from the mid-hills as they not only have large and contiguous forest areas and rich biodiversity, but also show differences in a variety of socioeconomic, demographic, and institutional aspects.

Discussion of Findings

The environment of upper-slope forests

Definition of 'upper-slopes' (or 'lekh')

For the purposes of the study the upper-slopes of the central Himalayas are defined as the area lying between 2,300 and 4,000masl.[5] This definition is based on local perceptions of differences between the *lekh* and Nepal's mid-hills (*pahad, besi*) and lowlands (*Terai*). Local people living within or near the *lekh* usually specify the upper-slopes according to a variety of distinctive circumstances and conditions, in which the land-use patterns change from predominantly agricultural to predominantly forest/grassland livestock husbandry, largely above 2,300m. Note that the Nepali term '*lekh*' and the English 'upper-slopes' are synonymous.[6]

4 See the full report for greater details; Messerschmidt and Rayamajhi 1996

5 In our earlier report, we set the lower limit of the upper-slopes at 2,000m, but have revised it upwards to conform more closely with local perceptions as well as with other environmental factors noted. Hereafter, the upper-slopes are defined as lying between 2,300 and 4,000m. Note that some of our research was carried out below the lower limit of this definition, as described in the text.

6 The correct spelling of the Nepali term for the upper-slopes (transcribed to English from Devanagri script) is *lek*. We have opted, however, to use the more common and popular (mis)spelling: '*lekh*'. We are indebted to Ram B. Chhetri for pointing out this orthographic discrepancy.

The definition of 'upper-slopes' is exemplified by the opinions of various experts and from brief remarks in the literature (LRMP 1986; Metz 1991, 1994; BZST 1993a,b; Jackson *et al.* 1993; BPP 1995b; Panday 1995; Jackson 1999). In general, the upper-slope forests and their environs are characterised as being more remote and isolated, with more severe climatic conditions, less accessible infrastructural advantages, more limited institutional attention, and greater difficulties in achieving subsistence livelihood than other areas.[7] These are broad generalities and are based on comparison with the mid hills; hence, they are not necessarily universally applicable and can be refined through more intensive scrutiny.

Because livestock grazing on the upper-slopes involves important resource management strategies, it is important to note the general context of environmental and socioeconomic characteristics under which livestock grazing operates. Thus, in brief, the *lekh* is defined as a place combining some or all of the following characteristics.[8]

- **Inaccessibility**. Most *lekh* forests are relatively inaccessible, compared with mid-hill forests. This results from:
  - the generally long distance from downslope settlements;
  - seasonal conditions (especially winter weather, deep snow, monsoon rainfall);
  - aspect (e.g., northern aspects are colder, with more snow); and
  - terrain (often quite steep and rugged).
- **A distinctive set of high altitude resources**. *Lekh* forests represent distinct species, associations, and forest types, in distinct high altitude combinations. They are generally dominated by:
  - broadleaved tree species (e.g., oak, rhododendron), conifers (fir, hemlock, juniper), mixed forest and associated trees and shrubs, many of which are not found at lower elevations;
  - large tracts of dense high forest and vast, open alpine pasture lands;
  - a generally wide range of wildlife species in greater numbers than in the densely populated mid hills; and
  - a lower population (overall and per village).
- **Traditional patterns of use**. Most *lekh* areas are defined with three basic criteria of use in mind:
  - being at or above the upper limit of agriculture (agriculture is absent for the most part, livestock husbandry is more prevalent) and having generally, little integration with mid-hill farming;
  - focused on single-purpose and single product activities (less diversity of use than in the mid-hills), and
  - based largely on seasonal accountability and seasonal availability of resources.

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7 As Jackson has noted elsewhere, "Nepali villagers generally use the term *lekh* to refer to upland areas that seasonally receive snowfall, but do not have permanent snow and ice." Furthermore, "The *lekh* areas can be considered as social and ecological 'cross-roads' between the lower and elevation temperate Middle Hills and the higher elevation alpine areas of the Himalayan range and the Tibetan Plateau" (1999:5).

8 These characteristics may be compared with the 'mountain specificities' identified and discussed by Jodha (1998).

In areas of the upper-slopes *lokta* bark (used in paper-making) and *nigaalo* (bamboo used for wicker crafts) are harvested in winter. Fuelwood (*daura*) is usually cut by late winter or early spring. Transhumant livestock grazing (*ghumti charan*) climaxes in the high pastures during the summer monsoon, starting with a spring ascent through the highlands and ending with an autumn descent back to the lower slopes.[9]

The Socioeconomics of Upper-slope Forests

Primary and secondary users

The ethnic identities of the people who live in or in close proximity to upper-slope forests vary by locale (especially by altitude), sometimes by season and specifically by *lekh* and district. The Tamang and Sherpa are the majority populations living in or near and using the resources on the upper-slopes of the Himalayas in Sindhupalchok district. The highest permanent settlements include Sherpa and Tamang villages at approximately 2,500m altitude on Helambu *Lekh* and 2,700m on Kalinchok *Lekh*, respectively, both in upper Sindhupalchok.

The Tamang and the Sherpa are also among the primary users of highland resources, in fact they predominate. The Tamang have the highest numbers (33% of the total population of the two districts). Sherpas rank fifth (only 4%). Secondary resource users, ranking between Tamang and Sherpa, include the typical mid-hill caste and ethnic groups such as Brahmin, Chhetri, Kami (Blacksmiths) and Newar. They are most directly involved in managing upper-slope resources and most directly affected by changes in policy or in the socio-economic situation, particularly as they relate to livestock husbandry, community forestry, and buffer zone activities (e.g., adjacent to Langtang National Park in Sindhupalchok).

Note that some primary users of resources of Himalayan *lekh* reside at lower altitudes, sometimes far below the *lekh* in altitude. Similarly, the secondary and tertiary users of the *lekh* typically come long distances (or their representatives; e.g., local herders entrusted with the management of cattle owned by valley dwellers). They tend to use upper-slope resources more on a strictly seasonal basis, often coming with permits issued by district government authorities, especially to gather *jaributi* (medicinal plants). The primary users, on the other hand, living closer to the *lekh*, tend to use them more or less in all seasons. The presence of seasonal lower slope 'outsiders' is one of the distinguishing features of use of upper-slope forest.

Land use and forests

There are three main land-use types in *lekh* areas: agricultural, forest and shrubs, and non-agricultural including grasslands. In both the *lekh* areas studied, forest and shrubs are the dominant vegetation group. Livestock grazers use a mixed resource base, consisting of all three land use categories in various combinations. Livestock grazing occurs in each – spring, summer, and fall in the

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[9] Terminology in italics designates common Nepali usage.

high forest/shrub and grassland pastures and during winter in the fallow agricultural fields at lower elevations. Of these, high forest/shrubland grazing is of equal, if not greater, importance than grazing the open alpine pastures, since they are used during both the upward and downward transhumant cycle, while the highest grasslands are used for a relatively brief period only during the snow-free summer months. It is important, then, to note the specific characteristics of *lekh* forests and shrublands.

The high forests and shrublands have four broad vegetation types: coniferous forest, broadleaved forest, mixed forest, and shrubs. The distribution of vegetation types mainly reflects climate, topography, altitude, and aspect. The distribution of some vegetation types is also affected by human impact.[10]

Coniferous forests at the lower altitudes of the *lekh* are dominated by *Pinus wallichiana* (*gobre salla*; Blue Pine) and *Tsuga dumosa* (*thingre salla*; Hemlock); and, at higher altitudes by *T. dumosa*, *Abies spectabilis* (*talis patra*) and *Juniperus* spp (*dhupi, dhupi salla*; Junipers). The broadleaved forests are dominated by various *Rhododendron* spp (*gurans*), *Quercus* spp (*kharsu, bangsi*; Oaks), *Symplocos* spp (*kaalikath*), and *Myrsine capitellata* (*setikath*) in all zones. The mixed forests consisted of both broadleaved and conifers. In general, the shrublands are degraded forms of forests and often show the greatest impacts of open grazing.

In our study area in the Mahabharat *Lekh* of Kabhrepalanchok, the area covered by forest (excluding forest plantations) declined from 42% in 1978 to 35% in 1992.[11] Conversely, the area under grassland has increased by the same proportion, while the area of shrubland has remained virtually unchanged (Tamrakar 1995, Jackson *et al.* 1998).

By comparison, in the area sampled in the Himalayan *lekh* of Sindhupalchok, the area covered by forest has declined from 86% in 1978 to 65% in 1992, a loss of forest from 19% of the total land area over the 14-year period. Of this amount approximately two-thirds was replaced by shrubland and one third by grassland (Tamrakar 1996, Jackson *et al* 1998).

As noted below, decreasing forests and concomitant increasing shrublands and grasslands are not characteristics of *all* areas in these two districts, but the fact that this phenomenon occurs here on the upper-slopes begs the question *why?* To answer, we now examine conditions in the two *lekh* areas in light of cultural adaptations, local lifestyles, and local management systems, especially as they are related to livestock management in response to resource scarcity. Following that, in the last section of the paper, we discuss recent and current management decisions and responses.

10 Schmidt-Vogt (1988) has made similar observations, especially regarding the effects of human impact on land-use patterns. See also Jackson (1999).

11 These figures are based on the total area of 12 local administrative units called VDCs (Village Development Committees; previously *Panchayats*), and include some forests below 2,300m, the lower limit of the upper-slopes.

Human and livestock impacts

The forests of the upper-slopes contain a vast wealth of biological biodiversity, much of which is important for local subsistence economies in the region. These biological resources are also important for the part they play in soil and water conservation. They are used in a variety of ways by many people. The livelihoods of local people depend to a great extent on resource quality and condition, access, and their sustained use as both raw materials and their value-added products.[12]

The upper-slope forests and their environs in both districts have been impacted heavily by human and livestock use. There were strong indications that, based on a variety of land-use changes and changes in forest resource conditions and qualities, some species and forest-types are threatened with degradation, to the point of extinction in some localities. For example, there has been a profound impact on selected fodder and timber tree species and on eco-types in both *lekh* areas (most seriously between 2,500 and 3,000m) as a result of excessive grazing, lopping, and harvesting of timber. This has led to changes in forest type,[13] and it raises questions of how more sustainable management can be effected.

The total area of upper-slope forests had declined in both districts of the study area, and forest area had been replaced by shrub and grasslands. There had also been a decline in the total area of agricultural land within the lower *lekh*. Loss of marginal agricultural lands and degradation of grasslands are accompanied by an increase in other categories of land use such as landslides, water bodies, and settlements.

In contrast, Jackson *et al* (1998) have shown that, between 1978 and 1992, in three lower-slope village development units (VDCs) of Sindhupalchok and in five of Kabhrepalanchok, there was a net increase in forest and agricultural land with a concomitant decrease in shrublands and grasslands. Other studies in four lower catchment areas of Sindhupalchok and Kabhrepalanchok, by the same authors, show a net increase in forest land with a decrease in shrub and agricultural lands.

It is also interesting to note a report of forest area changes in three hill districts in eastern Nepal in an area somewhat comparable to the study area. The forest area was found to be decreasing in Sankhuwasabha and Terhathum districts and increasing slightly in neighbouring Dhankuta district. All three districts showed a net decrease in the area of shrublands and grasslands and an increase in the area of agricultural land (Shrestha 1994).

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12 Throughout this study we hold to the distinction between 'forest *resources*' and 'forest *products*'. Forest resources are defined as the raw materials from a forest. They remain as resources until well after harvesting when they become, after some work or processing, value-added products for home use or market. See Messerschmidt *et al.* (in press), after Messerschmidt and Hammett (1998, 1994). Forest resources *and* their products are important in both the subsistence and commercial economies of the Himalayas.

13 This findings for Nepal are supported by recent research in the mid- to high mountain areas of the eastern Himalayas of Bhutan (Davidson 2000).

Our transect surveys indicate that the less accessible, more remote, higher altitude forests were more dense and mature than those closer to human settlements, as expected. Livestock pressure plays an important role in the overall decrease in density and increase in immaturity of forests in remote areas that are inaccessible from village settlements. Vast areas of shrubland were encountered at lower elevations, a result of extensive pressure and removal of the forest cover for both subsistence and commercial needs.

A medium soil cover (ground cover) was found along the transects surveyed between 2,000 and 2,500m and above 3,000m. Sites between 2,500 and 3,000m generally had less lower soil cover than sites lower down. These forests are used intensively throughout the year, especially the forest pastures which are subjected to concentrated livestock grazing and trampling at the cross-over point where the lowest winter yak-*chauri*[14] pastures and the highest summer water buffalo/common cattle pastures overlap. Where livestock pressure is highest, the forests are found to be seriously damaged, thus creating 'hot spots' needing management attention. Thus, relatively severe forest degradation is evident at the highest and lowest elevations of the upper-slopes.

We found human impacts to be pervasive at all altitudinal ranges, a finding supported by other researchers (Alirol 1979; Schmidt-Vogt 1988). There was some difference at lower altitudes, however, where both protected forests and high density shrublands are found in several areas.

In most of the lower altitude forests (from 2,000 to 2,500m), extreme pressure is being exerted as a result of the collection of fuelwood and fodder for subsistence purposes by the people from nearby settlements. In most of the areas surveyed, formerly high canopy forests have been or are currently being converted into very sparse forests and shrublands. In some of the higher *lekh* forests, important fodder trees, especially *Q. semecarpifolia*, are so heavily lopped that they are virtually branchless and produce no seeds at all. The threat to forest regeneration is clear; on the lower *lekh*, for example, one species of Oak (*Q. lamellosa*) has been virtually eliminated in this way.

The number of shepherds' camps (*goth*) in an area varies greatly across the Himalayan *lekh* of Sindhupalchok district, according to the locale. For example, the average number of yak-*chauri* herds using an area of two to three kilometres in radius for grazing ranged from 30 to 125 in the Kalinchok and Bhairab *Lekh*, but was only 0 to 6 over the same radius in the Cho-Cho and Yangrima *Lekhs*. The total number of yaks and *chauris* per *goth* ranged from 10 to 40.

The expansion of herds and pastures tends to affect the forest in two ways. One is the effect of herders cutting poles and immature trees to make temporary sheds and fences. Another is the effect of livestock browsing on the young regenerating seedlings, thus destroying them and reducing the regenerative capacity of the vegetation.

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[14] *Chauri* is a general term for the offspring of common cattle and yak.

It is important to note that, contrary to general assumptions, the condition of the forest does not always improve with increasing distance from settlements. For example, change is clearly evident even at relatively great distances from settlements in the troubling transition zone between seasonal yak-*chauri* and water buffalo-cattle herding. Forests are always altered, though perhaps not irreversibly, where seasonal or permanent shepherd camps are been established. The serious changes associated with pressure on forest resources around shepherd camps are also accelerated by forest fire. Extensive damage, caused by a forest fire which occurred around 1970, can be seen at elevations between approximately 2,900 and 3,800m in the Kalinchok and Bhairab *Lekhs* of north-east Sindhupalchok. These areas suffer from soil erosion and land degradation on the upper-slopes.

The Livestock Management System

In Nepal, 90% of the population is dependent on agriculture for their livelihood. Agriculture is a complex subsistence system in which livestock are an integral part of agricultural production. Herding of livestock and agro-pastoral management systems in the hills and mountains of Nepal are the result of a long tradition. However, a number of changes has taken place in livestock management in the study area in recent years (within the present generation) in response to the changing demographic and socioeconomic circumstances and biophysical conditions of the upper and lower slopes. These changes reflect a response of traditional herders. The main types of livestock management systems and the changes that have taken place are summarised in Tables 1 and 2 and Figure 2. We now describe them in more detail.

Upper-slope lifestyles and cultures

Nepal's highland people have developed a variety of lifestyles and cultures over many centuries of adaptation. In the modernising national economy of Nepal, however, they are in danger of losing their distinct identities as a result of two processes: change in the quality and condition of the upper-slope forest resources on which they depend and a more pervasive process of cultural homogenisation.

The people of Sindhupalchok who live in or near to the *lekh* have two main lifestyles:

- upland livestock herding, and
- upland dry-field (rain-fed) farming.

The herder's lifestyle is closely attached to mobile herds in camps and pastures. The farmer's lifestyle is tied to the land and village. Nonetheless, they are interlinked in the following ways.

- Both lifestyles are rich in tradition, in the sense of containing a vast amount of indigenous knowledge about the *lekh* and long-standing traditions about how to live, adapt, and survive there.
- Both lifestyles are closely interconnected—sometimes both are practised in the same family, or by individuals who move with relative ease back and forth between them over time, in the same or succeeding generations.

Table 1. **Upland Livestock Management, Type of Range, and Sociocultural and Economic Conditions in Sindhupalchok (the high Himalayan *lekh*) and Kabhrepalanchok (the high Mahabharat *lekh*) Districts**

Type of herd – range, altitude, seasonality	**Lifestyle** – social, cultural, economic	**Forest Resources** – processing, use & products*
a. Long distance, year round full transhumance (highest altitude: 4,500 m +)		
Mixed yak-*chauri* herds (only in Sindhupalchok District) • Fall–Winter: descent to as low as 2,800m (northern aspect) or 3,000m (southern aspect); at lowest *kharkas* in December–January • Spring-Summer: ascent to 4,500m +; at highest *kharkas* July–August	• Tamang, Sherpa§ • herder and family live in a semi-permanent movable camp (*goth*) • gender-based division of labour; e.g., women and girls collect leaves, grass, and *lokta*-bark, and prepare milk by-products; men cut poles, bamboo, and do other heavy work • little access to schools	• Primary resource use: grazing of forest and pasture, tree fodder livestock bedding, poles for sheds and fencing, fuelwood, bamboo • Secondary resource use: non-timber forest products (e.g., *lokta*, medicinal plants), bamboo • Primary products: cheese,± ghee, dried meat, calves, hides, yak tail whisks • Secondary products: bamboo crafts (mats, baskets), guard dog pups
Sheep-goat herds (only in Sindhupalchok District) • Autumn-Winter: descent to valleys as low as 1,500m; encamped on fallow fields December–January • Spring-Summer: ascent as high as 4,000m; July– August	• Tamang and other • other conditions as above	• Primary resource use: grazing of forest and pasture, poles for sheds and fencing, fuelwood, bamboo • Secondary resource use: non-timber forest products (e.g., *lokta*, medicinal plants), bamboo • Primary products: wool, meat, livestock for sale, animals for rituals • Secondary products: chickens (raised in the camps), dog pups

Notes: Sometimes a few goats are kept with yak-*chauri* herds in the highlands; see also goat-keeping under 'Stall-fed Livestock Management', below.

* Primary resource use directly supports herding; secondary use indirectly supports the overall subsistence enterprise by value-added processing and sale, trade or home consumption. Primary products are animals or their by-products; secondary products indirectly support the enterprise. The resources and products may not, of course, all be used by the same individuals; they are generalisations.

§ Schmidt-Vogt (1988; pp209-214) describes transhumant yak-*chauri* husbandry as the exclusive domain of Sherpas; that of mixed herds of water buffalo, common cattle, sheep, and goats to be the exclusive domain of Tamangs; and all other husbandry types to be open to anyone regardless of caste or ethnic identity. In very general terms, Schmidt-Vogt may be correct. There is a problem in Sindhupalchok, however, in identifying (or differentiating) some Sherpas from Tamangs. We often heard references to *sakkali* (genuine) and *nakkali* (fake) Sherpas, implying that some are socially upward-aspiring Tamangs. We observed *both* Tamangs and Sherpas tending yak-*chauri* herds.

± Three kinds of cheese are produced as the cash crop products of livestock herding: a) home-made *churpi* (dried cheese sticks) common in yak-*chauri goths*; b) *khuwa* (sweet condensed cottage cheese) common in areas, whereas buffalo milk is produced; and c) factory-made cheese in commercial rounds from both yak-*chauri* and buffalo milk.

b. Short distance, short period semi-transhumance (highest altitude: < 3,000 m). Two variants — (i) Himalayan *lekh* and (ii) Mahabharat *lekh*		
i. Water buffalo and common cattle herds, on the Himalayan *Lekh* of Sindhupalchok District • Winter: low valley bottoms, down to 1,200m • Summer: high pastures to 2,800m (northern aspect) or 3,000m (southern aspect)	• Tamang, Sherpa, Chhetri, and others • Usually adult male herders, often accompanied by older male children. Some herders hired by livestock owners • Usually female family members stay at home as subsistence farmers • Access to schools and other facilities	• Primary resource use: grazing in forest and pasture, tree fodder leaf litter for bedding, poles for sheds and fencing, fuelwood, bamboo for mats and crafts • Secondary resource use: non-timber forest products (e.g., lokta-bark, medicinal plants), bamboo • Primary products: milk, ghee, cheese, fertiliser, meat, hides
ii. Water buffalo and common cattle herds on the Mahabharat *lekh* of Kabhrepalanchok District • Winter: stalled at or near settlements (seldom over 2,200m), occasionally grazed on fallow fields or in nearby forest and shrublands • Summer: ascent to pastures up to 2,900m	• Tamang, Chhetri, Newar, and others • Usually adult male herders, often accompanied by older male children-some herders hired by livestock owners • Usually female family members stay at home as subsistence farmers • Access to schools and other facilities	• Primary resource use: a) *traditional* — grazing of forest and meadows, tree fodder, leaf litter for bedding, poles for sheds and fencing, fuelwood, bamboo for mats and crafts b) *for modern stall-feeding* — tree fodder, cutting grass, a few poles for stalls and fencing, conversion of agricultural products/waste into milk • Secondary resource use: fuelwood, timber • Primary products: milk, ghee, cheese, fertiliser, meat, hides

Note: Traditional semi-transhumance herding has been totally abandoned in Kabhrepalanchok's *lekh* within the present generation, replaced by stall-fed livestock management.

c. Stall-fed livestock management (permanently at the family homestead in the village) An adaptation primarily for increased milk production.		
Water buffalo and common cattle management in both study areas • Year round: stall-fed livestock with some brief grazing near the *lekh* • Improved buffalo breeds, with good milk-producing capacities; also cattle for traction	• Any caste or ethnic groups (low castes sometimes discouraged by higher castes for ritual purity reasons) • Conducive to male out-migration for labour or business opportunities • Women and girls manage livestock enterprise • Access to schools and other facilities	• Primary resource use: intense use of fodder trees lopping in nearest low *lekh* forests, cutting grass, major fuelwood consumption for cheese-making (especially sweet condensed *khuwa*), a few poles for stalls and fences, leaf litter for bedding • Primary products: milk, cheese, ghee, meat, hides, fertiliser
Goat-keeping, in both study areas • Year round: kept in stall and grazed daily on village shrublands and forests	• All castes and ethnic groups • Mostly women's enterprise with help from girls and boys who graze the animals and cut fodder and grass near the village • Overall, similar to the stall-fed management conditions described above	• Primary resource use: tree and grass fodder (a selective browser), poles for stalls, leaf litter for bedding • Primary products: milk, meat for ritual-religious purposes, fertiliser, animals for sale (cash income)

Table 2. **Change in Transhumant Livestock Herding Lifestyles on the Upper Slope (*Lekh*) Areas Visited**

Change	Name of *lekh*	Description of Lifestyle Change*
	Himalayan *lekh*, Sindhupalchok District	
Increase	• Bhairab • Kalinchok	- Increased number of yak-*chauri* livestock units, registered herds and pastures in use - Transition zone between yak and buffalo herds under heavy pressure - High competition in livestock herding overall - Good market for milk by-products (esp. *churpi* cheese) and sales of animal (calves).
Same	• Cho-Cho	- No significant change seen or noted on transects, nor heard from local informants
Decrease	• Yangrima-Helambu • Ripar-Bagamghyang	- Some decrease in usage and improved condition of fodder sources noted - Informants say that because of heavy competition and resource pressure, the number of herds and livestock units has decreased within this generation.
	Mahabharat *Lekh*, Kabhrepalanchok District	
Abandoned	• Walting-Buddhakhani-Sipaali • Dhungkharka	- Changing economic opportunities and out-migration during present generation - Conversion to stall-fed livestock management for milk/cheese production - Increased pressure on nearby oak forests for cutting fodder, easy access to markets

* See Figure 2 for concomitant changes in the condition of the natural resource base (pastures, forests and fodder trees).

- Both lifestyles are dependent in complex ways on the variety of resources of the upper-slope forests, without which they would be seriously threatened—they both require access to fodder for livestock, wood for fuel and timber for construction purposes, and herders especially need access to good pastures (*kharka*). Thus, sustainability of these resources is a paramount concern.

The upland dry-field farmers transfer considerable biomass energy between forests and fields in the form of forest fodder and livestock bedding materials (broadleaf litter and conifer needles), directly by lopping or indirectly through the conversion of fodder to animal manure. There is often a symbiotic association between upland farmers and herders, whereby animals are allowed

Figure 2. **Projected and observed changes in upper slope livestock grazing patterns, 1968 to present** (based in part on Alirol 1979)

Changing livestock numbers by years	Alpine/subalpine grass lands	Forest	Fodder trees
Consultants' observations across all *Lekhs* visited			
1996 Observations • decline in livestock numbers and herds in some areas; increase in others Marked decrease in livestock numbers observed (with local exceptions)	• over-grazed • degraded • loss of local interest in herding in some areas due to heavy competition on poor pastures	• severely degraded • poor regeneration of some valued species • less valued species predominating • composition of forest changing • some forest types threatened • loss of local interest in forest herding and switch to stall-fed practices	• insufficient to meet annual demand • some species exterminated and forest types threatened • less desirable species collected • more fodder trees on private land • stall-fed practices increasing • fodder substitutes being used (e.g., oil cake, stalks, and branches)
Alirol's projections for Kalinchok *lekh*			
1988	• over grazing (risk of severe degradation)	• forest degradation (no regeneration)	• totally insufficient to meet demand for winter feeding
1978	• entirely used	• substantially used	• over used (winter loss of weight)
1968	• under used	• partially used	• entirely used

Alirol (1979) correctly pre-dicted increase in livestock numbers in Kalinchok

NOTE: This figure is an adaptation and expansion of Alirol's 'Foreseeable development of the grazing pattern in the Kalingchowk region' of NE Sindhupalchok *lekh* (1979: 177, Table 21). Alirol's projections for Kalinchok *lekh* were good, both Kalinchok and neighbouring Bhairab *lekh* have indeed seen an increase in livestock numbers and herds in the 18 years since his study. Present observations indicate that the increase of livestock pressure in some locations has contributed to an overall decline in fodder resources and pasture quality.

to graze in the agricultural fields during winter in return for provide manure. We observed a number of winter shepherds' camps (*goth*) established in farmers' fields and being moved between fields in the lower *lekh* (where preparations for the spring upward movement were underway). Great energy is exchanged in this way between herd and farm.

Upland herding is closely adapted to forest conditions on the upper-slopes, but places intense pressure on the resource base. Much of our attention was drawn to this lifestyle, both because of the nature and outcomes of its associated forest resource-use patterns and because of certain other aspects, which are important to understand when considering future upper-slope, forest resource management initiatives.

Upland livestock management systems

Transhumance herding in Nepal is a cultural system characterised by mobile camps (*goths*) and seasonal movement between pastures (*kharkas*), ascending during spring to the summer pastures and descending during autumn to the winter pastures.

There were three styles of livestock management in the study area – full transhumance, semi-transhumance, and stall-fed livestock management (non-transhumance) (Table 1). Two of these are based on the seasonal transhumance movement of herds on the *lekhs* and are distinguished by variations in livestock type, altitudinal range, seasonality, and ethnicity.

- **Full transhumance pastoralism** is practised in the highest altitudes of Nepal and neighbouring Tibet (crossing the Nepal/China border) over long distances with year-round movement of mobile camps. Generally, the herds and shepherds stay on the highest pastures during July and August and on the lowest pastures during December and January. Two kinds of herd are involved in full transhumance: yak-*chauri* and sheep-goat (see Palmieri 1976, Alirol 1979, Brower 1987, Stevens 1993).
- **Semi-transhumance pastoralism** is conducted over short distances for fewer months of the year, with the same spring-autumn, up-down movement but maintaining a base camp at or near a settlement in which the herds are sometimes kept for up to half a year (over winter). Mixed or separate herds of water buffalo and common cattle follow this pattern.
- **Stall-fed livestock management** (non-transhumance) has virtually none of the distinguishing features of the transhumance systems noted above. Instead, it is based on a stall-feeding regime at the farmer's home base. Water buffalo (often of improved varieties), cattle, and goats are typically kept in this manner. They may be taken into nearby fields, shrubland or forests to graze but are kept in stalls at night or even most of the day, depending on the type of livestock (Table 1).

The causes and effects of the recent changes in livestock management styles include a complex array of new opportunities brought on, in part, by the construction of new roads into formerly remote locales; the opening of new markets for agricultural, livestock, and forest products; greater access to schooling and health facilities, including the supply of clean water; and new or expanding opportunities for migrant labour and small business investment in and out of Nepal. The result has been an overall pattern of sometimes dramatic social and economic change.

For example, out-migration in search of labour or business opportunities elsewhere (to Kathmandu, and to India and other countries) has modified and, in some instances, irreversibly changed highland lifestyles of both herding and farming. Furthermore, local social and cultural expectations have altered, based on the cumulative effects of access, principally to education and better health facilities. Such social changes are not necessarily bad, but many of them are not easily reversed and they all have an impact on resource use and cultural adaptations.

One result has been a demographic shift of population away from the vicinity of the upper-slopes – the 1991 national census reported declines in population of up to 50% in selected VDCs adjoining the *lekhs* in both of the study areas (e.g., near Dhungkharka and Buddhakhani *Lekhs* of Kabhrepalanchok and Helambu, Bhotang and others of northern Sindhupalchok) (HMG/N 1991). This has effected village life as well as the ecological conditions of the forest resources of the upper-slopes (see Tables 1 and 2 and Figure 2).

Overall, our findings indicated that the demographic, socioeconomic, and biophysical situation on the upper-slopes is dynamic, complex, and changing.

The response: rejuvenation of community-based management

The three distinct patterns of livestock management described above are clear indications of a strategic response of herders to resource scarcity. New income-generating activities have evolved concomitantly with the change in the livestock herding pattern, especially the harvesting of *lokta (Daphne)* bark to make Nepali paper, *nigaalo* (bamboo) for wicker crafts, and various *jaributi* (medicinal herbs) for trading. To some extent, these changes lessen the pressure on some resources and increase it on others. To a great extent, they substitute for income foregone by less intensive livestock herding. The traditional and indigenous transhumance system is gradually being replaced by a more sedentary, stall-fed livestock system. Over time, further change in the condition of forest resources should be expected, though it is arguable if the changes will reduce grazing pressure.

Despite various socioeconomic changes and political constraints, traditional livestock grazing systems are still prevalent in some upper-slope locales. The individuals involved, however, recognise the pressures that exist on the resource and have begun to rationalise their use of forest and pasture resources by extra-legal restrictive measures under community or communal pasture management systems. Initiatives include artificial seeding of pastures, breed improvement, and reducing the size of herds.

Several factors need to be understood before the full picture of the local response becomes clear. While pastures are regarded by some as relatively open access, common properties, the imposition of controls in several places by those more involved and concerned has changed people's views of them in important ways. These include the role of the local administrative units (the VDCs) and ward committees, in association with traditional livestock herder associations (*gothaalo samiti*), in controlling access to some upland pastures through strictly managed permit systems. This is a good sign for the development of pasture and forest management and rejuvenation of forest resources and sustainability. In part, these actions reflect how national policy can affect or influence local practice.

The Pasture Nationalisation Act of 1974 has had an important effect on perceptions of pasture tenure, how pastures are treated, how access to them is controlled, and how they are managed overall. Private ownership (previously quite common) of pastures is no longer allowed; all pastures are now under the control and management of the local VDCs. The Act was promulgated prior to the introduction of community forestry and prior to the development of the user group approach to natural resource management, both of which began with the Decentralisation Act of 1983. It is our observation that, whereas some *kharka* management is both *de facto*[15] and *de jure*[16] under the control of the VDCs and wards, there is a potential for relatively non-political user group management and it is encouraged and enabled by more modern policy, for example, the government's progressive community forestry and buffer zone laws and regulations (HMG/N 1973, 1993a, 1995, 1996).

Sustainable management of upper-slope forest resources depends on a series of interactions between the resource use and management practices of communities on the upper and lower slopes. The user group, community management approach may, however, need to be adapted and modified to fit some of the special circumstances of the upper-slope forests and the buffer zone surrounding the Langtang National Park in upper Sindhupalchok District. Our findings suggest that the long-standing knowledge and experience of user group development, based on the community forestry approach, can be adapted to integrate forest and pasture land into the management of the overall landscape and ecosystem of the upper-slopes.

Conclusion

The livestock herders of Nepal have a lot of indigenous knowledge about the upper-slopes, their forests, and grassland resource base. The adaptive strategies they have adopted in response to the changing biophysical, socioeconomic, and political situation are remarkable. These observations suggest that there is a very complex set of livestock management systems and variables related to the effect on resources that need further study. Government legislation alone will not solve the problem; if livestock management systems are to survive and prosper there must be commitment and integration of local community (indigenous) initiatives. For example, the community- and user group-based approach to resource management now found in widespread uses in lower slope communities should be adapted and extended to include integrated management of forests and pasturelands of the upper-slopes. Increased technical support and strengthening of participatory management options, particularly among existing resource user groups and interest groups, may result in more effective and sustainable management of the forests and pastures of the upper-slopes, thus reducing pressure on those resources.

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15 *de jure* = legal, formal officially recognised management decreed by the administration, law, etc.

16 *de facto* = the actual system - the informal system in actual practice

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Forest Profile by Rapid Assessment

(complete one from for each block of forest, shrubland or grassland)

Name of Forest	
District	
Village Development Committee	
Ward Number	
Range Post	
Information collected by (your name)	
Date information was collected	

Main Vegetation Type (circle one)

Grassland	Shrubland	Conifer Forest	Broadleaf Forest	Mixed Forest

Write the names of the three most dominant species

Estimated Area (ha)		Measured Area (ha)	
Altitude	Yes / No	Aspect	
Local Management? (circle)	Yes / No	Planted? (circle)	Yes / No
Forest Change in Last 5 Years (circle)	Now Worse / Same / Better	Year (s) of Planting (if planted)	
Forest Handed-over as CF? (circle)	Yes / No	Current Stocking (if planted, seedlings per ha)	
Forest User Group Code (if handed over)		Stocking Class (if planted, circle one)	Understocked Stocked Overstocked

Annex 1, Cont.....
Pages 2 of 5

Forest Condition Characteristic 1

For forest or shrubland complete the following four forest condition characteristics (refer to Forest Condition Characteristics' Table) then use these characteristics to determine Forest Condition Class (see Forest Condition Class Table). Grasslands are automatically classified as 'Very Degraded Forest'. Definitions of Grassland, Shrubland and Forest can be found in the Definitions' Table.

SOIL COVER?	SOIL COVER CLASS? (circle one soil cover class only)
more than 50% of the soils are covered	High
25% to 50% of the soils are covered	Moderate
less than 25% of the soils are covered	Low

Forest Condition Characteristic 2

CROWN COVER (use for shrubland or forest only)	DOMINANT CROWN COVER CLASS? (circle one crown cover class only)
more than 70%	Dense
40% - 70%	Moderate
20% - 40%	Sparse
less than 20%	Very Sparse

Forest Condition Characteristic 3

DENSITY OF REGENERATION	REGENERATION CLASS? (circle one regeneration class only)
more than 5,000 trees or shrubs per hectare	Dense
1,500 - 5,000 trees or shrubs per hectare	Moderate
500 - 1,499 trees or shrubs per hectare	Sparse
less than 500 trees or shrubs per hectare	Very Sparse

Write the names of the three most dominant species in the regeneration.

Forest Condition Characteristic 4

DENSITY OF SEED TREES (use for shrubland only)	SEED TREE CLASS? (circle one seed tree class only)
more than 50 seed trees per hectare	High
10 - 50 seed trees per hectare	Moderate
less than 10 seed trees per hectare	Low

Forest Condition Class
Use the four forest condition characteristics recorded above to determine a forest condition class for this block (see the Forest Condition Definitions sheet).

Condition Class? (circle one)	VERY DEGRADED	DEGRADED	MEDIUM	GOOD

Other Information

Participatory Map, Sketch Map, VDC Map or other map exists? (circle one)	Yes / No
Reference number of this forest block on map (if map exists)	
Does a plant species' list for the forest block exist? (circle)	Yes / No

Comments

Definitions

Main vegetation type	Definition
Grassland	Vegetation dominated by grass species and where the area covered by tree or shrub crowns is less than 10%.
Shrubland	Vegetation dominated by woody plants that are multi-stemmed near the ground or, if single stemmed, are less than 2 metres' tall. An upper stratum of emergent trees may be present and comprise up to 5% of the total crown cover.
Forest	Vegetation dominated by woody plants more than 2 metres' tall, with a single stem or branches well above the base. The area covered by tree crowns must exceed 10%.
Conifer Forest	75% or more of the tree species present are coniferous.
Broadleaf Forest	75% or more of the tree species present are hardwoods.
Mixed Forest	All other combinations of tree species present.

FOREST CONDITION CHARACTERISTICS

Forest Condition Characteristic	Definition
Soil Cover	The percentage of the area assessed that has the mineral soil surface totally covered by either live vegetation or a layer of other plant material.
Crown Cover (Forest)	The percentage of the area assessed that is within the vertical projection of the periphery of tree crowns, where tree crowns are treated as opaque.
Crown Cover (Shrubland)	The percentage of the area assessed that is within the vertical projection of the periphery of shrub crowns, where shrub crowns are treated as opaque.
Regeneration (Forest)	Seedlings, saplings and coppice regrowth of naturally occurring tree species that are less than 2 metres' tall.
Regeneration (Shrubland)	Seedlings, saplings and other regrowth that do not originate from a stump above ground level and which are of naturally occurring shrub species and are less than 0.5 metres' tall.
Seed Trees	Trees greater than 2 metres' tall which have healthy, intact crowns capable of producing flowers and seed within one growing season.

Annex 1, *continued*
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FOREST PROFILE BY RAPID ASSESSMENT

FOREST CONDITION CLASS

Soil Cover Class	Dominant Crown Cover Class	Regeneration Class	Seed Tree Class	Condition Class
Low or Moderate	very sparse or sparse	very sparse or sparse	low	VERY DEGRADED
			moderate or high	VERY DEGRADED
		moderate or dense	low	VERY DEGRADED
			moderate or high	DEGRADED
	moderate or dense	very sparse or sparse	low	DEGRADED
			moderate or high	MEDIUM
		moderate or dense	low	MEDIUM
			moderate or high	MEDIUM
high	very sparse or sparse	very sparse or sparse	low	VERY DEGRADED
			moderate or high	DEGRADED
		moderate or dense	low	DEGRADED
			moderate or high	MEDIUM
	moderate or dense	very sparse or sparse	low	DEGRADED
			moderate or high	GOOD
		moderate or dense	low	MEDIUM
			moderate or high	GOOD

Alpine Vegetation of Northwestern India: An Ecological Review

Gopal S. Rawat
Wildlife Institute of India, Dehradun

Abstract
The alpine zone occupies nearly one third of the geographical area of the Himalayas and represents one of the most interesting biomes in the region. This is a zone of treeless vegetation consisting of dwarf and matted shrubs, herbaceous meadows, bogs, and fell-fields paved with mosses and lichens. Other vegetation types include arid pasture and steppe formations of the Trans-Himalayas. Large numbers of resident and migratory pastoral communities use the alpine areas for livestock grazing and others earn their livelihood by extracting various plants of medicinal value. Ecologists in recent years have raised concern over degradation and over use of alpine areas.

This paper presents a review of the major ecological work pertaining to the alpine vegetation of the Greater and Trans-Himalayas within northwestern India. The major physiognomic and community types, floristic structure, successional trends, and biomass productivity and associated conservation issues are discussed. A few management options pertaining to human and livestock use are given, including more quantitative, management-oriented studies and long-term ecological monitoring of these fragile areas.

Introduction

The alpine zone represents one of the most fascinating biomes in the Himalayas. It forms nearly 33% of the geographical area in the region; *ca.* 80% of the area is vegetated and the remaining 20% is under perpetual snow (GOI 1989). The alpine vegetation comprises closely woven and matted strands of shrubs, herbaceous meadows, bogs, and fellfields paved with mosses and lichens and is limited by a distinct timberline at around 3,300±200m in the northwest to 3800±200m in the northeast. The diversity of life forms, structure, and composition of alpine vegetation have always attracted a large number of naturalists, phytogeographers and ecologists (e.g., Mani 1978, Rau 1975). It is believed that most of the forest vegetation below the natural treeline was derived from tropical forests of peninsular and Indo-Malayan origin, but the alpine vegetation originated only after the final phase of Himalayan upliftment with the subsequent increase in cold-arid climate (particularly in the north-western Himalayas), and the migration of flora from the adjoining regions (Whyte 1976, Vishnu -Mittre, 1984). A closer look at the present day alpine vegetation reveals interesting facts related to both past geo-climatic changes and the ecology and history of human use in the region.

The alpine zone in northwestern India (NWI) is spread over four biogeographic provinces (Rodgers and Panwar 1991), viz., the Ladakh mountains; the Eastern Plains, adjacent to the Tibetan plateau; the North-western Himalayas; and the Western Himalayas. It constitutes nearly 48% of the total geographical area in the region and about 91% of the total alpine area within Indian territory (Table 3). This is largely the result of the wider latitudinal variation and harsher cold-arid climate. Of all the alpine landscapes in the region, the meadows have been the particular subject of interest among naturalists and ecologists on account of their plant species' richness and patterns of adaptation to extreme environmental conditions (Smythe 1938, Rau 1975, Hajra 1983, Wadhwa *et al.* 1987). The meadow areas are commonly termed alpine (moist or arid) pastures and are used as summer grazing grounds by several migratory and local pastoral communities. Other uses of alpine areas include adventure tourism, pilgrimage, commercial exploitation of wild medicinal herbs, and recreation. In addition, this region forms the upper catchment of most of the Himalayan rivers which support millions of people in the lower hills as well as the plains of north India. Thus, the health of the alpine ecosystem is closely linked with the environmental stability and human welfare in the whole region.

Table 3. **Extent of alpine vegetation and livestock populations in North-western India**

State	Geographical Area (sq.km)	Alpine Vegetation (sq.km)	Permanent Snow (sq.km)	No. of Livestock (in '000)
UP hills	51,103	8,524	4,376	840
HP	55,670	17,296	4,934	4800
J&K	222,240	131,851	39,097	4660
Total	**329,013**	**157,671**	**48,407**	**10,300**

(Source: Lal *et al.* 1991)

In recent years several authors have voiced concern about degradation and over- exploitation of alpine areas (Singh and Kaur 1980, Shah 1988). Despite a large number of ecological studies, no comprehensive guidelines have been developed for the conservation and management of these areas. In this paper, I review the major ecological works pertaining to the alpine vegetation of the Greater and Trans-Himalayas within NWI, which covers the states of Jammu & Kashmir (J&K) and Himachal Pradesh (HP) and the hills of Uttar Pradesh (UP). The vegetation characteristics in terms of major physiognomic and community types, factors influencing the species' richness, and biomass production are discussed along with major conservation issues and the implications of various research findings for the conservation and management of the alpine ecosystem.

Physiognomy and Community Structure

The alpine vegetation of NWI has been described and classified by various authors such as Schweinfurth (1957), Mani (1978), Puri *et al.* (1989). The stunted nature of alpine plants as an adaptation to cold climate and exposure to strong winds, blizzards, snow storms, and various other factors have been well documented. Studies on the Raunkiaer's Life Form spectra (Kachroo *et al.* 1977, Rawat and Pangtey 1987, Ram and Arya 1991) have revealed a preponderance of chamaephytes and geophytes in the alpine areas exhibiting typical perrenial- annual growth habits.

The broad physiognomic and community classes of vegetation in the region are given below.

Alpine Vegetation of the Greater Himalayas[17]
The alpine zone within the western and northwestern Himalayas is generally separated by a distinct treeline characterised by birch-rhododendron (*Betula utilis-Rhododendron campanulatum*), fir (*Abies pindrow*), or brown oak (*Quercus semecarpifolia*) forests. The major vegetation types in the alpine zone include the following.

Alpine Scrub
The area immediately above the natural treeline is occupied by various shrubby formations, e.g., *krummholz* (stunted forests of *Rhododendron campanulatum* and associated shrub species), riverine willow scrub (*Salix-Myricaria* association along river banks), *Rosa-Lonicera* scrub, and pure patches of *Rhododendron anthopogon, Cassiope fastigiata,* and *Salix lindleyana.* The latter forms matted snow-bed communities in association with various perennial herbs.

Alpine Meadows
Locally known as '*bugyal*' in the Garhwal and Kumaon regions, '*dhar*'or '*thach*' in HP and '*marg*' in J&K, the alpine meadows are the natural herbaceous formations located above the alpine scrub, or immediately above the treeline in the absence of the latter. The meadows comprise a large number of herbaceous communities with varying proportions of tussock forming grasses and sedges. Dabadghao and Shankarnarayan (1973) categorised the alpine meadows under *Deyeuxia — Deschampsia* type of cover. Generally grasses are low in abundance and herbaceous plants belonging to various dicot families predominate. Such formations are locally recognised as distinct '*bugyal*' types in the UP hills (Rawat and Rodgers 1988). Several tall forb communities also exist in areas of deep soil and camping sites of livestock. Recently attempts have been made to develop a quantitative classification of meadow communities in the Himalayan alpine areas (Kala *et al.* 1998; and Singh 1999).

Scree Slopes and Moraines
The morainic environs and areas generally lie above 4,500 masl, they represent pioneer environments, and include fell-fields dominated by mosses and lichens. No attempts have been made to identify plant communities in such areas. The angiospermic taxa typical of such areas include species of *Rheum, Saxifraga, Sedum, Rheum, Corydalis,* and *Androsace*. Rawat and Pangtey (1987) studied the floristic structure of the snowline vegetation in the Kumaon Himalayas and found that Brassicaceae, Asteraceae, and Ranunculaceae were the dominant families in terms of species number above 5,000m. These areas are similar to the cold deserts of the Trans-Himalayas.

Timberline ecotone and sub-alpine (anthropogenic) herbaceous formations, which gradually merge with the alpine communities, are also included under high altitude vegetation. The blanks within the cool temperate and sub-alpine forests created by migratory graziers are termed '*thaches*' in HP.

[17] The Greater Himalaya in India is synonymous with the High Himalaya Physiographic Zone in Nepal.

Vegetation of the Trans-Himalayan Regions
Almost all the areas in the Trans-Himalayas are devoid of forest vegetation. Hence, it is difficult to find a clear ecotone of treeline, unlike the main Himalayas. However, sporadic patches of *Juniperus macropoda* and *Salix* woodlands can be seen in parts of the Lahul Valley (Aswal and Mehrotra 1994). The Trans-Himalayan vegetation is otherwise distinguishable from those of Himalayan alpine areas by the virtual absence of both *krummholz* formations and extensive moist meadows. The major formations in this area include the following.

Steppe Formations
The majority of the plateau and gentle slopes in the Trans-Himalayas exhibit a Mediterranean type of climate and steppe vegetation, i.e., scattered low shrubs with sparse grasses and forbs. Several communities have been reported in the cold arid regions of Ladakh and Spiti regions, e.g., *Artemisia-Caragana, Ephedra-Juniperus, Salix-Myricaria,* and *Lonicera-Rosa* (Chundawat and Rawat 1994).

Herbaceous and Grassy Meadows
A few patches close to the valley bottoms with moist clayey soil are dominated by herbaceous communities similar to those of the main Himalayan meadows. These communities are often called alpine arid pastures (*cf.* the alpine moist meadows of the main Himalayas) and include *Potentilla-Geranium* type, *Festuca-Stipa* grass communities, and *Carex* dominated meadows. Quantitative studies on the community structure and composition in these areas are lacking, except for a few surveys, e.g., Kachroo *et al.* (1977), Hartmann (1987), and Manjrekar (1997).

Cold Deserts
A considerable area in the Trans-Himalayas falls under cold desert, which supports less than 5% vegetation cover. Such areas include scree slopes, very high altitude (>4,800m) pioneer environments, and other rocky slopes dotted with a few hardy grasses and herbs, e.g., species of *Stipa, Melica, Christolea, Sedum, Draba,* and *Saussurea.*

Floristic Composition and Species' Diversity
Geographically, NWI has been categorised under the 'Western Himalayas' which was recognised as a distinct floristic zone by earlier phytogeographers. Many workers have described the floristic composition of alpine meadows in the region, e.g., Ghildiyal 1956, Dhar and Kachroo 1983, Hajra 1983, Rawat 1984, and Agarwal 1990. Over 4,500 species of vascular plants have been reported from this region. Of these, nearly 1,500-1,600 species are thought to occur exclusively in the alpine zone (Rau 1975). There is a great deal of variation in the species richness within various geographical areas depending upon various factors such as landscape diversity, stability of land forms, soil moisture, soil depth, and proximity to glaciers or to human settlements (Puri *et al.* 1989). Generally, the alpine vegetation in the main Himalayas is very rich in terms of plant species compared to similar geographical areas in the Trans-Himalayas. For example, Kala *et al.* (1998) reported over 520 species of vascular plants from an area of 87.5 sq.km of the Valley of Flowers (VOF) in the Garwhal

Himalayas, whereas < 500 species have been recorded in the nearly 89,000 sq.km area of Ladakh at a similar altitudinal range (Kachroo *et al.* 1977). Kala *et al.* (1998) observed that overall species' diversity decreases with increase in altitude, but diversity of sites within each zone varies considerably (Table 4). Plant species' richness and composition in alpine meadows are known to be governed by several factors such as the action of glaciers and avalanches, snow melt and deposition, and soil depth and richness, and the resultant variation in landscape diversity (Billings and Bliss 1959, Semwal *et al.* 1981, Kala *et al.* 1998).

Table 4. Plant species' richness across various landscape units in the Valley of Flowers National Park, Garhwal Himalayas

Landscape Unit	Altitude (m)	Mean no of Spp / quadrat $\pm$ SD	Total spp in 25 quadrat
Sub-alpine meadow	3,000	15 ± 5	38
Eroded slope	3,300	9 ± 3	37
Stable slope	3,350	14 ± 4	51
Treeline gap	3,300	18 ± 6	67
Valley bottom	3,400	17 ± 4	62
River bed	3,300	10 ± 2	50
Moraine	3,400	9 ± 3	42
Lower slope	3,500	12 ± 2	38
Plateau	3,550	15 ± 3	47
Stable meadow on higher slopes	3,700	13 ± 3	45
Scrubby slope	3,600	7 ± 2	12

(Source: Kala *et al.* 1998)

Successional Trends

The alpine habitats are, perhaps, the most heterogeneous and fragile. The vegetation in these areas exhibits a complex mosaic of succession. While meadows and several scrub communities can be regarded as climatic climaxes, a large number of intermediate and edaphic types can be recognised at the landscape level. Therefore, it is often difficult to trace the path of Clementsian succession. Several communities are sensitive to micro-topographic changes (Kikuchi and Ohba 1988), making the successional studies more difficult. Kala *et al.* (1998), based on various stages of landscape stability, have suggested two parallel courses of succession for the alpine meadows of the VOF near the treeline (3,500$\pm$200 masl). These are as follow.

Meadow Succession

The moss-lichen (pioneer) community in a glaciated valley on the terminal and south facing lateral moraines give rise to several broadleaved herbaceous formations, e.g., *Cyananthus-Kobresia-Anaphalis* association. *Danthonia cachemyriana* patches form a climatic climax on such slopes. *Kobresia* sedge meadows at such altitudes are considered as a climax community.

Forest succession
The north and north-eastern aspects have a higher moisture regime and less exposure to sun and wind, which promotes the growth of shrubby species that thrive well under heavy snow, the snow-bed communities. Some of these shrubby intermediate communities eventually give way to birch-rhododendron (*Betula utilis - Rhododendron campanulatum*) communities on more stable slopes with deeper soil.

Contrary to the Clementsian model suggested by a few authors for the Himalayan alpine areas, Mishra (1998) has proposed a catastrophic model to study the dynamics of vegetation and predict the changes in the vegetation communities for the Trans-Himalayan rangelands. An experimental study dealing with this aspect is underway in Kibber Wildlife Sanctuary (Mishra, C. personal communication).

Seasonality and Biomass Production
Although the growing season (May to September) is very short in the alpine zone, not all species attain their maximum biomass at the same time. Most of the species complete their growth cycle rapidly within 3-5 months in order to ensure survival. Kala *et al.* (1998), while conducting a biomass study, separated a total of 69 plant species, including one dwarf woody shrub, 4 grasses, 2 sedges, 3 ferns, 50 herbaceous dicots, and 9 other monocotyledons, from a grazed alpine site in the Garhwal Himalayas. They found that above ground biomass varied considerably between the camping sites (CS), steep slopes (SS) and undulating landmass (ULM) areas. The live shoot biomass increased continuously from the onset of the monsoon (June), attained a peak in the first week of September, and declined thereafter. *Danthonia cachemyriana* contributed the highest biomass on SS (356 g m^{-2}), *Geranium wallichianum* on ULM (232 g m^{-2}), and *Polygonum polystachyum* on CS (189 g m^{-2}). Of the total above ground biomass production in the sampled area, the loss due to trampling and grazing by livestock was 26%, 23%, and 22% on ULM, CS, and SS, respectively. In a community level study at an alpine site in the Garhwal Himalayas, Rikhari *et al.* (1992) found that the above ground community phytomass values ranged from 112 to 398 g m^{-2}, while the below ground net primary production ranged from 59 to 250 g m^{-2}.

Conservation Issues

Livestock grazing
The history of livestock grazing in the alpine meadows of the northwestern Himalayas dates back several centuries (Tucker 1986). It is estimated that this region now supports nearly 1.2 million livestock, which includes sheep, goats, cattle, yak, cattle–yak hybrids, horses, and donkeys (Kawosa 1988). Since the lower altitude grazing lands are limited in extent, summer migration to higher altitudes and alpine meadows has become a common practice as a means to sustain the number of livestock.

Several authors have studied the production potential and biomass uptake by livestock in the alpine areas of the UP hills (e.g., Ram *et al.* 1989; Negi *et al.* 1993; Kala *et al.* 1998). Sundriyal (1995) has observed that agro-pastoralists in the western and central Himalayas generally keep more cattle than really needed, mainly because of easy access to free grazing areas and their inability to dispose of or cull the population as a result of religious sentiments. While some authors believe that livestock grazing is essential to maintain species' diversity in these areas (Naithani *et al.* 1992; Negi *et al.* 1993; Saberwal 1996), others advocate alternative grazing practices and policies (Sundriyal and Joshi 1990, Rawat & Uniyal 1993, Mishra & Rawat 1998). Although the alpine pastures play an important role in relieving the grazing pressure on forests and grazing lands at lower altitudes, the increased number of livestock and overuse of certain pastures can, potentially, lead to degradation of the high altitude grasslands and the habitats for wild herbivores.

Based on the intermediate disturbance hypothesis, a few authors, such as Rawat and Rodgers (1988), have opined that a moderate level of grazing may enhance herbaceous species' diversity in alpine meadows. However, in the absence of quantitative studies it becomes difficult to decide what level is 'moderate', and to choose graziers in terms of whom to allow and whom not. Grazing animals affect plant communities in several interrelated ways, including plant defoliation, nutrient removal, redistribution of nutrients through excreta, and mechanical impacts on soil and plant material through trampling. Nevertheless, some flowering plants such as *Iris kumaonensis, Anemone rivularis, Primula denticulata, Taraxacum officinale, Plantago major, Inula grandiflora, Rumex nepalensis, Polygonum polystachyum,* and *Urtica dioica* show a tendency to increase under grazed conditions. This may be mainly due to their non-palatability and ability to withstand grazing. Thus, livestock grazing has a differential impact on different plant species, and the practice cannot be seen as completely negative.

Collection of Medicinal Plants

A large number of medicinal plants has been found in the alpine zone of NWI (Dhar & Kachroo 1983, Rawat 1984, Kala 1997, Singh 1999). Several local communities depend on these herbs for their own consumption as well as commercial extraction. As a result, many species are reported to have become rare and others are in danger of local extinction causing concern among conservationists (Rawat 1994). Most of the medicinal plants growing in the alpine meadows have tuberous or rhizomatous roots. Digging of fragile alpine soil to collect such herbs, and subsequent trampling and grazing by livestock, leads to spread of weeds and soil erosion. In the Western Himalayan meadows, exploitation pressure is particularly high on *Dactylorhiza hatagirea, Picrorhiza kurrooa, Jurinea macrocephala,* and *Aconitum heterophyllum*. At present, there are only a few protected areas in the western Himalayas where extraction of medicinal plants is prohibited. Kala *et al.* (1998) compared the density and abundance of various medicinal herbs in and around the Valley of Flowers National Park and found that some of the rare and threatened medicinal plants were completely absent from the grazed and unprotected alpine meadows.

Collection of Fuelwood

Agro-pastoral communities, tourists, pilgrims, and other visitors to alpine areas consume a large amount of fuelwood. Consumption of fuelwood is particularly high around the treeline and sub-alpine zone of the greater Himalayas and the thickly populated areas of the Trans-Himalayas. There are clear indications that the natural treeline in many parts of the Himalayas has lowered considerably as a result of regular camping and removal of woody vegetation (Rawat & Uniyal 1993). Selective removal of highly preferred woody species such as *Juniperus macropoda* and *J. communis* can also lead to local extinction of such species. Extraction of fuelwood, particularly from the low productive areas of the Trans-Himalayas, is one of the burning issues in the conservation of steppe communities. In the absence of larger trees and shrubs, local people dig out the low shrubs and undershrubs in large quantities in order to warm the houses and cook during long and severe winters (Manjrekar 1997). In addition, collection of livestock dung from the higher pastures for fuel is a common practice in the Trans-Himalayas. The ecological implications of such practices have not been investigated so far.

Wildlife Use

The alpine habitats support a diverse array of faunal communities. The typical mammalian fauna inhabiting the alpine areas include Himalayan tahr (*Hemitragus jemlahicus*), blue sheep (*Pseudois nayaur*), Himalayan ibex (*Capra ibex sibirica*), Tibetan antelope (*Pantholops hodgsoni*), Tibetan gazelle (*Procapra picticaudata*), Ladakh urial or shapu (*Ovis vignei vignei*), Tibetan argali or nayan (*Ovis ammon hodgsoni*), and Tibetan wild ass (*Equus kiang*), with apex predators such as snow leopard (*Uncia uncia*) and Tibetan wolf (*Canis lupus chanko*). Alpine habitats also harbour some of the highly threatened and vulnerable bird species such as Tibetan sand grouse (*Syrraptes tibetanus*), snow partridge (*Lerwa lerwa*), chukar partridge (*Alectoris chukar*), and snow cocks (*Tetraogallus tibetanus* and *T. Himalayas us*). So far only a few ecological studies have been undertaken on habitat use by wild herbivores in the alpine areas (Green 1985, Chundawat 1992, Sathyakumar *et al.* 1994, Manjrekar 1997, Bhatnagar 1997). Mishra (1997) estimated that the livestock holdings of agro-pastoral communities in Kibber wildlife sanctuary (Trans-Himalayas) have increased by 37.7% in 10 years, potentially resulting in more conflicts with wild carnivores such as snow leopard and wolf.

Management Options

<u>Management of grazing areas and livestock in the Trans-Himalayas</u>—Livestock grazing is the mainstay of the economy for several agro-pastoral communities in the Trans-Himalayas. At present there are no policy guidelines available on the optimal use of grazing resources in this area. Management authorities are faced with conflicting situations, particularly with respect to livestock depradation by wild carnivores and habitat degradation by large flocks of migratory graziers. Rotational grazing of degraded pastures and limiting the number of livestock are some of the options for management in this region. Mishra (1997) has suggested a self-financing compensation scheme, and modification of existing livestock pens to reduce the livestock–wild carnivore conflict in selected areas of the Trans-Himalayas.

<u>Livestock grazing in the PAs</u>—India's Wildlife (Protection) Act 1972 prohibits livestock grazing within the NPs. The settlement of grazing rights in the Himalayas Parks often leads to conflicts and controversies. It must be accepted that it is not possible to achieve a complete ban on livestock grazing in all the

Himalayan protected areas (PAs). Hence, demarcation of grazing and non-grazing areas or other forms of zonation (e.g., core and buffer) will have to be practised so that livestock grazing can be managed within buffer zones.

Rare plants and their habitats—Plant species may be rare as a result of restricted habitats, small population size, narrow range of distribution and/or over-exploitation in the recent past. Management authorities for conservation areas should develop site-specific or species-specific conservation plans depending upon the sensitivity of plants to various practices.

Management of degraded areas—Heavily eroded and degraded sites within the PAs should be protected on a temporary basis in order to allow recovery. Some of the native herbs that are fast growing and opportunistic, such as *Polygonum polystachyum* (Polygonaceae), should not be viewed as 'weeds' and uprooted. Kala *et al.* (1998) have highlighted the role of such herbs and opined that they play an important role in the stabilisation of the alpine environment in terms of soil formation, stabilisation of slopes, role in the forest succession near the treeline, and soil enrichment.

Research and monitoring—Further experimental studies and long-term monitoring on various management-related topics will be useful for the sound management of these areas. Some of the topics that have not been covered in terms of research in alpine areas are: (a) competition and dietary overlaps between domestic and wild ungulates; (b) the effect of differential grazing on vegetation cover and species' diversity; and (c) autecological investigations of some valuable plants such as *Dactylorhiza hatazirea, Picrorhiza kurrooa,* and *Aconitum heterophyllum*.

Peoples' participation—Involvement of local people in the ecodevelpment, conservation, and management of alpine sites has been emphasised frequently in most publications and meetings in recent years. Strong initiatives are needed to bring this concept into practice.

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Rangeland, Animal Husbandry and Wildlife in Annapurna, Nepal: A Case Study from Manang Valley

Som B. Ale
King Mahendra Trust for Nature Conservation, Nepal

Abstract
Like many traditional pastoral societies in the Himalayas, the traditional pastoral systems in the upper Manang (Nyeshang) Valley are currently undergoing substantial change as a result of external influences related to modern development activities, and this is affecting the age-old balance between herbivores and plants. The changing patterns of land use in the valley have led to a fluctuation in livestock and wildlife numbers over the past several decades. At present, local elimination of the wolf and an almost complete cessation of hunting of blue sheep have led to an increase in the number of blue sheep. It would be of interest to monitor the impact of the changing numbers of wildlife and livestock on the vegetation composition and productivity of these remote wild lands, and thereby on the whole functioning of the ecosystem. Recently, the King Mahendra Trust for Nature Conservation's Annapurna Conservation Area Project (ACAP) has focused on the collection of multiyear data on rangeland, livestock, and wildlife. These data will be used to identify the patterns of dynamics of the wild and domestic animal population, and will allow the project to correlate fluctuations with predator (e.g., snow leopard) abundance and or other ecological parameters (e.g., rangeland quality). This long-term research and monitoring approach, designed as an essential part of the array of ongoing conservation and development activities, is expected to enable assessment of the impact of the project in the region, and provide sufficient feedback to make corrections and refinements.

Background

In the high mountains of the Himalayas, the continued presence of an assortment of wild ungulates, their domestic relatives (the livestock), and their mammalian predators, is a clear indication that wild animals and livestock can co-exist (Fox *et al.* 1994, Miller and Jackson 1994, Schaller 1998). For the past several centuries, grazing of livestock has been the dominant human land use in these remote high altitude valleys. However, many of the traditional pastoralist systems are currently undergoing substantial change as a result of external influences related to modern development activities, and this is affecting the age-old balance between herbivores and plants (Miller 1987), and thereby the whole predator-prey system. To date, only a few studies have been made on the ecological interactions between the region's pastures and wildlife in the light of changing land use and modern development activities, although interest has already begun to grow (Miller and Bedunah 1993, Fox *et al.* 1994, Fox 1998).

The upper Manang Valley is a dry alpine landscape, and is a transition zone between the moist southern Himalayan slopes and the high desert steppes of Tibet. This valley is also known as Nyeshang and comprises the villages of

Khangsar, Manang, Brahka, Ghyaru/Ngawal, and Pisang (Pohle 1990).[18] The abundant pastures of upper Manang have long supported the traditional herding of yaks, yak-cow crosses, cattle, and sheep and goats. Thus, livestock are and continue to be the major source of livelihood for the agro-pastoral communities of Manang. Unlike other settlements along the northern fringe of Nepal, Manang has never been a major trading link between Tibet and Nepal. Even so the inhabitants of Manang have been active in trading abroad for a long time. By 1940, most traders were able to invest in their homeland, especially after retirement. Traditionally-minded traders spent their entire capital establishing yak herds and flocks of sheep and goats bought from nearby Mustang and Dolpa districts. Livestock numbers rose between 1940 and 1960, and the pressure on the habitats of blue sheep may also have increased. This was followed by the decimation of blue sheep populations by Khampas, the freedom fighters who fled Tibet following the Chinese exertion of full control over Tibet in 1959. Hence, during the 1960s and early 1970s, there was a drastic decrease in blue sheep numbers in the entire Manang and Mustang trans-Himalayan areas, as well as of the large wild predators such as wolves and snow leopards. The Nyeshang Valley, for example, now has no resident wolves (Fox and Ale unpublished). The Nepalese government in 1973 eventually stopped the activities of Khampas.

The period between the 1960s and the early 80s was a period of mass migration. Almost two-thirds of the population migrated out of the valley to Kathmandu, the capital, and other urban areas. The livestock numbers subsequently decreased dramatically, thus the pressure on the pastures and wild ungulates. The traditional village committees also banned the hunting of blue sheep during this period. The combination of a reduction in livestock numbers, elimination of wolves, and an almost complete cessation of hunting, has apparently led to an increase in the blue sheep population within upper Manang in recent years (Fox and Ale unpublished).

For the past two decades, the Nyeshang Valley has been developing as one of the most popular trekking routes in Nepal, because of its spectacular scenery and culture, attracting some 15,000 trekkers annually. Since the 1990s, the valley has drawn the attention of government and non-government projects, e.g., Ghenjyang Irrigation Project, a multi-million rupees government project that is trying to bring a massive portion of abandoned lands under irrigation particularly in Manang village, and construction of a huge Buddhist monastery in Ngawal, being some of the examples. The ACAP has also been actively involved in community-based conservation and development work since 1993.

All these development activities have made the valley once more attractive, and, as a result, several households have now returned to Manang, raising the spectre of an increasing livestock population. There is concern that the pressure on wildlife habitat may once again be increasing. Clearly, over the past several

[18] Nyeshang Valley is culturally distinct from other regions of Manang District such as the Nar region to the north and Gyasumdo region to the east (Pohle 1990). This paper addresses trends in Nyeshang Valley only and does not reflect the situation in the remote northern portion of Manang District, comprising the villages of Nar and Phu, which have not been subject to the same pace of socioeconomic change evident in Nyeshang.

decades these major changes have affected the traditional lifestyle, land-use practices, and the array of wildlife occurring there (Fox and Ale unpublished). There is a need to substantiate these socioeconomic changes and the impacts they have had or continue to have on the rangelands and on the whole functioning of the ecosystem.

Rangelands and Traditional Pastoralism

Rangelands comprise approximately 12% of the total 1,914 sq.km. area of Manang district; a further 80% of the district is barren rocks and snow-covered mountains. The upper Manang rangelands consist of scrubland vegetation at an average altitude of 4,039masl, and alpine grasslands, at an average altitude of 4,563 masl. The vegetation cover for grasslands ranges from 51-100%, more than for shrublands. Sedges like *Carex* and *Kobresia* and grasses such as *Calamagrostis* and *Stipa* dominate the alpine grasslands. These grasses/sedges comprise two-thirds (66%) of the total species' composition. The remaining vegetation cover (34%) of the grasslands is comprised of herbs and forbs, the five most dominant species being *Bistorta macrophylum, Cortia depressa, Tanacetum nubiganum, Potentilla* sp, and *Leontopodium himalayanum*. The four most dominant genera of the scrublands are *Juniperus (J. indica and J. squamata), Rosa (R. sericea), Berberis,* and *Lonicera*. The vegetation cover of the shrublands ranges from 26-50%. Herbaceous cover is low for shrublands. However, one can notice some grasses (dominant being *Calamagrostis* sp, *Danthonia cumunsii,* and *Koeleria cristata*), but only among dense thorny bushes and on steep rocky terrain; and hence inaccessible to livestock. Scattered throughout the open areas of the shrublands are less palatable herbs and forbs. Among them *Cremanthodium arnicoides, Tanacetum nubiganum, Aster* sp, *Ajuga bracteosa,* and *Thalictrum elegans* are the most dominant species (Ale 1993).

These grasslands and shrublands support livestock and an array of wildlife that characterise the upper Manang trans-Himalayan ecosystem. The shrublands are clearly more grazed/browsed than the alpine grasslands because of their closer proximity to villages and the possibility of access during winter months. However, these lands may not be overgrazed. One way of determining whether rangelands are overgrazed is to look at the health of the livestock and large wild herbivores (in this case blue sheep) that graze and browse there. The blue sheep and livestock in upper Manang are healthy and robust, at least during the summer months.

Knowledge about land use and the impact of different land-use practices is of fundamental importance to Manang's livestock, wildlife, rangelands, and agriculture. Grazing is an important land use and has a functional relationship with the agricultural, economic, social, and religious activities; it also influences the survival of the region's wildlife (Miller 1987; Brower 1991; Fox *et al.* 1994; Fox 1998). The abundant pastures of upper Manang have long supported the traditional herding of livestock. Traditional animal husbandry practices illustrate the operation of land-use controls that permit sustained livestock production in constrained conditions.

The most important constraint to keeping livestock in these semi-desert lands is the availability of winter forage. In a landscape of marked relief, where cultivable ground is scarce, cropping for direct human consumption certainly takes precedence over cultivation of fodder. Nevertheless, hay fields are maintained throughout the valley. Even so supplementary feeding in the form of hay and crop residues is small and not generally enough to last the winter, so livestock must depend on what the land offers in terms of grazing resources. Although summer grazing is luxuriant, it is only possible for a few short months, and then begins a long harsh winter that almost always exhausts the stored supplementary feed. This essentially means that animal numbers must be in balance with winter feed limits. In Manang the response of farmers and pastoralists to this has been to create a detailed set of social rules and regulations for grazing. The mechanism for regulation of grazing is operated through land tenure arrangements and communal controls over common land resources. Seeking to limit risks, the pastoral production system is based on flexible strategies which allow people to take advantage of the seasonal rangeland condition.

Community-imposed restriction of access to common lands is an important strategy which has played a crucial role in maintaining sustainable use of the available forage resources. One such rule forbids cutting premature wild grasses on communal lands. Such rules are so firm that they have become social lore. The community schedules the livestock movement in such a way that critical winter grazing lands are protected for the duration of the growing season. The key to this control is the '*Tohsom*' system. *Tohsom* literally means field-watcher. The *Tohsom* committee consists of a varying number of members depending on the size of the village and the lands under cultivation. Every year, before the onset of growing season, this committee is organized by the village committee and is automatically dissolved at the end of the growing season. Livestock must leave the village by the date set by the committee members. The livestock are thus pushed higher with the onset of the rains and the first green, thereby protecting forage around the village for the winter. This thus ensures rotational grazing between the high pastures located between 4,000 to 5,000 m and the fields around the villages (3,500 m), thereby maintaining the balance between existing, but scarce, resources in both high and low areas. Such complex, but flexible animal husbandry practices, which mediate the effects of grazing animals on the rangelands, have helped to maintain the equilibrium between livestock, landscape, and wildlife.

Such indigenous practices may explain the continued existence of large herds of blue sheep on high pastures in many areas of the Himalayas (see also Brower 1990, 1991; Furer-Haimendorf 1983). Also, the biomass of livestock in some parts of Manang Valley has been reported to be three times that of blue sheep (Jackson *et al.* 1994), suggesting unavoidable livestock depredation (Oli 1992; Ale 1994). At the same time, livestock may be helping to sustain the population of predators, such as the snow leopard, in the valley (Jackson *et al.* 1994).

Today traditional land-use patterns are constantly changing in the face of increasing economic, social, and political forces, thus clearly affecting the balance between resource users and the limited resources available. Trade and tourism are the two factors that have affected the traditional lifestyle of inhabitants of upper Manang. Their involvement in international trade affected their traditional lifestyle and subsistence occupations, particularly livestock husbandry, which in turn affected their ability to invest in the tourism industry. Contrary to the popular opinion that increasing prosperity leads to an increase in livestock holdings, these socioeconomic changes have led to a steady decline in livestock numbers. In 1994, the population estimate was only around 5,400 head of livestock (62% small ruminants) for the entire upper Manang Valley. Prior to the 1960s, Manang village alone had approximately 500 cattle and more than 3,000 sheep and goats. By 1996, sheep and goat numbers decreased by 25%. Yaks also declined in number by 1996 in comparison to the 1960 figure, for instance, Khangsar (500 vs. 100), Brahka (200 vs. none), Ghyaru/ Ngawal (200 vs. 80), and Manang (700 vs. 300). A change in livestock ownership pattern has also occurred. In the past many owned a few livestock; the present trend is for a few to own many livestock. Along with these changes has been a decline in importance of social systems such as the *Tohsom* practice in smaller villages such as Ghyaru and Pisang, although still functional in the larger villages such as Manang proper.

Research and Monitoring

No attempt has yet been made to collect any systematic data on the region's wildlife and other natural elements. An initial inventory of all the mammalian species in the region is a prerequisite if we are to address the relevant issues raised above. The ACAP has recently started a research and monitoring scheme in Manang Valley on rangeland condition and wildlife status to keep track of changes and their possible impacts on predator and prey population dynamics. The long-term goal of this research and monitoring aspect of the project is to support ACAP's database and thus help to conserve and manage the region's wildlife and the rangelands. The major objectives over the years are as follow.

- Monitor blue sheep numbers and snow leopard abundance
- Study the prey-predator relationship
- Conduct field experiments to study forage competition, behavioural interactions, and the various effects of grazing in different micro-habitats
- Monitor livestock number
- Examine trends in the vegetation composition and productivity of the rangelands

The research and monitoring work is designed as a joint venture between the ACAP and the Earthwatch project, USA. Experts from the University of Chicago at Illinois, USA, are involved in designing the project by means of which in-country expertise is being developed for the sustainability of the monitoring scheme.

Starting in 1999, an initial inventory of the mammalian species in the region was initiated with the Earthwatch Project. Since direct observation of larger species such as blue sheep and livestock (e.g., yak, cattle, sheep, and goats) in open valleys such as Manang is not a problem, the research team used direct visual observation (cf. Sinclair 1985, Fox *et al.* 1994). They also used standard indirect methods (trapping, sign search) for elusive species (e.g., snow leopard, rodent), followed by intensive visual observation for recording spatial distribution, habitat selection of blue sheep and livestock using categorical habitat types, and other behavioural patterns (e.g., vigilance). Future methods used to address the questions of competition will include assessments of habitat partitioning, resource partitioning, and behavioural patterns in various habitats. Although some visual techniques for food selection are possible, scientifically sound faecal/pellet analysis for both blue sheep and livestock will be done. This will also be done to see the diet composition, primarily of snow leopards, over the years (see Oli 1991). Grazing enclosures will also be constructed in places to document the influence of different domestic and/or wild species on vegetation productivity and composition. To study the behavioural interaction of predator-prey, we will conduct vigilance observations and manipulative foraging experiments for the prey community. This will require constant monitoring of blue sheep, livestock distribution through direct observation, and of snow leopards through indirect methods during the research period.

The preliminary 1999 Manang data revealed a mean density of 5.9 blue sheep per sq.km in a total study area of 61.2 sq.km, which is comparable to the figures from earlier studies (Fox and Ale, unpublished).

Previously, the ecosystem theory related to food chain dynamics suggested that carnivores generally regulate herbivores (Hairston *et al.* 1960). However, more recent revision of this theory (Oksanen *et al.* 1981) in relation to productivity of environments suggests that in areas of low productivity, the predator component may not be abundant enough to regulate herbivore populations. This leaves the natural system dominated by an essentially plant-herbivore (two link) trophic relationship (Fox 1995). Strong evidence for just such a two-way link relationship in low productivity areas has been provided by Messier (1995). Within the context of Manang Valley, the predator (snow leopard) may play a tracking, not a regulatory, role in ungulate (blue sheep) population dynamics, which would mean that the natural ecosystem of Manang could be a two-trophic system. Whether snow leopards regulate the prey population has yet to be addressed.

Over the past several decades, the livestock number in this valley has fluctuated (see above). The actual effects of these changes on the dynamics of the blue sheep, their habitat, and wild populations of snow leopard in the long run are important, and it is important to understand these in order to formulate proper policies for sustainable biodiversity conservation in the region. More extensive studies have been done in African ecosystems than anywhere else (Jarman 1974; Sinclair 1985; Sinclair and Arcese 1995). The basic ecological questions, such as range-use patterns by wild and domestic ungulates, selection of grazing habitats, and anti-predator behaviour addressed by the proposed project, will definitely enhance our understanding of the natural systems.

Multi-year data are expected to reveal patterns in wild and domestic animal population dynamics, allowing researchers to correlate fluctuations with predator abundance or other ecological parameters (e.g., rangeland quality), thus showing the status of the ecosystem in general. It will not be possible to include all species in management plans; management for biodiversity may be achieved by focusing on indicator species that can act as surrogates for the larger community. This strategy requires the monitoring of populations and development of long-term habitat suitability indices for species that are known to be sensitive to stresses like habitat fragmentation, overgrazing, or other kinds of degradation (Meffe and Carroll 1994, Morrison *et al*. 1992). Selecting indicator species is a difficult task because the population dynamics of the indicator species chosen is usually 'noisy'. For example, long-lived species may persist in altered or sink habitats for decades but not reproduce, thus falsely indicating habitat quality. The population of indicator species should be relatively easy to observe and monitor to track the species' population dynamics. An animal with the ideal combination of characteristics may be hard to find. Given the constraints, I suggest that blue sheep may be a possible indicator species for the trans-Himalayan ecosystem. This choice is mainly based on the fact that they are relatively large and conspicuous and hence their population dynamics can be examined in detail without much difficulty.

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Grasslands in the Damodar Kunda Region of Upper Mustang, Nepal

Rita Arjel Koirala
Tribhuvan University, Nepal
Rinjan Shrestha
King Mahendra Trust for Nature Conservation, Nepal
and Per Wegge
Department of Biology and Nature Conservation, Agricultural University of Norway

Abstract

This study was carried out in a 117 sq.km area in the Damodar Kunda region of upper Mustang in Nepal during the summer of 1996. Stratified quadrat sampling was used to describe the floristic composition of five vegetation types distributed in three different zones inhabited almost exclusively by three different herbivores, the Tibetan argali (*Ovis ammon hodgsonii*), the naur or blue sheep (*Pseudois nayaur*), and the domestic goat (*Capra hircus*).

The spatial arrangement, species' composition, and relative coverage of the five vegetation types varied with landscape pattern, aspect, and altitude. Dry Grassland was distributed in all three habitat zones. Lonicera Community and Wet Meadow vegetation types were found in both the naur and goat zones. Desert Steppe and Dry Meadow were restricted to the argali zone.

Forage availability and species' richness were lowest in the argali zone, situated between 5,140 and 5,250 masl, and graminoids were more abundant than forbs—with *Saussurea graminifolia* the most abundant species of the latter . The naur zone, between 4,950 and 5,050 masl, was richest in forage with graminoids the most abundant forage category, although the shrub *Potentilla fruticosa* was the most abundant species. The goat zone, between 4,800 and 4,900 masl, was moderately rich in forage and the richest in terms of species . The most abundant forage category here was shrubs, particularly the species *Lonicera rupicola*. Because the three ungulates were spatially separated with distinct differences in summer diet (Koirala and Shrestha 1997), resource competition is probably minimal during summer at current animal densities. Domestic stock grazing by goats could probably be increased without negative effects on the rare and endangered Tibetan argali, provided animals are only herded within the Namta watershed. Domestic stock grazing should not be extended into the Tehchang watershed of the argali zone until the seasonal habitats of Tibetan argali are better known, as increased summer grazing by goats might have a negative effect on the winter pastures of this wild sheep species.

Introduction

More than 48% of the land area in the Himalayan region of Nepal along its northern border with Tibet is occupied by natural grassland vegetation (LRMP

1986). Himalayan region grasslands are complex with a mosaic of vegetation communities along a steep altitudinal gradient combined with a myriad of topographical features. The region thus has a comparative ecological advantage over the plains by providing habitats for a unique assemblage of large wild ungulates (Schaller 1977). Naur (or blue sheep)-*Pseudois nayaur*- and argali, *Ovis ammon hodgsonii,* are the main wild ungulates in these grasslands (Schaller 1977; Miller 1993; Jackson *et al.* 1994; Wegge and Oli 1997).

The grasslands not only support a large number of plant and animal species, they also provide a livelihood for mountain people. Because they are low in primary production, they are generally unsuitable for growing crops. Hence, livestock grazing presents the only way at present to convert primary production to secondary products, such as meat and milk products, and non-food products, such as fibre, hide, and manure - all important products for the subsistence livelihood in this region (Miller 1993, 1995).

So far, only a few studies have been carried out in this part of the country (Richard 1994, Ale 1993). Information on the floristic composition and other habitat features is a prerequisite for land-use planning and management. The study described here was carried out in the Damodar Kunda region of Upper Mustang, near the Tibetan Autonomous Region (TAR) of China. The objectives of the study were to describe and compare the different plant communities in and the habitats used by three coexisting ungulates: two wild ungulates - the rare Tibetan argali and the more common naur - and domestic goats.

Study Area

The Damodar Kunda region of upper Mustang is located in the north-eastern part of Mustang District at an altitudinal range of 4,700m to 5,900m (Figure 3). It is bordered by the TAR of China to the north and east and by peaks reaching more than 6,000m in altitude to the south and west. The study area covered approximately 117 sq.km.

The Damodar Kunda is regarded as a highly sacred site by both Hindus and Buddhists. The area is traversed by the Techang and Namta rivers, the latter being one of the headwaters of the Kali Gandaki River. The landscape in the north of Techang is open, undulating, gently sloped terrain with interspersed round-topped hills, small lakes, and gullies, whereas the terrain in the south of the Namta is more rugged and precipitous.

The climate is controlled by the rain shadow effect created by the Himalayas. The general physiognomy can be described as high elevation cold desert (Ojha 1986; Brown 1982), similar to that of the Tibetan Plateau (Miller 1994). Total annual rainfall is less than 200 mm and more than half of the total precipitation occurs as snow during the winter. The minimum temperature remains below zero from early October to the middle of April. The snow and frozen land start to thaw at the beginning of April.

In general, the vegetation represents high altitude grasslands that are Tibetan in character (Stainton 1972). Plant cover is sparse, with a clear gradient related to substrate moisture. Plant communities vary from xeric to mesic type depending

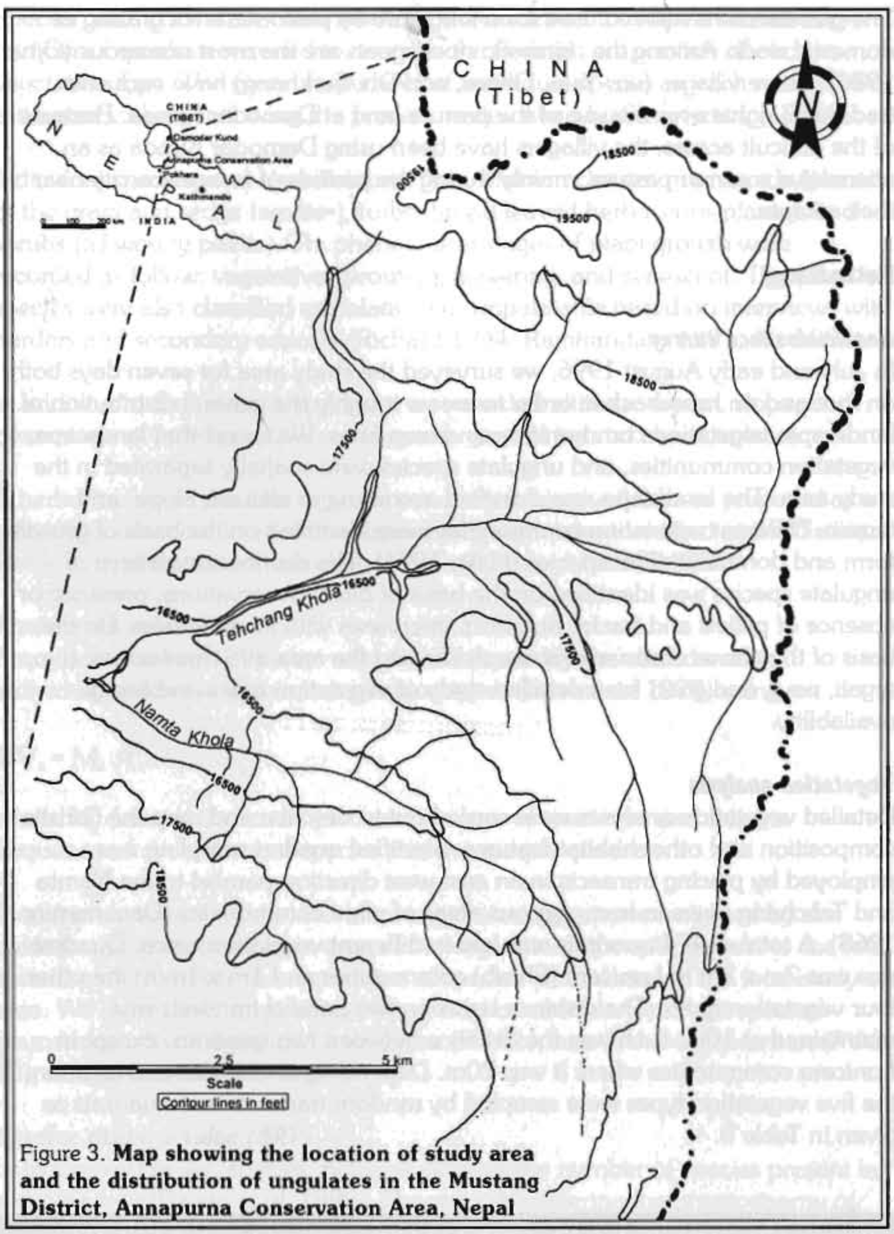

Figure 3. **Map showing the location of study area and the distribution of ungulates in the Mustang District, Annapurna Conservation Area, Nepal**

upon the micro-climate. This has led to the formation of five distinct plant communities in the study area.

The Damodar Kunda region is an important area of faunal diversity. Wolf (*Canis lupus*), snow leopard (*Uncia uncia*), and brown bear (*Ursus arctos*) have been reported (BCDP 1994), and the Tibetan lynx (*Felis lynx isobellina*) and red fox (*Vulpes vulpes*) are also suspected to exist. Naur and argali are the only wild ungulates known to the area (Koirala and Shrestha 1997). Other mammalian species include marmot (*Marmoota himalayana*), pika (*Ochotona* sp.), and woolly hare (*Lepus sp.*).

The grasslands have been used for a long time by pastoralists for grazing of domestic stock. Among the domestic stock, goats are the most numerous (Ojha 1986). Three villages (viz. Yara, Ghara, and Dhi/Surkhang) have exclusive traditional rights over the use of the pasture land at Damodar Kunda. Because of the difficult access, the villagers have been using Damodar Kunda as an alternative summer pasture, mainly during the periods of forage scarcity near their villages.

Methodology

Reconnaissance survey

In July and early August 1996, we surveyed the study area for seven days both on foot and on horseback in order to assess roughly the general distribution of landscape, vegetation communities, and ungulates. We found that landscape, vegetation communities, and ungulate species were spatially separated in the study area. The landscape was classified according to altitude, slope, and terrain. Different vegetation communities were identified on the basis of growth-form and dominant plant species (Miller 1994). The distribution pattern of ungulate species was identified on the basis of direct observations, presence or absence of pellets and tracks, and from interviews with local herders. On the basis of the above observations, we delineated the area into three zones (i.e., argali, naur, and goat) for a detailed study of vegetation types and forage availability.

Vegetation analysis

Detailed vegetation analyses were carried out to describe and map the floristic composition and other habitat features. Stratified quadrat sampling was employed by placing transects in an east-west direction parallel to the Namta and Tehchang rivers in homogenous areas of plant communities (Daubenmire 1968). A total of 474 quadrats was laid in different vegetation types. Quadrat size was 2m x 2m in *Lonicera* (Shrub) communities and 1m x 1m in the other four vegetation types. The distance between two parallel transects was maintained at 10m, such was the distance between two quadrats, except in *Lonicera* communities where it was 20m. Depending on the size and location, the five vegetation types were sampled by random transacts and quadrats as given in Table 5.

Table 5. **The distribution of transects and quadrats in the different vegetation types present in three ungulate zones**

Vegetation Types	Goat zone		Naur zone		Argali zone		Total / vegetation type	
	N	T	N	T	N	T	N	T
Lonicera Community	60	(3)	25	(2)	A		85	(5)
Wet Meadow	60	(12)	10	(2)	A		70	(14)
Dry Grassland	60	(6)	92	(12)	20	(2)	172	(20)
Dessert Steppe	A		A		120	(10)	100	(10)
Dry Meadow	A		A		27	(6)	27	(6)
Total sample / zone	120	(21)	127	(16)	167	(18)	N=474	(55)

N = total number of quadrats, T = total number of transects, and A = absent

Species' area curves (Daubenmire 1968) were drawn to check the minimum number of quadrats required to describe the floristic composition of each vegetation type. The percentage cover of individual species in each quadrat was estimated visually following the procedure described by Smart *et al.* (1976).

Individual species were classified into three lifeform classes: graminoids (plants of the grass and sedge families), forbs (broad leaved herbaceous plants), and shrubs (all woody plants). Thephenological stages of plant growth were recorded as follow: vegetative/sprouting, flowering, and senescent. The plant species were also classified as palatable or unpalatable based on interviews with herders and secondary sources (Richard 1994; Rajbhandary 1991; Ale 1993).

In addition to the vegetation survey, we recorded altitude, aspect, slope, and percentage of bare ground/scree to assess general habitat characteristics.

A herbarium of all the plant species encountered in the field was prepared as a reference collection. Unidentified specimens were later identified at the National Herbarium in Kathmandu and by the range ecologist at ICIMOD.

Prominence value (PV)

Prominence values (PV) were calculated to quantify the abundance of individual species in different vegetation types (Dinerstein 1979) using

$$PV_x = M_x \sqrt{f_x}$$

where M_x denotes the mean percentage cover of species *x*, and f_x is the frequency of occurrence of species *x* in the sample quadrats.

Prominence values within individual vegetation types were weighted by the corresponding proportionate area of the vegetation type with respect to the total area in order to obtain an expression of species' abundance in the total study area. We estimated forage availability based on abundance. Plant species' abundance was categorised as very rare (PV<1), rare (PV 1-5), common (PV 5-40), and abundant (PV>40).

Species richness value (SRV)

In its simplest sense, species' richness denotes the number of species present in a community (Begon *et al.* 1996). However, considering the physiognomy of the study area, we calculated the species' richness value by weighting the total number of species present with the corresponding proportionate area of the vegetation community as shown by the following equation:

$$SRV_a = \sum_{i=1}^{s} N_i \times A_i$$

where SRV_a is the species' richness value for habitat *a*; N_i is the total number of species in vegetation community *i*; A_i is the proportionate area of vegetation community *i* with respect to the total area of habitat *a*, and *s* is the total number of vegetation communities.

Results and Discussion

The three zones differed in landscape pattern, spatial arrangement of vegetation types, and distribution of ungulates (Figure 4). The southern side of the Namta River was mostly covered by steep topography and inhabited by naur, while the argali were found in the more flat and open terrain on the northern side of the Tehchang River. The goats were herded along the northern side of Namta River where the topography was moderate and vegetation was luxuriant. The naur and goat habitats in Namta Valley shared many landform characteristics except aspect. Both differed clearly from the argali habitat. Table 6 illustrates the general habitat characteristics of the three ungulate species.

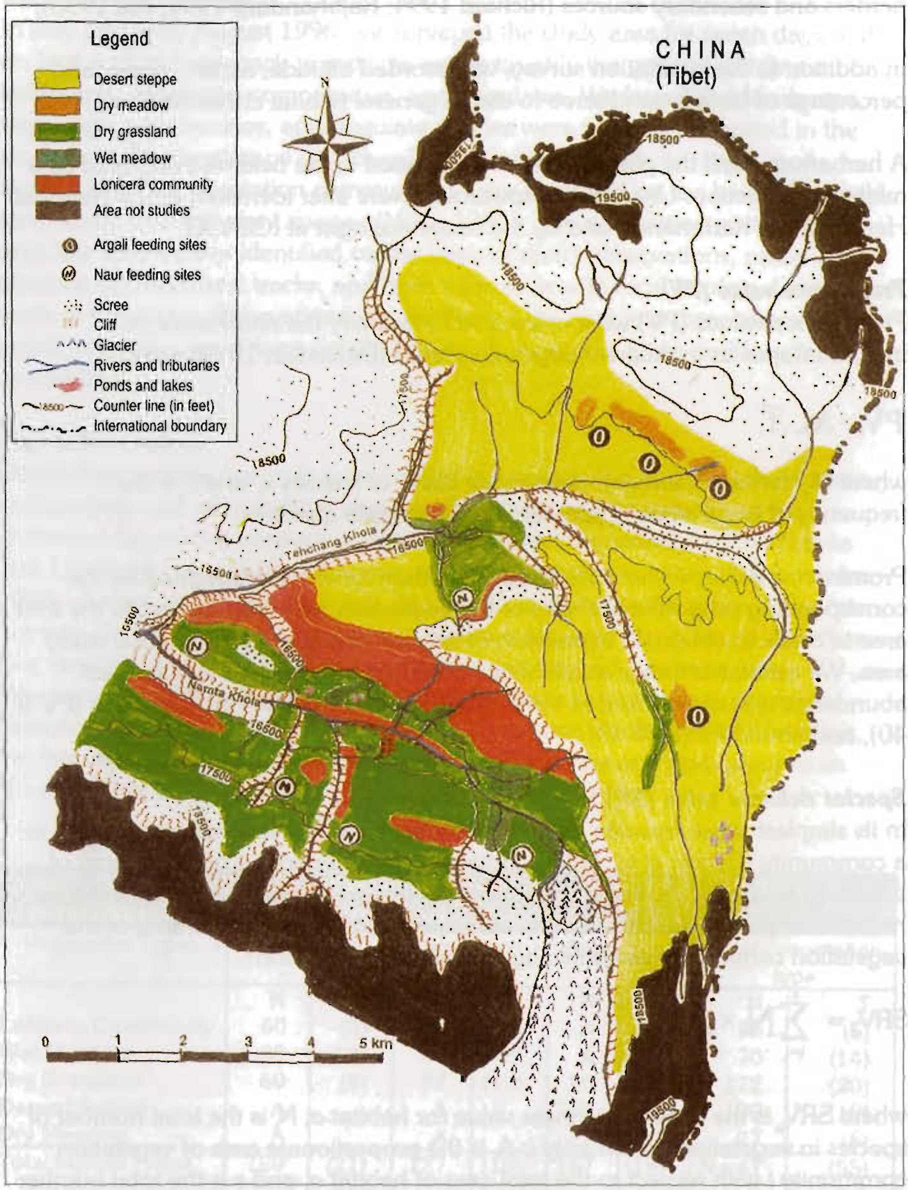

Figure 4. **Map of the study area showing vegetation types, feeding sites and other habitat features of the ungulates**

Table 6. **General habitat features of the argali, naur, and goat zones in the study area**

Features	Argali zone	Naur zone	Goat zone
Ungulate species	Argali	Naur	Goat
Approximate area (sq.km)	81.8	33.2	13.0
Altitude (m)	5140-5270	4950-5050	4800-4900
Aspect	SW	NE	SW
Slope (degrees)	0-5	5-45	5-25
*Bare ground coverage	69%	27%	37%
Total plant species	33	56	57
Vegetation type	Desert Steppe (90%) Dry Meadow (5%) Dry Grassland (5%)	Dry Grassland (70%) Lonicera Comm. (25%) Wet Meadow (5%)	Dry Grassland (30%) Lonicera Comm. (60%) Wet Meadow (10%)
*Ecological density/sq.km	1.3	5.5	30.1
**Crude density/sq.km.	0.9	1.6	3.3

* Based on vegetation quadrats, which did not include the completely unvegetated scree
** Rough estimates as no systematic population censuses were carried out

The Argali Zone

The argali zone was situated at the highest altitudinal range (5,140-5,250m). It covered approximately 88.9 sq.km or 70% of the study area. The general topography was flat and open. Scree covered more than half of the zone. The major drainage was formed by the Tehchang River. Vegetation cover was very low (ca 30%) and the bare ground coverage would have been higher if unvegetated scree had been included (Figure 4). The zone contained three vegetation types in which a total of 33 plant species was recorded: Desert Steppe, Dry Meadow, and Dry Grassland.

Desert Steppe—Desert Steppe was the most extensive vegetation type, covering almost 90% of the area of the argali zone. Bare ground coverage was >70%, the highest among the three vegetation types (Table 7). We identified a total of 18 different species: 6 graminoids, 11 forbs, and one shrub. Forbs and graminoids dominated the vegetation with the forb *Saussurea graminifolia* as the most abundant species. *Kobresia pygmea*, *Kobresia* sp., and *Carex ustulata* were common graminoids. *Potentilla fruticosa* was the only shrub found in this community.

Dry Meadow—Dry Meadow vegetation was patchily distributed and located in relatively moist pockets within the Desert Steppe type; covered only 5% of the area of the argali zone. Bare ground coverage (49%) was lower than that of Desert Steppe.The vegetation type contained a total of 25 species: 6 graminoids, 18 forbs, and 1 shrub. Graminoids dominated the vegetation (Table 7). The most abundant species in Dry Meadow was the graminoid *Kobresia pygmea* followed by the shrub *Potentilla fruticosa*. Common forbs were *Saussurea graminifolia* and *Arenaria glanduligera*.

Dry Grassland—Dry Grassland was distributed patchily along the banks of the Tehchang River and its south-east tributaries (Figure 4). This vegetation type covered approximately 5% of the area of the argali zone, and had nearly 50%

Table 7. **Argali zone - Mean Coverage (c%), Frequency (f) and Prominence Values (PV) of the three most abundant species within each lifeform category in each vegetation type. The approximate proportionate area (A) of each vegetation type is shown in parentheses**

Species	Desert Steppe (A=90%)			Dry Meadow (A=5%)			Dry Grassland (A=5%)			Total PV*
	c %	f	PV	c %	f	PV	c %	f	PV	
Graminoids	12.7	-	106.0	28.3	-	228.1	33.1	-	317.1	122.7
Kobresia pygmea	4.2	70	35.1	14.5	78.2	128.2	-	-	-	38.0
Kobresia sp.	3.5	74	29.9	5.0	57.5	38.0	-	-	-	28.8
Carex ustulata	3.0	89	28.1	-	-	-	-	-	-	25.8
Stipa sp.	-	-	-	4.1	55.0	30.1	18.4	100	183.8	21.3
Carex sp.	-	-	-	-	-	-	9.3	100	92.5	4.6
Agrostis sp.	-	-	-	-	-	-	2.9	65	23.2	2.9
Other graminoids	2.0	69	12.9	4.7	138.6	31.9	2.5	50	17.7	-
Forbs	13.2	-	107.0	10.4	-	58.5	6.8	-	41.6	101.3
Saussurea graminifolia	4.4	91	42.0	2.2	49.6	15.4	-	-	-	38.5
Arenaria glanduligera	4.0	93	38.1	1.3	53.9	9.9	-	-	-	34.8
Saxifraga hemispherica	1.7	59	13.3	-	-	-	-	-	-	12.2
Saussurea eriostemon	-	-	-	-	-	-	1.4	55	10.2	1.7
Sedum sp.	-	-	-	1.1	42.9	7.0	-	-	-	1.0
Dracocephalum heterophyllum	-	-	-	-	-	-	2.0	55	14.8	0.7
Potentilla anserina	-	-	-	-	-	-	1.0	40	6.3	0.3
Other forbs	3.1	108	13.7	5.8	220.0	26.2	2.4	95	10.2	-
Shrubs	2.8	-	22.2	12.8	-	124.5	11.1	-	86.2	30.5
Potentilla fruticosa	2.8	65	22.2	12.8	95.0	124.5	11.1	60	86.2	30.5
Mean vegetation cover	29%	-	-	52%	-	-	51%	-	-	-
Mean bare ground	71%	-	-	48%	-	-	49%	-	-	-

*Weighted on the basis of proportionate area of each vegetation type.

bare ground. A total of 14 plant species was recorded, consisting of 4 graminoids, 9 forbs, and 1 shrub. Vegetation composition was dominated strongly by graminoids, particularly by *Stipa* sp. Other abundant species were *Carex* sp. and *Potentilla fruticosa*. Among the forbs, *Dracocephalum heterophyllum* and *Saussurea eriostemon* were the common species. We could not find *Saussurea graminifolia*, *Arenaria glanduligera*, or *Kobresia pygmea*, the most common species of Desert Steppe and Dry Meadow, in this type of grassland.

Forage Availability—*Saussurea graminifolia* (total PV = 38.5) and *Kobresia pygmea* (total PV = 38.0) were the most available plants at the species' level (Table 7). The former was more abundant in Desert Steppe than in Dry Meadow, whereas *Kobresia pygmea* had the highest prominence value in Dry Meadow. *Potentilla fruticosa* (Total PV = 30.5) was the only available woody species in the habitat.

The most available forage category at the life form level graminoids (total PV = 122.7), followed by the forbs (total PV = 101.3), and shrubs (total PV = 30.5) (Table 7). But the availability of each category varied with vegetation type: both graminoids and forbs were almost equally available in Desert Steppe, whereas graminoids were more available than forbs in Dry Meadow and Dry Grassland (Figure 5).

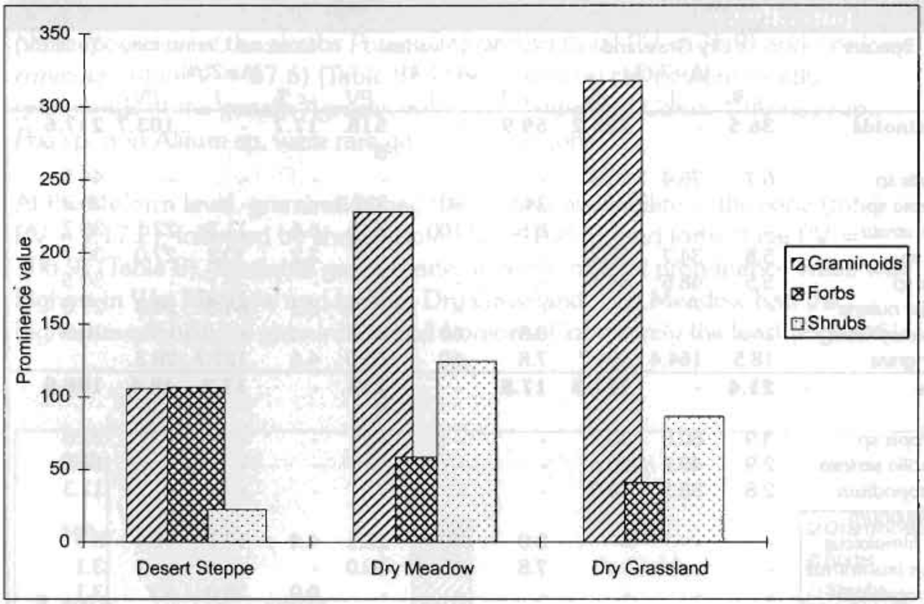

Figure 5. **Composition of available vegetation by lifeform in the different vegetation types in the argali zone**

Species' Richness Value (SRV)—SRV was highest in Desert Steppe (SRV=18.2) followed by Dry Meadow (SRV=1.3) and Dry Grassland (SRV=0.8). The total Species' Richness Value was the lowest (SRV=18.2) among the three zones.

The Naur Zone

The naur zone was located on the south side of the Namta River at a lower altitude (4,950-5,050m) than the argali zone (Figure 4). It covered approximately 28% of the study area and had a more rugged topography than the argali zone. Vegetation was more patchily distributed, with a bare ground coverage of 27%, the lowest among the three zones. The naur zone comprised three vegetation types in which a total of 56 plant species was recorded.

Dry Grassland—Dry Grassland was the dominant vegetation type, covering approximately 70% of the zone. It was more or less continuously distributed in the habitat with little more than 30% bare ground (Table 8). We identified 47 species: 10 graminoids, 33 forbs, and 4 shrubs. Although graminoids dominated the vegetation, the shrub *Potentilla fruticosa* was the most abundant plant species. Graminoids, such as *Agrostis* sp., *Carex* spp., and *Stipa* sp., and the forbs *Oxytropis* sp., *Leontopodium himalayanum*, and *Potentilla serecia* were also common plant species.

Table 8. **Naur Zone: Mean coverage (c%), frequency (f) and prominence values (PV) of the three most abundant plant species within each lifeform category in each vegetation type. The approximate proportionate area (A) of each vegetation type is shown in parentheses**

Species	Dry Grassland (A=70%)			Wet Meadow (A=5%)			Lonicera Community (A=25%)			Total PV*
	c %	f	PV	c %	f	PV	c %	f	PV	
Graminoids	**36.5**	**-**	**236.2**	**59.9**	**-**	**518.5**	**17.7**	**-**	**103.7**	**217.6**
Agrostis sp.	6.7	76.4	58.8	-	-	-	-	-	--	44.5
Kobresia sp.	-	-	-	34.5	90	327.3	-	-	-	36.3
Carex atrata	-	-	-	8.8	100	87.5	6.6	11.3	22.1	30.7
Stipa sp.	5.8	34.7	34.2	-	-	-	3.2	70.2	27.0	30.7
Carex sp.	5.5	48.6	38.4	-	-	-	-	-	-	30.5
Elymus nutans	-	-	-	-	-	-	3.3	64.8	26.3	27.6
Kobresia filicina	-	-	-	8.8	60	67.8	-	-	-	10.5
Other grass	18.5	164.4	104.7	7.8	60	36.0	4.6	127.7	28.3	
Forbs	**21.4**	**-**	**121.3**	**17.8**	**-**	**198.9**	**-**	**11.3**	**48.4**	**106.9**
Oxytropis sp.	3.9	60.0	30.2	-	-	-	-	-	-	21.6
Potentilla sericea	2.9	49.2	20.3	-	-	-	-	-	-	14.5
Leontopodium himalayanum	2.8	33.1	16.0	-	-	-	-	-	-	11.3
Aster himalaicus	-	-	-	3.0	70	25.1	4.4	17.7	18.4	5.9
Juncus leucanthus	-	-	-	7.8	60	60.0	-	-	-	3.1
Dracocephalum heterophyllum	-	-	-	-	-	-	0.9	38.0	5.7	3.1
Ranunculus chaerophyllus	-	-	-	7.0	40	44.3	-	-	-	2.2
Artemisia sp.	-	-	-	-	-	-	1.2	50.7	8.8	2.2
Other forbs	11.8	314.7	54.8	12.0	330	69.4	4.8	150.1	15.6	-
Shrubs	**11.2**	**-**	**95.9**	**2.3**	**-**	**14.2**	**49.8**	**-**	**403.3**	**168.6**
Potentilla fruticosa	11.0	75.0	95.6	2.3	40	14.2	5.8	41.0	37.3	76.9
Lonicera rupicola	0.2	3.1	0.3	-	-	-	28.6	88.7	269.5	67.6
Hippophae tibetana	-	-	-	-	-	-	13.2	49.3	92.6	23.2
Cotoneaster sp.	-	-	-	-	-	-	2.2	2.5	3.5	0.9
Mean vegetation cover	69%	-	-	92%	-	-	79%	-	-	-
Mean bare ground	31%	-	-	8%	-	-	21%	-	-	-

* Weighted on the basis of proportionate area of each vegetation type.

Lonicera Community—Lonicera Community type vegetation had a patchy distribution. It covered approximately 25% of the area with 79% vegetation cover (Table 8). A total of 28 species was recorded: 7 graminoids, 17 forbs, and 4 shrubs. Shrubs dominated the vegetation with *Lonicera rupicola* as the most abundant species followed by *Hippophae tibetana*. Among graminoids, *Stipa* sp. and *Elymus nutans* were the most common species.

Wet Meadow—Wet Meadow vegetation was found along rivulets in poorly drained pockets; it constituted only 5% of the zone (Table 8). Within the community, vegetation cover was more than 90%. It was characterised by a thick sod layer and dominated by sedges. A total of 21 plant species was recorded: 6 graminoids, 14 forbs, and one shrub. The vegetation was dominated by graminoids. *Kobresia* sp. was the most abundant species followed by other *Carex* sp. and the forbs *Juncus leucanthus* and *Ranunculus chaerophyllus*.

Forage availability

Although the naur zone was dominated by Dry Grassland, the most abundant plant species were the shrubs *Potentilla fruticosa* (total PV = 76.9) and *Lonicera rupicola* (total PV = 67.6) (Table 8). Other common plants were mostly graminoids of the genera *Agrostis*, *Kobresia.*, *Stipa* and *Carex*. *Chesneya* sp., *Poa* sp. and *Allium* sp. were rare genera in this zone.

At the lifeform level, graminoids had the highest availability in the zone (total PV = 217.2), followed by shrubs (total PV = 168.6), and forbs (total PV = 106.9) (Table 8). Available green matter in terms of total prominence value was highest in Wet Meadow and least in Dry Grassland. Wet Meadow had the highest availability of graminoids and Lonicera Community the least (Figure 6).

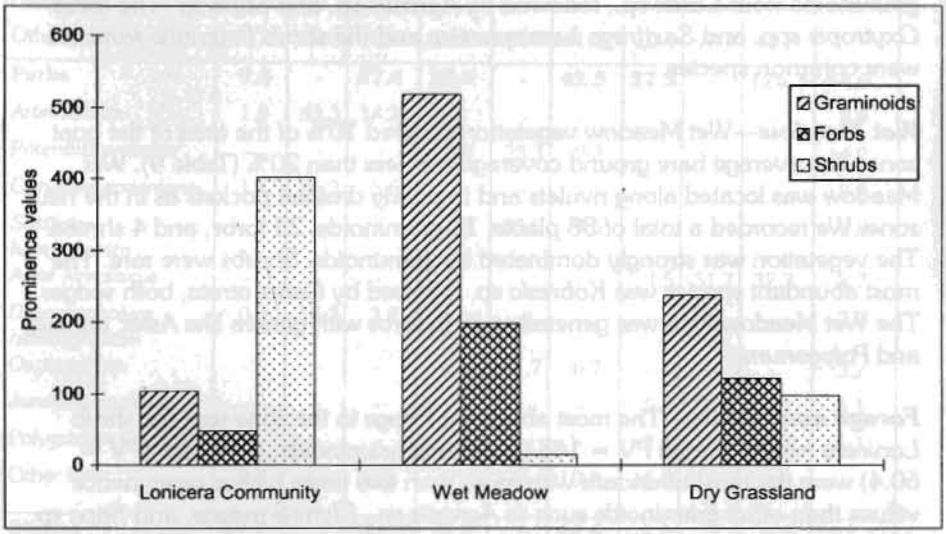

Figure 6. **Composition of available vegetation by lifeform in the different vegetation types in the naur zone**

Species' Richness Value (SRV)—Among the three zones, the naur zone had the highest species' richness (SRV=40.1). Among the vegetation types, SRV was highest in Dry Grassland (SRV=32.9) followed by Lonicera Community (SRV=7) and Wet Meadow (SRV=1.1).

The goat zone

The goat zone was located along the north side of Namta River and had a moderate topography and luxuriant vegetation. It was the smallest zone in terms of area (approximately 13.0 sq.km or 11% of the study area) and lay between 4,800 and 4,900m. The zone was drained by the Namta River and its northern tributaries. The slope ranged between 5 and 25°. Total bare ground (37%) was higher than in the naur zone, but less than in the argali zone. The goat zone contained three vegetation types, dominated by Lonicera Community which formed a continuous belt along the Namta River (Figure 4). A total of 57 plant species was recorded in this zone.

Lonicera Community—This was the dominant vegetation type and covered almost 70% of the total goat zone. It had a continuous distribution on the southern aspect of Namta Valley along the river and half way up the slopes. We recorded a total of 34 plants: 7 graminoids, 22 forbs, and 5 shrubs. Shrubs strongly dominated the vegetation composition. *Lonicera rupicola* was the most abundant species followed by *Caragana brevifolia* (Table 9).

Dry Grassland—Dry Grassland vegetation was found in saddle-like basins and on less steep slopes (<15°). It covered approximately 30% of the zone and had a little over 35% bare ground. A total of 42 plants was recorded: 9 graminoids, 29 forbs, and 4 shrubs. PVs of graminoids were more than eight times higher than those of forbs or shrubs (Table 9). The most abundant graminoids were *Carex* sp., followed by *Agrostis* sp. and *Stipa* sp. The forbs *Oxytropis* spp. and *Saxifraga hemispherica* and the shrub *Potentilla fruticosa* were common species.

Wet Meadow—Wet Meadow vegetation covered 10% of the area of the goat zone. The average bare ground coverage was less than 20% (Table 9). Wet Meadow was located along rivulets and in poorly drained pockets as in the naur zone. We recorded a total of 38 plants: 11 graminoids, 23 forbs, and 4 shrubs. The vegetation was strongly dominated by graminoids. Shrubs were rare. The most abundant species was *Kobresia* sp. followed by *Carex atrata*, both sedges. The Wet Meadow type was generally rich in forbs with genera like *Aster, Juncus*, and *Polygonum*.

Forage availability—The most abundant forage in the zone was the shrub *Lonicera rupicola* (total PV = 148.0). Among graminoids, *Carex sp.* (PV = 60.4) were the most abundant with more than two times higher prominence values than other graminoids such as *Agrostis* sp., *Elymus nutans*, and *Stipa* sp. (Table 9). *Chesneya* sp., *Kobresia filicina*, and *Poa sp.* were rare plants in the zone and had very low total prominence values.

At the life form level, shrubs (total PV = 223.1) were the most available and forbs (Total PV = 54.0) the least available forage categories. Availability of shrubs in Wet Meadow was negligible (Figure 7).

Species' Richness Value (SRV)—The Species' Richness Value for the zone was 36.8. It was highest in Lonicera Community (SRV=20.4) followed by Wet Meadow (SRV=3.8) and Dry Grassland (SRV=12.6).

Comparison of the three zones

Vegetation types—Of the five different vegetation communities, only Dry Grassland was present in all three zones (Table 6). Desert Steppe and Dry Meadow vegetation types were only found in the argali zone, whereas Wet Meadow and Lonicera types were found in both the naur and goat zones.

Table 9. **Goat zone: Mean coverage (c%)Frequency (f) and Prominence Value (PV) of the three most abundant plant species within each lifeform in each vegetation type. The approximate proportionate area (A) of each vegetation type is shown in parentheses**

Species	Lonicera Community (A=60%)			Dry Grassland (A=30%)			Wet Meadow (A=10%)			Total PV*
	c %	f	PV	c %	f	PV	c %	f	PV	
Graminoids	**7.6**	-	**53.0**	**45.6**	-	**353.3**	**55**	-	**398.3**	**177.6**
Carex sp.	-	-	-	19.2	93.3	185.2	-	-	-	60.4
Agrostis sp.	2.1	68.3	17.6	7.2	70.0	60.0	-	-	-	30.5
Elymus nutans	2.2	55.0	16.4	-	-	-	-	-	-	21.3
Stipa sp.	1.6	40.0	10.3	7.0	45.0	47.0	-	-	-	20.3
Kobresia sp.	-	-	-	-	-	-	22.0	71.7	186.2	19.1
Carex atrata	-	-	-	-	-	-	13.6	65.0	109.5	11.0
Carex ustulata	-	-	-	-	-	-	9.0	43.3	59.2	5.9
Other graminoids	1.7	50.0	8.8	12.2	80.0	61.2	10.4	78.3	43.3	-
Forbs	**9.6**	-	**47.4**	**10.0**	-	**42.9**	**27.3**	-	**126.3**	**54.0**
Artemisia sp.	1.8	63.3	14.3	-	-	-	-	-	-	8.9
Potentilla anserina	-	-	-	1.8	28.3	9.3	-	-	-	4.2
Corydalis govaniana	1.1	26.7	5.6	-	-	-	-	--	-	3.8
Saxifraga hemispherica	-	-	-	1.3	35.0	7.6	-	-	-	3.8
Aster himalaicus	-	-	-	-	-	-	4.5	51.7	32.3	3.7
Dracocephalum heterophyllum	0.9	18.3	3.7	-	-	-	-	-	-	3.2
Oxytropis sp.	-	-	-	1.0	41.7	6.7	-	-	-	3.2
Juncus leucanthus	-	-	-	-	-	-	5.3	35.0	31.1	3.1
Polygonum sibiricum	-	-	-	-	-	-	2.2	23.3	10.7	1.1
Other forbs	5.8	233.3	23.8	5.9	178.3	19.2	15.3	213.3	52.8	-
Shrubs	**42.2**	-	**348.7**	**8.3**	-	**44.8**	**1.3**	-	**4.3**	**223.1**
Lonicera rupicola	26.7	85.0	246.2	0.3	5.0	0.7	0.0	1.7	0.1	148.0
Caragana brevifolia	11.5	51.7	82.7	1.2	13.3	4.3	0.1	5.0	0.3	50.9
Potentilla fruticosa	1.8	25.0	9.2	5.0	45.0	33.3	0.1	3.3	0.2	15.5
Hippophae tibetana	2.2	23.3	10.7	1.8	13.3	6.5	1.1	11.7	3.8	8.7
Mean vegetation cover	72%	-	-	74%	-	-	84%	-	-	-
Mean bare ground	28%	-	-	26%	-	-	16%	-	-	-

* Weighted on the basis of proportionate area of each vegetation type.

Phenology—In all three zones, most of the plants were at the flowering stage (70% in the argali and naur zones and 63.2% in the goat zone). Some plants (up to 19%) were in the early growing stage and a few grass species (>15%) were already in senescence.

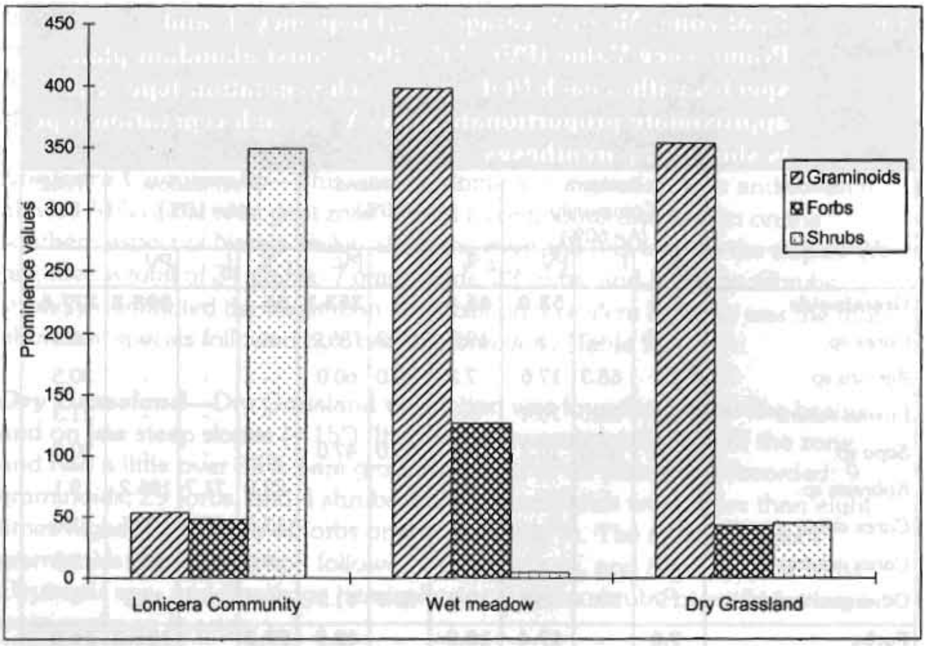

Figure 7. **Composition of available vegetation by lifeform in the different vegetation types in the goat zone**

Palatability—Only two unpalatable species, *Meconopsis horridula* and *Carex sp.*, were recorded in the argali zone. Important palatable species widely distributed in the argali zone included *Kobresia pygmea, Kobresia* sp., *Saussuaria graminifolia, Stipa,* and *Elymus nutans.*

The unpalatable species in the naur zone included such species as *Cotoneaster, Primula, Anaphalis contorta, Carex* sp., *Bistorta,* and *Meconopsis horridula*. The common palatable species recorded in this zone were *Kobresia* sp., *Stipa* spp., and *Lonicera rupicola.*

Unpalatable species were common in the goat zone. Notable among them were *Caragana, Primula, Anaphalis contorta, Carex* sp., *Bistorta, Elsholtzia eryostyachia,* and *Meconopsis horridula,* among which *Caragana* was the most abundant. The common palatable plants in the goat zone were *Lonicera rupicola, Stipa, Kobresia,* and *Elymus nutans.*

Species' Richness Value (SRV)

We recorded a total of 33, 56, and 57 plant species in the argali, naur, and goat zones, respectively. Hence, species' richness in terms of total number of species was higher in the goat and naur zones than in the argali zone.

The Dry Grassland in the naur and goat zones had three times more species (47 and 42 species respectively) than the Dry Grassland of the argali zone (14 species). Lonicera Community and Wet Meadow had more species in the goat zone than in the naur zone. Within the argali zone, Dry Meadow (25 species) was the most and Dry Grassland (14 species) the least species-rich vegetation types

When species' richness was adjusted to the proportionate area of vegetation types, SRV was found to be highest in the naur zone (SRV=40.1) and lowest in the argali zone (SRV=18.2). A closer look at the vegetation types in the individual zones revealed that the Dry Grassland (SRV=32.9) of the naur zone, Lonicera Community (SRV=20.4) of the goat zone, and Desert Steppe (SRV=18.2) of the argali zone had the highest species' richness values.

Forage availability

Total available forage was lowest in the argali zone (total PV=254.0) and highest in the naur zone (total PV=493.1) (Table 10). Both graminoids (total PV=217.6) and forbs (total PV=168.6) were most available in the naur zone, whereas shrubs (total PV=223.1) were most available in the goat zone. Thus, the argali zone, which covered the largest area, was poorest in total available forage.

Table 10. **Total prominence values of plant species by lifeform in each ungulate zone calculated using weighted averages of all vegetation types with the amount of barren ground included in the estimates**

Life form	Argali zone	Naur zone	Goat zone
Graminoids	122.7	217.6	177.6
Forbs	101.3	106.9	54.0
Shrubs	30.0	168.6	223.1
Total	254.0	493.1	454.7

Conclusion

The argali zone, at the highest altitude among the three habitat zones, was marginal in terms of available forage with highest bare ground coverage (69%). Vegetation was almost equally dominated by forbs and graminoids. Of the 33 different plant species recorded in the zone, only 9 species were common (PV>5)—the other 24 species were rare. The forb *Saussurea graminifolia* was the most abundant species.

The naur zone was found mainly on moderate to steep slopes with a northern aspect near scree and rock outcrops. Bare ground coverage was the lowest and species richness value the highest among the three ungulate zones. The vegetation was dominated by different species of graminoids. Of the 56 species recorded, 17 were common (PV>5) and 39 rare. The shrub *Potentilla fruticosa* was the most abundant species.

The goat zone was located at a lower altitude in the Namta Valley. Plant species' richness (57 species) was the highest among the three zones. Vegetation was dominated by shrubs. Of the 57 plant species recorded, only 13 species were common (PV>5) — the other 44 were rare. The shrub *Lonicera rupicola* was the most abundant species. Forage availability was higher than in the argali zone but lower than in the naur zone.

Management Implications

The Damodar Kunda region provides a mosaic of habitats with a unique aggregation of rare and endangered wild animal species. Hence, the region can appropriately be termed a biodiversity 'hot spot' of the country, and hence requires special management programmes to support conservation of the asset.

Damodar Kunda also has good quality pasture with relatively abundant palatable forage resources such as *Kobresia* spp., *Stipa* sp., *Lonicera* sp., *Elymus* sp., *Agrostis* sp., and *Saussurea* sp., for both livestock and wild herbivores (argali and naur). The good condition of the pastures is also indicated by the presence of breeding populations of argali and naur and the relatively few and low coverage of unpalatable species.

Excessive grazing by domestic stock during the summer may limit forage availability for wild ungulates during winter if they do not move out of the area. It is not yet known whether the rare and endangered argali remain in Damodar during winter, but naur traditionally move down to lower elevations during and after the rutting season in December. Studies of the seasonal habitat use by argali, of the pasture condition and, in particular of the impact of summer grazing by livestock on forage quality and availability during winter, are required to assess the possibility of promoting animal husbandry in the region.

Acknowledgements

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Ecological Separation between Ibex and Resident Livestock in a Trans-Himalayan Protected Area

Yashveer Bhatnagar, Gopal S. Rawat, A.J.Thomas Johnsingh
Wildlife Institute of India, Dehradun
and Michael Stüwe
Smithsonian Institution, USA

Abstract
The spatio-temporal overlap in resource selection by resident livestock and Asiatic ibex (*Capra ibex sibirica*) was studied in Pin Valley National Park, a Trans-Himalayan protected area important for conservation of the endangered snow leopard and ibex.

Approximately 350 resident livestock grazed in the 300 sq.km study area within the park between May and December every year. This relatively large livestock population could potentially compete with the estimated 250 ibex for space and food. In this paper we have tried to establish whether ibex and resident livestock compete at the level of habitat selection. Diet selection and possible pasture degradation were outside the purview of this paper. We located seven radio-collared ibex over one year and also recorded the location of any domestic animal on a 1:50,000 topographical map. Various habitat attributes were recorded for each sighting.

During summer ibex migrated to higher elevations (mean 4,400m) while most livestock continued to use the lower valleys (<4,100m). There was greater altitudinal overlap, during spring and autumn, however ibex primarily grazed on steeper slopes, closer to escape terrain. We suggest that ibex and resident livestock used the habitat differently throughout the period of overlap in the Park, and thus livestock did not interfere with ibex at this scale of resource selection. We note, however, that this situation resulted primarily from two factors: a) nearly all resident livestock were herded back to settlements at night and were thus mainly grazed near habitations; and b) livestock holdings were not increased because of the problem of collecting enough forage for winter stall feeding.

Introduction

In mountain pastures, livestock is widely regarded as competing with wild herbivores by depleting resources and degrading the pastures (Schaller 1977, Shah 1988, Rikhari *et al.* 1992). Further, studies indicate that such grazing can lead to loss of plant biodiversity, including rare and endemic plants (Kala *et al.* 1998). In recent years, there have been reports of increased pressure on the Himalayan rangelands and protected areas as a result of a rise in livestock populations in response to the shift from subsistence to market economies (Lal *et al.* 1991; Mishra 1997). Government agencies try to prohibit livestock grazing within wildlife protected areas in India as per the Indian Wildlife Protection Act - 1972 (GOI 1992). Our observations indicate that in the Trans-Himalayan regions pasturelands are at a premium, and livestock are an important resource for the primarily agro-pastoral community who may have no place other than in a protected area to graze their livestock. Given this situation, it is important to assess whether livestock in a protected area are actually detrimental to the ecosystem, and only to prohibit grazing if they are. For this reason we quantified the extent of habitat separation between sympatric populations of ibex, the primary wild ungulate in Pin Valley National Park, and resident livestock.

Study Area

The Pin Valley National Park (675 sq.km) is located in the rain shadow of the Pir Panjal range in the Lahul and Spiti district of Himachal Pradesh, India. This region is characterised by a cold, arid climate with a short plant growth period between June and September. There are a total of 17 villages in Pin Valley with a human population of *ca.* 1,250 people (Bhatnagar 1996). All these villages are located in the 'buffer zone' to the east and south of the national park (Figure 8). Of these, only eight villages depend to varying degrees on the Parahio catchment that constitutes the northern portion and bulk of the national park (Bhatnagar 1996). People depend on the park for collection of fuelwood and fodder and for livestock grazing and agriculture. Pin Valley residents have a total livestock population of 2,360 animals, and the eight dependent villages a total of 1,270 animals with a mean livestock holding of 9.8 animals per family (Pandey 1991, Bhatnagar 1996). Based on a survey of 75 families (livestock holding 733) in the eight dependent villages, Bhatnagar (1996) reported that goats (27%) and sheep (24%) dominated the holding, followed by donkeys (15%), horses (12%), yak-cow hybrids (males are called dzo and females dzomo, 10%), yaks (8%), and cows (3%). People graze their livestock in the park between May and December every year. By the end of December, animals are herded back to the villages and are stall-fed till May or June.

Seventeen migratory herders from Shimla and Kinnaur districts, with *ca.* 8,000 sheep and goats, have been permitted to graze their stock in Pin Valley by the Forest Department (Pandey 1992). Every June, they enter the region from the Bhaba pass lying south of the national park and leave the park by mid August, spending 50 to 60 days in the region. Seven to eight groups with *ca.* 2,900 sheep and goats graze their stock in the upper Parahio watershed, in the Khamengar, Debsa, and Killung nalas. Since these animals were not grazed in the intensive study area as defined by the seven radio-collared ibex (Bhatnagar 1997), we limited our study to the possible competition posed by the resident livestock that remained in the area for about eight months.

Methods

Livestock Abundance and Distribution

Residents who brought in livestock from the dependent villages were interviewed to assess the numbers of various species being brought into the study area and the pastures where they were grazed. This information was cross-checked by actual counts in those areas to get an estimate of abundance and distribution.

Habitat Utilisation by Livestock

Data on the habitat utilisation (Table 11) by livestock were collected along the trails while monitoring the radio-collared ibex (Bhatnagar 1997). In the process,

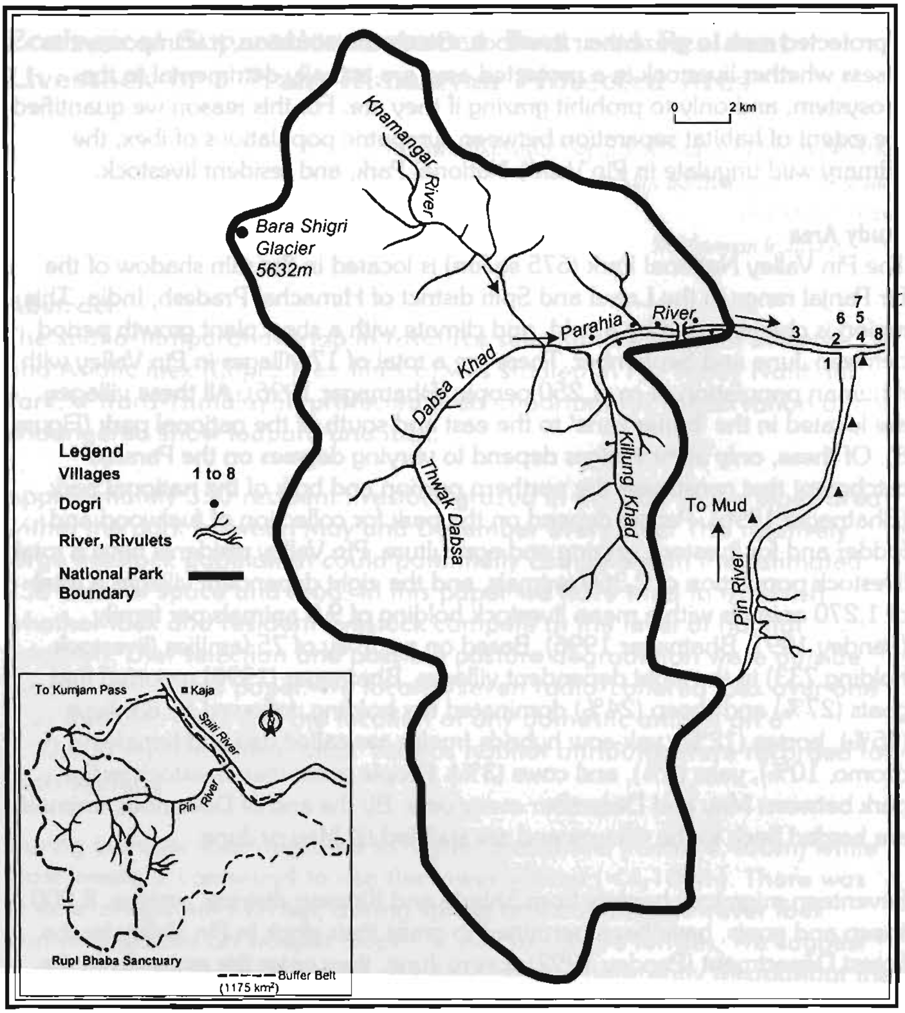

Figure 8. **Map of Pin Valley National Park (675 sq.km) showing the study area in the Parahio watershed. Note that villages are primarily located around the eastern periphery of the park and the summer settlements are inside the park**

approximately 10 km in the Kidul Chu Valley and 8 km in the Parahio-Kocho Valley were surveyed three to five times every week. We obtained 296 sightings of livestock and 237 of ibex covering spring (15 April to 30 June), summer (1 July to 15 September), and autumn (16 September to 30 November). This included the major period of overlap (May to December).

Habitat variables that determine use by ibex and livestock may differ. For example, the value of distance to escape terrain (ET) for ibex is not the same for horses or other livestock species, except goat and possibly sheep. The variables were, however, recorded for livestock to differentiate between usage by ibex and livestock, not for studying habitat use by livestock *per se*.

Table 11. **Habitat variables and their categories used in quantifying habitat use by ibex in Pin Valley National Park**

Habitat Variable	Categories/Description
Terrain type	1. **Interspersed Rocky Slopes (IRS) I**: steep (usually >40°), broken areas, usually below large rocky slabs & cliffs. 2. **Rocky slabs**: parallel rock slabs with occasional plant patches. 3. **Cliffs**: rocky slopes > 50° 4.**Rocky slopes**: slopes with an exposed rock cover of >20%, usually stony fields 5.**Smooth slopes**: smooth slopes with rock cover < 20%, usually good vegetation cover. 6. **Scree**: loose rocky slopes fanning out below rocky slabs and cliffs. 7. **Old moraine**: steep unstable high bank, often bordering the valley bottom. 8. **Valley bottom**: usually rocky, flat land at the base of the valley; has occasional shrubby patches. 9. **Glaciers**.
Aspect	North (338° to 23°), North-East (24° to 68°), East (69° to 113°), South-East (114° to 158°), South (159° to 203°), South-West (204° to 248°), West (249° to 293°), North-West (294° to 337°).
Slope	Angle estimated in degrees intervals of 5°
Closest dist. to cliffs (escape terrain)	Estimated in units of 5 m
Altitude	Elevation in metres

Analysis

Since the data were not normally distributed, only nonparametric tests were used. Seasonal differences in the use of various habitat categories by livestock were tested based on a Chi square test of independence (Sokal and Rohlf 1995). For nominal variables, differences between ibex and livestock were tested based on a Chi square test of independence, while differences between continuous variables were tested using the Kruskal Wallis Oneway ANOVA test (Sokal and Rohlf 1995). To study seasonal differences in the use of altitude between ibex and livestock, we subtracted each of the observed records of altitude of ibex with that of livestock to obtain a distribution of all possible differences. We repeated the same for distance to escape terrain, but here we subtracted the observed figures of use by livestock with use by ibex. If the values of differences were grouped closely around zero, this would indicate a minimal difference in use by the two groups; if positive, it would mean ibex used higher altitudes than livestock or in the case of distance to escape terrain, that livestock grazed farther from escape terrain than ibex. Negative values would imply the opposite.

The habitat preferences of livestock were investigated for comparison with ibex based on Marcum and Loftsgaarden's (1980) 'non-mapping technique'. Availability of the habitat attributes was estimated using 200 random points in the study area. The proportionate use of habitat categories was then compared with the availability to assess which habitat categories were used more than their proportional availability ('preferred'), less than their proportional availability ('avoided'), and in proportion to availability.

Results

Livestock abundance and distribution

The resident livestock in Pin Valley can be grouped into two categories.

1. *Species dependent on human settlements*: sheep, goats, donkeys, and cows/ dzomo that were directed to pastures every morning, and herded back into pens in the evening. Their distribution was quite predictable and close to settlements.
2. *Species' independent of human settlements*: free-ranging (yaks) and partially free-ranging species (adult horses) which may be herded back into pens but were essentially kept in pastures far from settlements.

The dependent villages had a livestock holding of 1,266 animals, but only *ca.* 350 of these (28%) (Table 12) were grazed within the national park and adjacent tracts that formed the study area. The remainder in the first category were grazed close to the villages, and those in the second category were grazed further downstream along the Pin River. Sheep and goats constituted roughly half of the livestock that grazed in the study area (Table 12).

Table 12. **Species-wise population estimates of livestock in the eight villages dependent on the Parahio catchment, Pin Valley National Park, and which actually graze in or in the vicinity of the study area. The overall population estimates are from Pandey (1991) and the estimates for Parahio are based on counts and interviews with locals**

Species	Dependent villages	Study area (Parahio)	Livestock type wise proportion in study area
Settlement Dependent			
Sheep & Goat	529	145	
Cows, Dzomo	149	40	67%
Donkeys	243	45	
Settlement Independent			
Horse	134	60	33%
Yak, Dzo	211	60	
Total livestock	1266	350	

Habitat and spatial separation

The livestock showed seasonal differences in the use of terrain type (c^2 test, $p<0.0001$), aspect ($p<0.0001$), distance to escape terrain ($p<0.0001$), and altitude ($p=0.0004$), but not in the use of slope categories ($p=0.33$). Since ibex also showed seasonal differences in habitat use (Bhatnagar 1997), the three seasons, spring, summer, and autumn, were considered separately.

There was a high degree of spatial overlap between ibex and resident livestock in spring (Figure 9). In summer, however, ibex moved to higher elevations, while most livestock remained along the valley bottom, resulting in spatial separation (Figures 10, 11).

The ibex choice of terrain type, aspect (c^2 test, $p<0.001$), slope, distance to escape terrain, and altitude (Kruskal Wallis test, $p<0.05$) differed from that of livestock in all seasons except spring, when the use of aspect did not differ (c^2, $p>0.05$) (Table 13). Altitudinal separation was at a minimum during spring, with a median difference of 160m, and at a maximum during summer, with a median difference of 540m (Figure 11, Table 14). Over 75% of the ibex sightings were above livestock during spring, and this was even greater during summer (92%) and autumn (89%). Settlement independent livestock had some amount of altitudinal overlap with ibex but this was minimal for the settlement dependent livestock (Figure 11). Compared to ibex, livestock used gradual slopes and occurred farther from escape terrain (Kruskal Wallis test, $p<0.05$) (Figure 12, 6). The median difference in the use of distance to escape terrain by livestock and ibex was 60m in spring, and increased to 160m in summer. Over 90% of livestock sightings were further from escape terrain than ibex in each season (Table 14).

Table 13. **Frequency distribution (%) showing difference between ibex and livestock in the use of altitude and distance to escape terrain (ET) in Pin Valley National Park. Differences refer to the difference between all possible pairs of values of these variables used by livestock and ibex based on their sightings in spring, summer, and autumn. For altitude the difference was (altitude ibex – altitude livestock) and for distance to ET, it was (ET livestock – ET ibex)**

	Spring	Summer	Autumn
Altitude (m)	(n = 3355)	(n = 17490)	(n = 5928)
Median altitude difference (m)	160	540	400
- 800 to 0m	22	08	11
1 to 500m	66	39	52
501 to 1,000m	12	47	28
1,001 to 1,400m	00	06	09
Distance to ET	(n = 3355)	(n = 16072)	(n = 5928)
Median difference in ET (m)	60	160	150
-200 to 0m	10	07	04
1 to 50m	26	09	15
51 to 100m	38	20	18
101 to 150m	11	11	14
> 150m	15	53	49

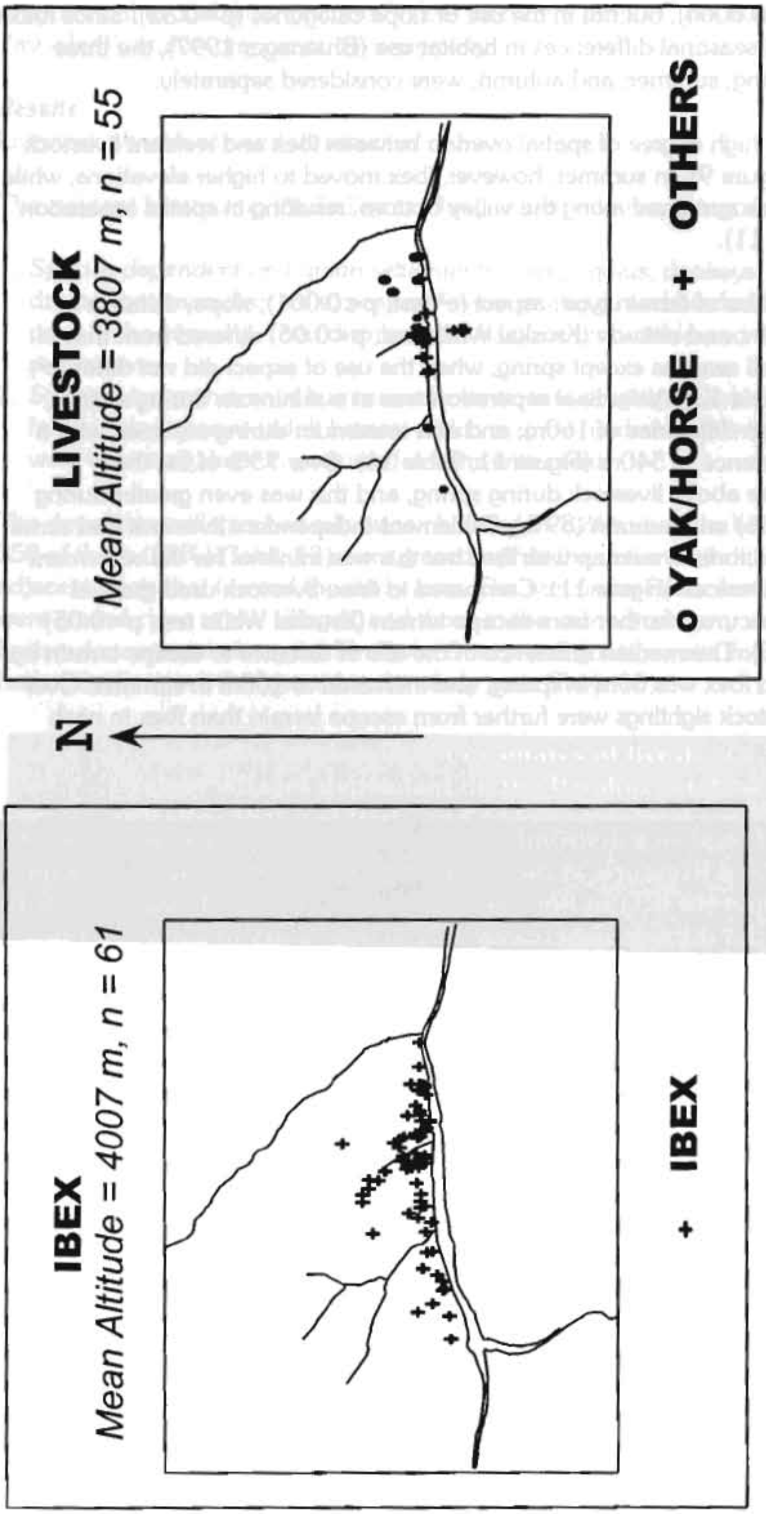

Figure 9. **Distribution of ibex and livestock during spring (1994, 1995). Note the spatial overlap between ibex and livestock near the valley bottom**

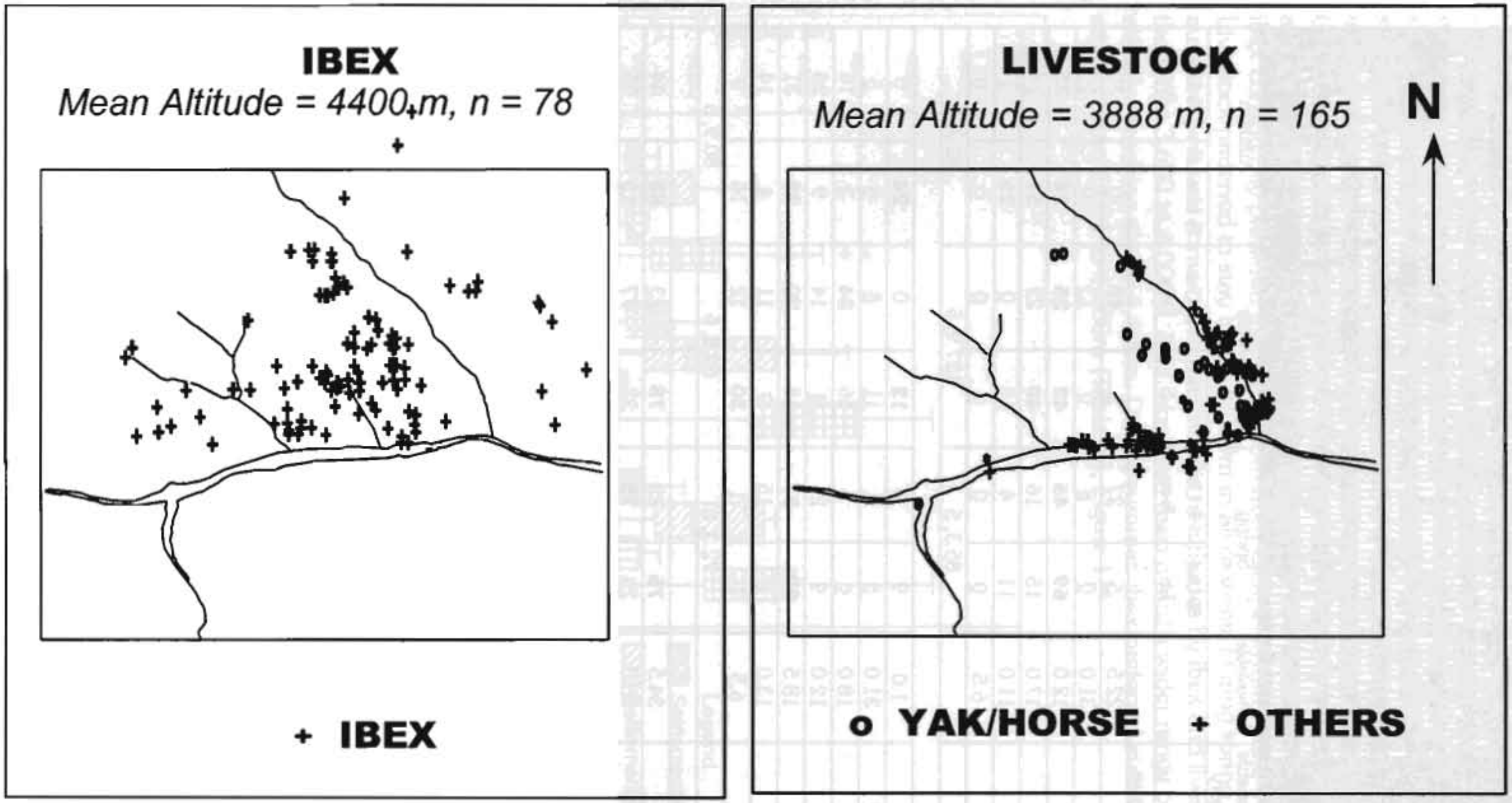

Figure 10. **Distribution of ibex and livestock during summer 1994. Note that while most livestock continue to use the lowest slopes, ibex move to higher elevations, thus minimising spatial overlap**

Table 14. Seasonal habitat selection by livestock (LS) compared to use by ibex during the three seasons of overlap (May 1994 to December 1994; spring, includes May 1995) in the intensive study area. Preferences are calculated based on Marcum and Loftsgaarden's (1980) Bonferroni confidence intervals. Preference (bold), avoidance (underline), and usage in proportion to availability (normal text) must be treated in a relative sense. χ^2 values are for differences in the use and availability of LS only (all $p<0.0001$). See Bhatnagar (1997) for more details

Habitat variable & category	% Available	Spring		Summer		Autumn	
		% Use LS	% Use Ibex	% Use LS	% Use Ibex	% Use LS	% Use Ibex
Terrain type							
IRS	22.5	5	27	5	**40**	0	30
Sl/Cl.	31.0	0	8	0	13	0	10
RS	12.0	**69**	**45**	**42**	**25**	**24**	**35**
SS	17.0	15	16	**40**	22	**51**	24
Other*	11.0	11	4	13	0	**25**	1
Glacier	6.5	0	0	0	0	0	0
		85.3, 5		127.9, 5		82.3, 5	
Aspect							
Flat	1.0	9	0	**12**	0	**24**	0
N,NE,NW	31.0	5	1	11	8	6	5
E	18.0	6	5	16	**34**	3	16
SE	12.0	9	21	4	14	9	**25**
S	18.5	**69**	**57**	18	20	**38**	31
SW	13.0	2	15	9	11	4	14
W	6.5	0	1	**30**	12	16	9
		72.3, 6		69.8, 6		80.9, 6	
SL (°)							
00-30	34.5	**76**	25	**78**	23	**85**	44
31-60	55.0	24	**75**	22	**77**	15	55
61-90	10.5	0	0	0	0	0	1
		31.9, 2		74.0, 2		58.2, 2	
DTET (m)							
0	32.5	0	8	1	12	00	6
01-50	33.0	14	**82**	7	64	17	**90**
51-100	16.0	**53**	10	23	21	17	3
101-150	4.0	15	0	**13**	1	**16**	1
>150	14.5	18	0	**56**	2	**50**	0
		55.3, 4		136.3, 4			
Altitude (m)							
3600-3800	11.5	**66**	17	**41**	3	**70**	12
3801-4000	11.0	**31**	**48**	**41**	7	21	13
4001-4200	17.0	2	22	10	15	4	30
4201-4400	13.0	1	6	6	23	5	23
4401-4600	13.0	0	4	2	**25**	0	4
4601-4800	11.0	0	3	0	17	0	13
>4801	23.5	0	0	0	10	0	5
		103.0, 6		144.6, 6		118.0, 6	

* Terrain type 'other' includes scree, valley bottom, and old moraine.

We analysed preferences for all the livestock categories pooled together because of the sample size needed for a chi square test. Ibex and resident livestock showed similarities in the selection trends for terrain type, aspect, and to some extent altitude during spring (Table 14). Both groups of animals preferred rocky slopes during all seasons, but the use of interspersed rocky slopes by ibex and smooth slopes and 'other' terrain types by livestock was high during summer and autumn. While ibex preferred slopes with an inclination between 31° and 60°, livestock consistently preferred slopes ≤ 30° (Table 14). Livestock used areas farther than 100m from escape terrain during summer and autumn, while ibex consistently preferred areas 1 to 50m from escape terrain (Table 14). Livestock preferred to stay below 4,000m in all seasons. During spring and autumn there was some overlap in the use of altitudes by ibex and livestock in the range 3,600 to 4,000m. Ibex, however, used a much wider range of altitudes reaching above 4,400m. During summer, ibex preferred even higher regions, from 4,401 to 4,600m (Table 14, Figure 11).

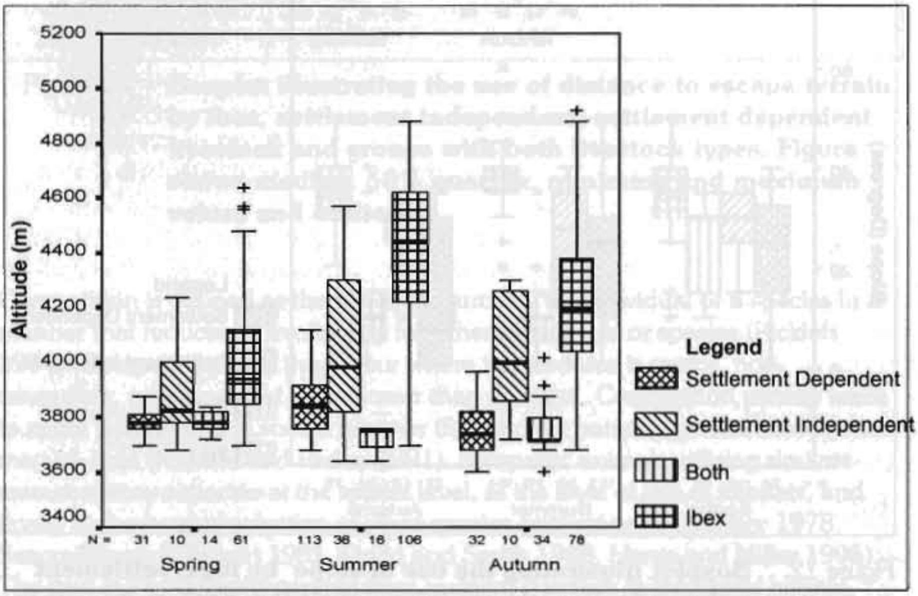

Figure 11. **Boxplot illustrating the use of altitude by ibex, settlement independent, settlement dependent livestock and groups with both livestock types. Figure shows median, 50 % quartile, minimum and maximum values and outliers.**

Discussion

We estimated that there were 200 to 250 ibex in the Parahio watershed (Bhatnagar and Manjraker, unpubl. data) sharing the area with *ca.* 350 resident livestock between May and December each year. There are no comparative figures from other areas, but with over 1.4 livestock for every ibex, the pressures imposed by them on the area could be substantial. However, the results show that concentrated use of areas by livestock during all three seasons was limited primarily to the lowest slopes near the valley bottom (Figures 9, 10).

Habitat Separation between Ibex and Resident Livestock

There was some overlap in the use of altitudes, terrain types, and aspect by ibex and livestock during spring and autumn (Figure 11, Table 14). However, the separation between the two was clear during all seasons in terms of use of slope and distance to escape terrain (Figures 12 and 13). The separation between ibex and livestock was highest during summer when they differed in the use of altitude and terrain type as well as in other variables. Ibex and livestock are thus most likely to compete for resources during spring and autumn, while during summer the possibility of either 'exploitation' or 'scramble' competition is excluded by the spatial separation. Ibex were seen foraging in the vicinity of and also in the same group as livestock during spring and autumn on about 10 occasions, without any overt antagonism. This shows that the chance of interference competition was minimal even during the period of overlap.

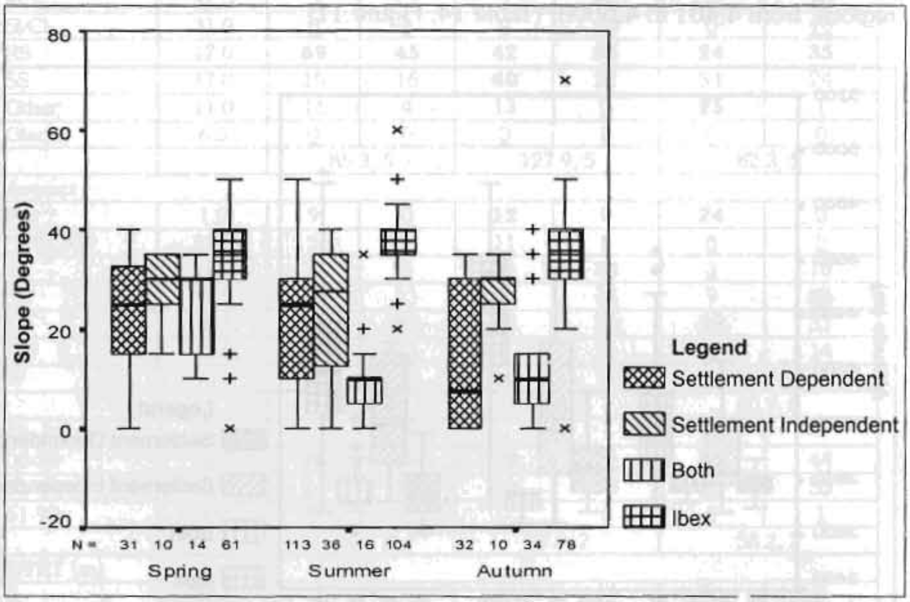

Figure 12. **Boxplot illustrating the use of slope by ibex, settlement independent, settlement dependent livestock and groups with both livestock types. Figure shows median, 50 % quartile, minimum and maximum values and outliers.**

Before analysing the competition between ibex and livestock further, we will look at human intervention in the use of habitats by the resident livestock. Approximately, 66% of the 350 resident livestock (settlement dependent) were directed daily by the owners into pastures selected on a rotation basis and were left to forage for three to twelve hours. Some of these animals were herded back into pens at mid-day for a few hours. Proximity to settlements was an important consideration in the choice of pastures, and usually all animals from this category were located within two kilometres of settlements along the lower valley. A large proportion of livestock were left to graze in fields after harvesting in August, to manure the fields. There was thus a decline in altitudinal use by livestock in September-October (Bhatnagar 1997).

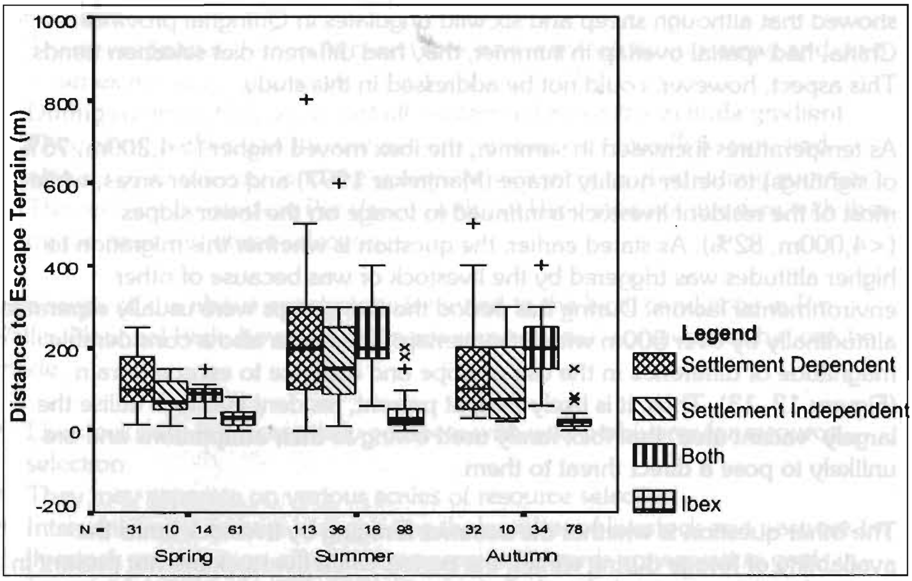

Figure 13. **Boxplot illustrating the use of distance to escape terrain by ibex, settlement independent, settlement dependent livestock and groups with both livestock types. Figure shows median, 50% quartile, minimum and maximum values and outliers.**

Competition is defined as the use of resource by an individual or a species in a manner that reduces its availability for other individuals or species (Ricklefs 1974). Competition may thus occur where the resource is scarce, non-renewable, or renewed at a rate lower than demand. Competition usually leads to niche partitioning in such a manner that in most natural communities species may co-exist (Milinski and Parker 1991). Sympatric animals utilising similar resources may separate at the spatial level, at the level of use of habitats, and finally at the level of selection of plant species or plant parts (Dunbar 1978, Seegmiller and Ohmart 1981, Dodd and Smith 1988, Harris and Miller 1995). The ibex in Pin Valley separated from resident livestock in the use of habitat. They used steeper areas and areas closer to escape terrain and, during summer, higher altitudes. It is important, however, to consider whether ibex separate into such areas as a result of, or independent of, competition from livestock.

During spring, the period of high spatial overlap, both groups used the lowest altitudes where the snow had thawed and fresh sprout was available. During this period, ibex had little choice as the upper-slopes were snow bound and plants had not sprouted. During May and June ibex were often attracted by the green pastures developed by the residents at Gechang barely 50m from their houses (by thawing snow early by dusting soil on the snow). Both, ibex and livestock primarily fed on *Lindelofia anchusoides* and some grasses which sprouted early (Manjrekar 1997). The extent of overlap in the diets, however, needs to be quantified. 'Exploitation competition' between ibex and livestock during this period is thus quite likely, but is probably minimised by separation in terms of use of steeper slopes and proximity to escape terrain. Harris and Miller (1995) showed that although sheep and six wild ungulates in Quinghai province, China, had spatial overlap in summer, they had different diet selection trends. This aspect, however, could not be addressed in this study.

As temperatures increased in summer, the ibex moved higher (>4,200m, 75% of sightings) to better quality forage (Manjrekar 1997) and cooler areas, while most of the resident livestock continued to forage on the lower slopes (<4,000m, 82%). As stated earlier, the question is whether this migration to higher altitudes was triggered by the livestock or was because of other environmental factors. During this period the two groups were usually separated altitudinally by over 500m with little overlap. There was also a considerable magnitude of difference in the use of slope and distance to escape terrain (Figures 12, 13). Thus, it is likely that, at present, resident livestock utilise the largely 'vacant area' that ibex rarely used owing to their adaptations and are unlikely to pose a direct threat to them.

The other question is whether the summer foraging by livestock limits the availability of forage during winter, the period when livestock are not present in the area? The habitat usage by ibex in winter showed a clear avoidance of areas with excessive snow and a preference for rugged areas with easier accessibility to forage and escape terrain (Bhatnagar 1997). These never or rarely descend to areas as low as 3,800m, the median altitude of livestock usage (see Bhatnagar 1997 for more details). Thus summer grazing by resident livestock probably doesn't deplete winter forage for ibex because most of the livestock grazing areas remain under heavy snow during winter and are not used by ibex anyway. Thus, even during this period, resident livestock would not adversely impact forage availability to ibex.

Potential Threats to Ibex by Resident Livestock

The previous paragraphs suggest that the resident livestock are unlikely to have an adverse impact on ibex. This statement has to be taken with caution, as the primary reason for it is the more or less stable resident livestock population in Pin Valley (Bhatnagar 1996) and the manner in which people restrict usage by their livestock too near their settlements. Residents said that, although they may like to own more livestock, a restriction on this was imposed by the amount of fodder they can collect for the winter stall feeding (Bhatnagar 1996). If extra fodder is made available, there is a likelihood that livestock holdings will grow and have an adverse impact on ibex usage. The impact can be higher during spring when their ranges overlap, the resources are scarce, and ibex are in a poor body condition after the long winter.

Resident livestock may pose a threat to ibex through transmission of contagious diseases. People in the area occasionally reported cases of foot-and-mouth disease (FMD) and pneumonia among their livestock. However, during the course of the study, when over 8,000 ibex were classed in over 1,000 groups, only on one occasion was a limping ibex with a possibility of FMD observed.

A separate study on the habitat use by migratory livestock and the impact of fuelwood removal from the park may be necessary to ensure the long-term conservation of ibex in the PVNP.

Conclusions

1. There was spatial overlap between ibex and livestock during spring and, to a lesser extent, during autumn.
2. During summer, they were spatially separated along the altitude gradient.
3. They clearly differed in the use of slope, distance to escape terrain, and altitude in all seasons, and the difference was most marked during summer
4. The resident livestock in Pin Valley National Park does not interfere with ibex on the scale of habitat selection

The scope of the above conclusions is limited to the local conditions in Pin Valley National Park; however, there are some general conclusions that can be made.

- Livestock may not necessarily compete with wild herbivores for resource selection
- They may separate on various scales of resource selection
- Intervention by owners in regulating the number of livestock and pastures for livestock grazing is an effective compromise towards conservation goals in protected areas in the Trans-Himalayas that already have a scarcity of pastures
- The methods used in this paper can be used as a first step in assessing the impacts of livestock in a protected area

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A Participatory Approach to Rangeland Research and Management: Developing An Action Plan for Rangeland Conservation in Mountain Protected Areas in Nepal

Camille Richard
International Centre for Integrated Mountain Development, Nepal
Colleen McVeigh
Cornell University, USA (Postgraduate Student)

It is generally accepted that inter-disciplinary, participatory approaches are useful for understanding and addressing the complex issues related to protected areas, including rangeland use and management. However, although participation is often talked about, it is in fact rarely put into operation. In Nepal, people's participation in conservation management is mandated by law, and the Eighth Development Plan (HMG 1992) explicitly advocates that local people be included in conservation management to reduce discord between people and protected areas. Yet, despite the rhetoric and the legislative framework, true participation in resource management is far from satisfactory (Bhatia and Karki 1999). This stems mainly from a lack of understanding of what is truly meant by the term *participation* and a lack of institutional capacity to implement participatory approaches. For the most part, the resource management training programmes offered in Nepal continue to emphasise the technical components of conservation management and ignore participatory community development approaches and techniques.[19]

Participation as An Operational Concept

So what do we mean by *participation*? First let us illustrate what it is *not*. It is not simply designing a project and having local people do the work (i.e., labour sharing), or hiring locals as data collectors. Neither does it mean 'motivating' local people to adopt outside interventions. In practice, it is a collaborative process that is based on a philosophy of empowerment that facilitates the active involvement of stakeholders (in this case both communities concerned, conservation managers, and/or other relevant bodies) in decision-making processes, and gives credence and value to both scientific and local knowledge[20] (Waters-Bayer and Bayer 1994).

In a highly participatory exercise, stakeholders collectively set priorities; design, conduct, and analyse research; and implement, monitor, evaluate, and readjust actions. This is a contrast to more conventional approaches in which 'professional' researchers and managers extract information from local people and settings but retain exclusive control over the research and management process. Under the latter conditions, locals may contribute knowledge or may

19 This fact, noted almost a decade ago (see Gilmour and Fisher 1991 and Joshi 1993), remains true to this day.

20 Local knowledge, also commonly called indigenous knowledge, is that which is particular to a given culture or society. It is the basis on which societies organize how they think about and respond to the world around them, and make decisions about a multitude of activities, including agriculture and resource management (see Warren 1991).

provide their ideas and perceptions, but 'outsiders' still analyse the information and define the 'problems' and 'solutions' for the community rather than with the community. Figure 14 illustrates the two opposing ends of a participation gradient, differentiated according to the level of inclusiveness of all stakeholders, and offers examples of research approaches and/or tools that fall at either end.

←	→
Classic approach	**Participatory approach**
Exclusive	*Inclusive*
(Low participation in activity)	(High participation in activity)
All phases of research, planning, implementation and follow-up done by 'outsider experts'. Locals may contribute 'knowledge' but are not involved in decision-making *per se*.	Stakeholders together set priorities; design, conduct, and analyse research, and implement, monitor, evaluate, and readjust action.
Examples of activities	Examples of activities
- Conventional Research	- Participatory Action Research
- Government farm research	- Farmer-led research
- Rapid Rural Appraisal[21]	- Participatory Rural Appraisal

Figure 14. **A participation gradient**

The key to effective participation is that all stakeholders have a sense of ownership of the information generated and play a role in deciding what research is undertaken and what is done with the knowledge generated. The level of conflict among competing interest groups will necessarily affect the swift and effective implementation of participatory methodologies, but these obstacles are not usually insurmountable once a group of stakeholders mutually commit themselves to work through their differences. However, getting to this point can be difficult. The capacity to engage in the process itself requires crucial changes in attitude among conservation managers and a fundamental paradigm shift in prevailing resource management models. For the most part, whether rightly or wrongly, protected area staff in Nepal continue to see themselves in a policing role vis-à-vis local inhabitants, as opposed to partners in the conservation process. Local people in turn are usually suspicious of protected area initiatives, which they see as having little benefit while simultaneously bringing added hardship to their lives. If local participation is to have any meaning in the real sense of the term, then mutual trust and

21 We include Rapid Rural Appraisal (RRA) here because in practice this is a method that is essentially extractive.

accountability needs to be developed on both sides. If this is to happen, then the professionals engaged in conservation activities will have to take the initiative and will need to develop good communication skills—including a willingness to listen to local people and an ability to ask relevant questions—and be willing to engage with local people in a process of partnership and collaboration. Without these critical changes in mindset, any participatory approach is likely to fail.

Participatory action research: an operational methodology for participatory rangeland research and management

As the name suggests, participatory action research (PAR) is a research methodology that integrates the participation of stakeholders, social action, and academic research into one holistic process. It is research in the sense that it aims to generate useful knowledge. It is action-oriented in the sense that the research aims to inform and engender positive social change and community empowerment. It is participatory in the sense that it is a collective, community-based process whereby some community members collaborate with the professional researcher in an action research project. That is, community members act as co-researchers throughout the entire process - from the initial design through the presentation of results and discussion of future actions (Whyte *et al.* 1991; Greenwood 1991). Though the professional researcher may initiate and stimulate the process, he/she neither directs nor controls it.[22] In this way, PAR "self-consciously attempts to counter researchers' monopoly over the knowledge generation process, and thus the cultural forms, language, and policies that are derived from research" (Chesler 1991; see also Elden and Levin 1991).

Like other action research approaches, PAR seeks to link theory and practice. Conceptualised as a cyclical process encompassing a spiral of cycles of planning, action, observation, and reflection (McTaggart 1989), PAR aims to increase understanding of both the subject under study as well as the research and action processes underway (see Figure 15). It offers itself as an alternative to conventional research models[23] which stress the establishment of basic 'facts', hypothesis-testing, neutrality and objectivity on the part of the researcher, standardised assessment devices, and non-intervention. Instead, PAR begins by identifying the problems experienced by the community, advocates local solutions to local problems (i.e., context-bound knowledge), encourages the generation of 'local theory', and stresses commitment towards the goals identified by the group and personal action-taking by the researcher (Chesler 1991; Elden and Levin 1991; Whyte *et al.* 1991).

PAR is a methodology or framework, not a method or tool. Because it is process oriented, various 'tools' can be used to assess issues or attributes *using* participatory or conventional research methods (Fisher and Jackson 1999). The

22 This is not to say that professional researchers do not bring their own knowledge and needs to bear on the research process. In fact, according to Elden and Levin (1991), it is through the interaction of insider and outsider frameworks and expertise that new knowledge is generated.

23 See Chesler (1991) for a useful table that contrasts conventional research and PAR on the basis of goals, methods, relationships with participants/groups, base of operations/funding, research issues, and products and action.

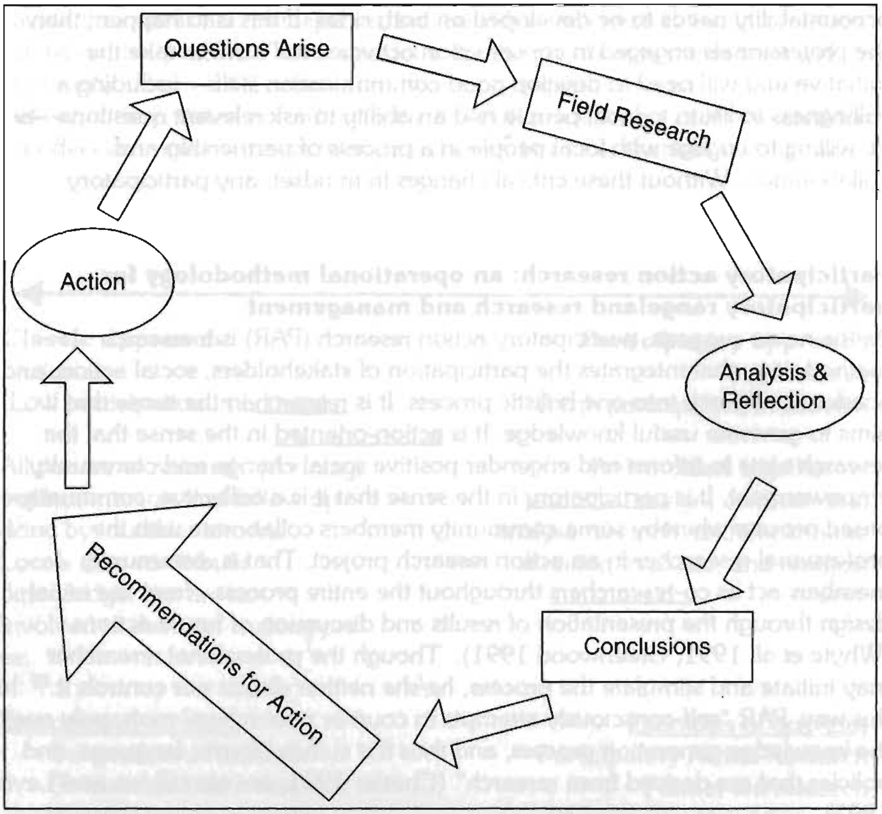

Figure 15. **The Cycle of Participatory Action Research** (Wadsworth 1984) (can be entered at any stage of the cycle)
* Analysis and Reflection include assessment not only of results but of the *assumptions* of the stakeholders involved (differing world views and how it affects the analysis of results).

latter methods, for example, are particularly useful in situations where more specific or technical data are required. Like methods themselves, the actual level of participation of group members will vary, both between and within projects. This will depend on the problems and conditions under study, the aims, capacities and interests of group members, and the skills of the professional involved (see, for example, Greenwood *et al.* 1993) (see Table 15). The key is that all members are involved in deciding which methods are chosen at any particular stage, and who will assume responsibility for them. The more

Table 15. **Examples of varying levels of stakeholder participation in specific research activities related to rangelands**

Issue	**Degree of participation by stakeholders in activity**	**Who conducts? (decided by PAR team)**
Pasture improvement	High – direct relevance to community	Line agencies and farmers
Remote sensing analysis of range resources	Low – highly technical	RS Specialist in consultation with PAR team

important an issue is to any given participant, the more likely that person is to participate in a particular activity.

The Strengths and Weaknesses of PAR

PAR offers a number of advantages over more exclusive, conventional approaches. It enhances and develops rapport between stakeholders (e.g., park managers and local communities), bridges gaps between scientific and indigenous knowledge, provides more interdisciplinary data, and facilitates integration. It also facilitates the prioritisation of strategies for future research and management activities by basing them on both the needs and limitations of those involved and helps to strengthen local capacity for planning, implementing, evaluating, and continuing activities. Furthermore, it can facilitate and accelerate the implementation process (because both communities' and outsiders' intentions are clarified and made transparent) and ensure continuity by increasing the commitment and responsibility of those involved.

Having said that, doing PAR is by no means easy and involves a number of trade-offs. For example, it is usually more time consuming than conventional research and requires extensive planning. As a collective process, PAR requires a higher level of coordination (both of people and agendas) than in standard research where the reseacher acts alone or directs research assistants. It also takes a longer time to reach decisions, particularly if the stakeholder group is large, heterogeneous, and/or unstable over time (i.e., members come and go). Considerable time must be devoted to negotiation and conflict management. Combining research with an action agenda further complicates and lengthens the process, simply because there is more to do. The amount of time invested, however, is usually offset by increased efficiency in the long-term, as inappropriate and/or undesired interventions are more likely to be discarded before they are put into motion, and useful and acceptable interventions are more likely to be adopted.

PAR is also risky in that individual members lack exclusive control over the research process and are required to place a high level of trust and confidence in other members of the group. Because problems are defined collaboratively in the field, the research is necessarily vague at the outset and members have no way of knowing where the process will lead. Because of this, PAR critics maintain that research generated using this approach lacks the rigour of more conventional scientific methods. Responding to this, Whyte *et al.* (1991) argue that information provided by community members who have a stake in the outcome of the research is generally more useful and accurate. They also point out that, because the research group includes members of the community being studied, the PAR approach ensures that information is subjected to rigorous cross-checking with people who have first-hand knowledge. Drawing on their own experience in PAR projects, they conclude, "... this cross-checking process has assured a far higher standard of factual accuracy than could have been achieved by standard social research methods" (Whyte *et al.* 1991:41-42). Finally, PAR is not a low-cost replacement for conventional investigation, but the long-term costs associated with conducting irrelevant research are usually avoided and/or reduced (Waters-Bayer and Bayer 1994).

Table 16. **Assessment matrix as a model for initiating a rangeland diagnostic study (not all boxes need to be filled in)**

Agro-ecosystem components	**Cross-cutting themes**				
	General description of component – temporal and spatial	Tenure patterns/ institutions – who regulates access to resources?	Social diversity (gender, relative wealth, ethnicity, etc) – Is access to resources equitable?	Indigenous knowledge regarding components – who are the local 'experts'?	Other?
Households (livelihoods, labour, skill, etc)					
Rangeland and forest pastures (winter and summer)					
Livestock (health, breeding, management, etc)					
Forests (pastures, other uses, etc)					
Croplands (crops, use of residues for livestock, manure application, etc)					
Social organisations/institutions affecting village life					
Markets for livestock products					
Past development interventions/policies					
Other?					

Initiating PAR in Rangeland Research and Management[24]

Developing action plans for rangeland conservation and management requires adopting a particular systematic framework (and attitude) for inquiry, planning, implementation, analysis and critical reflection. An **agro-ecological perspective** is needed, that takes into consideration the different ecosystems (elevation, climatic variability, and associated farming systems) in the region. This entails an interdisciplinary analysis of pastoral systems and the linkages among communities, the environment, the market arena, government policies, and development plans. PAR can then be used as a framework for assessment, planning, and implementation.

Figure 16 illustrates the logical flow of information necessary to implement effective interventions in agro-pastoral ecosystems (but could be applied to other farming systems as well). Phase I and II are essentially 'diagnostic' phases that are the foundation for future action and are conducted to identify who uses resources, how they are used, the temporal and spatial patterns of use, the key decision-makers regarding use, and the impacts of use. Resource professionals cannot manage rangelands collaboratively with stakeholders if they do not know with whom they are working and what they are managing. Although the phases, as outlined in Figure 16 at first glance appear to be a linear process, in reality they represent a cycle of logical steps such as presented in Figure 15. In many instances, interventions have taken place before the local conditions were understood or appreciated. Therefore, phases I and II are also meant to investigate the impacts of any past interventions and, if necessary, initiate steps to correct unintended consequences.

The diagnostic phase is designed to shed light on the complexities and indigenous rationale of land-use systems in protected areas. Table 16 shows an Assessment Matrix that can be used as a framework for a diagnostic study in rangeland systems (to be modified depending on site conditions). Agro-ecosystem components are listed in the left hand column, including past interventions in the community. Cross-cutting themes, such as tenure and local institutions, social equity, and indigenous knowledge, run across the top.

Some examples from rangeland areas of Nepal

Pastoral production systems in mountain areas are generally characterised by diversity and mobility. Mountain rangelands are, by definition, a marginal resource, naturally low in productivity and influenced by erratic precipitation patterns in the form of either snow or rain. In response to this variable environment, mountain communities often engage in multi-resource activities, including trade, single season cropping, and livestock husbandry to meet their livelihood needs and to minimise risk.

It is an ecological reality that livestock must be mobile to maintain rangeland health, and this is the basis of extensive grazing systems. This is true whether one is talking about large arid rangelands or small intensively managed pastures. Mobility has been shown to be a good indicator of sustainable

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[24] Parts of this section have been adapted from training materials prepared for the Regional Training Course 'Participatory Approaches to Rangeland Research and Development' conducted by ICIMOD and RECOFTC, in Jomsom, Mustang, June 7-20, 1999.

Phase I. Develop a better understanding of the agro-pastoral management system, including historical patterns, socioeconomic factors, and indigenous knowledge of rangelands and livestock, and their linkages to agriculture and forests (diagnostic phase).

- Have problems/constraints faced by the community been identified?
- Are the spatial and temporal patterns of livestock mobility and other land uses identified?
- Are the local conditions mutually understood to a degree that all stakeholders are comfortable with proceeding to the next phase?

Yes? No?

Phase II. Assess the ecological state of rangelands (determine the significant trends in relation to rangeland condition, livestock production, and biodiversity). This cannot be done effectively without completing Phase I.

- Are indigenous and scientific world views regarding the landscape mutually understood?
- Is there a general understanding (among all 'stakeholders') of ecological conditions?
- Is there a negative impact of land use on the environment (mutually perceived)?

Yes? No?

Phase III. Intervention

- Were interventions mutually identified as a need? Mutually planned?
- Remember that the 'intervention' may not be technical!

Yes? No?

Phase IV. Proceed with intervention and evaluate sociological and ecological impacts (repeat Phases I and II).

Figure 16. **A Logical Flow Chart for Participatory Action Research in Rangelands**

rangeland health, and as such is compatible with biodiversity conservation (Sneath 1996; Miller 1997; Steinfeld *et al.* 1997; Wu 1997). Conversely, restriction of livestock movement is often associated with over-grazing. Thus if one can identify the factors that lead to changes in livestock mobility, one can often address the causes of rangeland degradation. Restriction of mobility is often associated with reduction in the grazing area caused by: 1) increased population densities (human and/or animal); 2) forest conservation or protected area initiatives that prohibit grazing and/or burning, which in turn affect local management systems; 3) expansion of agriculture into grazing areas, such as along valley bottoms or marginal upper-slopes; and/or 4) changing socioeconomic factors leading to shortage of labour (Chakravarty-Kaul 1996, Jodha 1998, Wu and Richard 1999).

A number of factors in agro-pastoral systems determine livestock movement, which is tightly linked to agricultural patterns. These affect movement both among pastures and within pastures (rotational grazing). The following are typical examples of the rationale for livestock movements, in this case from the subsistence agro-pastoral community of Ringmo village in Shey Phoksundo National Park, Dolpo, Nepal (Richard and MacLeod 1994).

Reasons for Macro-Movement (among pastures)

- Timing of cropping, ploughing, harvesting
- Timing of milking /breeding/ manure collection
- Transportation (trade)
- Availability of labour (including division of labour between women and men)
- Types of animals (species, milking, breeding, or unproductive animals) and their use (e.g., for ploughing or for trading transport)
- Availability of pastures (tenure)

Micro-mobility (within pastures)

- Rotations between pastures determined by plant-animal indicators
- Sites for camps/watering holes
- Types of livestock - in terms of plant utilisation and ability to range from central camps. For example, in summer pastures, non-milking female yak and breeding male yak are not brought into camp at night and can range further than small ruminants and milking animals that are corralled every evening. This differential grazing creates gradients of impact with the highest impact closest to camps.

The conditions that dictate livestock movement in the above example are primarily set by natural environmental factors; the agro-pastoral production system reflects adaptation to these conditions. However, the larger socio-political arena can and usually does influence herding patterns. In contrast to Dolpo, the agro-pastoral system in Upper Mustang, Nepal, provides an example of the consequences of restricted livestock mobility. Previously reliant on yak husbandry, this region and its inhabitants have undergone significant changes in recent years.

In the past, Tibetan herders used summer pastures in Upper Mustang and Mustang herders used winter pasture in Tibet through mutually cooperative arrangements. With the closing of the Tibetan border in the 1980s by the Chinese government, Mustang herds no longer had access to winter pasture in Tibet (Blumont 1997). As a result, yak herds have almost completely disappeared from Upper Mustang due to a lack of winter forage, as they cannot travel to lower elevation pastures like other livestock such as hill cattle, sheep, goats, and horses. Livelihood options, other than livestock husbandry and agriculture, are limited in this region. Consequently, many residents migrate out in search of income, thus reducing the labour available to manage the remaining livestock herds. There has also been an increase in the use of *Caragana* shrub for fuelwood because of the lack of yak dung (Blumont 1997) which has negatively affected the rangelands in and around villages. Thus, there is not only a continuing degradation of the environment surrounding village areas, but also a gradual cultural decline.

Using the diagnostic tools shown in Table 16, key socioeconomic and ecological factors can begin to be identified. Using Mustang as a simplified example, these would be: importance of yak in meeting basic household needs such as for food, fibre, and fuel; the sociological and ecological consequences of losing that source (declining livelihood options and increased pressure on *Caragana* shrubland and subsequent erosion); declining interest to remain in Upper Mustang and out-migration due to the limited livelihood options; and thus limited labour available to work with remaining livestock. Given this situation, key avenues for intervention would initially exclude activities that increase labour demands without immediate benefits (e.g., pasture improvements). Instead, options should be identified that would help diversify the local economy, based upon an assessment of local needs, environmental constraints, unique niche-based resources, and existing human strengths and capacities. In the case of Mustang, this would most likely involve improving the infrastructure for market access and improving processing and business skills, which would involve other key stakeholders in the development process (such as regional traders, district officials, and government agencies). Protected area managers will only be able to garner local support for conservation in such cases when all players are identified and brought to the negotiation table to devise realistic prescriptions for diversifying livelihoods in these remote mountain regions.

Designing the action plan

These initial steps (which will vary depending on local situations) should be considered when designing a participatory action plan for a particular protected area.

- Consider your resources in terms of available funds and capacity. Do protected area staff have the capacity to conduct participatory action research? If not, where can the skills be found? In other departments? Using consultants?
- Find personnel that work well with local communities and form an initial PAR team.
- Collect and collate the existing information on the PA.
- Identify knowledge gaps (from your information synthesis).
- Present the gap analysis to various stakeholder groups (like local communities, NGOs, traders, local government officials) for feedback.
- During group meetings, set initial priorities and objectives for research based

on mutually shared issues and concerns.

- Select the initial Core Stakeholder Team to conduct diagnostic phases based on group interest (membership can change throughout the PAR process depending on need).
- Conduct a diagnostic rapid assessment using an agro-ecosystem framework (Table 16) with methods such as PRA or RRA and rapid ecological assessment.
- Present this information in stakeholder group meetings for feedback.
- Mutually define the next phase based on the outcome of studies and group consensus.
- Implement the next phase.
- Evaluate and continue the process.

Conclusion

The main goal of any participatory approach in protected area conservation management is to link institutions, such as extension/line agencies, NGOs (where they exist), and local communities together in order to pursue a common goal—to improve rangeland and livestock conditions—and, in so doing, rural livelihoods. To build the necessary linkages requires two-way channels of communication, which in turn requires a fundamental shift in the way we think about development research and a more inclusive process than allowed by conventional methods and models. We suggest that participatory action research, a collaborative, reflective process that links both action and research, is a helpful framework for achieving that goal. With a dynamic flow of information and decision-making, we can better reach our ultimate target audience — the local farmer and pastoralist — and jointly conserve Nepal's rich biodiversity.

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Managing People-wildlife Conflict on Alpine Pastures in the Himalayas

Rodney Jackson
International Snow Leopard Trust, Seattle, Washington, and The Mountain Institute, Franklin, West Virginia

Abstract
Many communities in the Himalayas suffer recurrent loss of valuable livestock to wild predators like the endangered snow leopard (*Uncia uncia*), thereby presenting park managers with the need to find ecologically sound and economically sensible long-term solutions which best balance the needs of pastoralists with those of wildlife sharing the same habitat. Since 1996, the author, The Mountain Institute, and the International Snow Leopard Trust have been experimenting with new and more participatory ways of dealing with this highly contentious issue in Tibet, and to some extent in Sikkim. Community-based workshops, employing APPA (Appreciation Participatory Planning and Action) and PRA (Participatory Rural Appraisal) techniques, seek to reduce depredation loss, increase villagers' income, and protect nature, while at the same time building community self reliance for planning, resource management, and income generation within the targeted protected area. This paper summarises the methods used and results obtained thus far and includes, as appendices, a detailed 'tool-box' of simple, participatory techniques and project planning criteria that could be applied to the problem throughout the Himalayas.

Introduction

Himalayan and Tibetan Plateau rangelands provide habitat for a unique assemblage of large mammals that have adapted to the harsh climatic and environmental conditions over evolutionary time scales (Schaller 1998). Examples of carnivores are the snow leopard (*Uncia uncia*), lynx (*Lynx lynx*), brown bear (*Ursus arctos*), dhole (*Cuon alpinus*), and wolf (*Canus lupus*). Endemic ungulates range from wild sheep and goats like the bharal or blue sheep (*Pseudois nayaur*), Asiatic ibex (*Capra ibex*), argali (*Ovis ammon*), Himalayan tahr (*Hemitragus jemlahicus*), goral (*Naemorhedus goral*), and takin (*Budorcas taxicolor*), to members of the antelope family like the Tibetan antelope (*Pantholops hodgsoni*), Tibetan gazelle (*Procapra picticaudata*), and wild yak (*Bos grunniens*) or deer species, most prominently the musk deer (*Moschus chyrsogaster*), and very rare red deer (*Cervus elaphus*).

Many of these species are listed in the Red Data Book or protected under Nepal's National Parks and Wildlife Protection Act. In recent decades their numbers have declined and their distribution has become increasingly fragmented as a result of poaching, over-hunting, commercial meat harvesting, and the direct and indirect effects of increased human use of high alpine pasture habitats (Fox 1994; Nowell and Jackson 1996; Shackleton 1997). These may include grazing competition between wildlife and domestic stock, soil and pasture degradation, predation of livestock, disease transmission, depletion of natural prey species, and disturbance to breeding or foraging wildlife, as well as marginalisation of critical wintering habitat (Fox 1997; Jackson 1990). Currently, protected areas (PAs) provide the primary habitat for harbouring vital core populations, with the surrounding unprotected buffer zone and corridors facilitating genetic exchange between increasingly isolated PAs, according to the metapopulation concept (Jackson and Fox 1997; Meffe and Carroll 1994). Using habitat modelling techniques, Jackson and Ahlborn (1990) described the importance of the Shey-Phoksundo National Park and Annapurna Conservation Area for maintaining a viable population of snow leopards in Nepal.

The high Himalayan pastures have long been used seasonally and permanently by resident or nomadic herders, whose existence depends upon finding their livestock adequate food and shelter — especially during the winter and early spring when forage is most scarce or likely snow-covered, and animals are stressed by poor nutrition and a high thermoregulatory demand. In recent decades, increasing vehicular access has led to more penetration and use of formerly uninhabited and very remote rich wildlife areas like Tibet's Chang Tang (Miller and Jackson 1994; Schaller 1998).

As native prey species' populations are reduced and depleted, so snow leopards must increasingly rely upon domestic stock for their survival. Faecal analysis indicates that livestock are an important component in the diet of the endangered snow leopard in Nepal, India, Mongolia, and parts of China (Oli *et al.* 1993; Chundawat and Rawat 1994; Schaller *et al.* 1988), so that reports of increased domestic depredation by the species is hardly surprising (Oli *et al.* 1994; Jackson *et al.* 1996). Indeed, it could be argued that pastoralists in some areas actually support or subsidise high densities of snow leopard, lynx, and wolf by ensuring that they have a ready supply of food available to them! In the Annapurna Conservation Area's Manang sector, for example, livestock biomass may be three times that of blue sheep, even although this area supports as many as 10 blue sheep per sq.km (Jackson *et al.* 1996; Oli 1994).

Protected areas and the allied welfare of contained wildlife populations will doubtless be placed at greater risk with continued loss of crops and livestock, which is rapidly emerging as the leading source of conflict between parks and local communities throughout the region (Kharel 1997; Mishra 1997; Saberwal *et al.* 1994; Sekhar 1998). For example, a comprehensive household-level survey of herders living in the Annapurna Conservation Area Project's (ACAP) Khangsar village suggested that predation accounted for 63% of all livestock mortality over an 18 to 24 month period, mostly attributed to snow leopard (Jackson *et al.* 1996). Predation rates were estimated at 21.1% for yak-*chauri* (mostly sub-adults), 0.8% for cattle, 7.1% for sheep and goats, and 19.6% for horses (with females and foals being taken more often than stallions). Predators are frequently blamed for loss actually resulting from other sources of mortality, such as disease, consumption of poisonous plants, or accidents.

Losses were not evenly distributed among the households: 37% of households suffered 50% of the total loss reported. Generally, households reporting depredation loss owned larger herds than households reporting no loss. Losses occurred throughout the year, peaking in early winter and spring. All horse and cattle, virtually all yak-*chauri* (93%), and 78% of the goat and sheep kills reported to Jackson *et al.* (1996) were being poorly guarded at the time. Virtually all incidents occurred in cover-rich sites and many of the kills took place during daylight hours. Field checks validated predation as the probable cause of death in at least 40% of these incidents; evidence for the remaining accrued from villager reports and kill site remains, but scavenging as a cause of death could not be ruled out. Despite knowing that several snow leopards, including a female with two cubs, were active within the immediate area, Khangsar villagers allowed their livestock to graze unattended, even after several had been killed, and in spite of having alternative, 'predator-free' pastures available to them. Over a 24-day period, 17 goats and 6 yak cross-breeds were lost.

Oli *et al.* (1993) reported that the predation rate in other nearby communities totalled 2.6% of the stockholding, with the losses representing as much as 25% of the average household's per capita income. Hardly surprisingly, most local people held a strongly negative attitude towards the wolf and snow leopard. In India's Kibber Wildlife Sanctuary, Mishra (1997) reported that 18% of the livestock holding was killed over an 18-month period, amounting to 1.6 animals per household per annum with an estimated total value of US$ 128 per family per year. Villages received compensation in only 28 of 131 reported cases. According to local residents, predation rates in the area sanctuary have increased markedly since its establishment. Mishra (1997) attributes this to a dramatic increase in livestock numbers accompanying the shift from subsistence to more commercially-based animal husbandry. Surveys in Nepal, India, and Mongolia have indicated that horses are taken in significantly greater proportion than their relative abundance; their high economic value only intensifies the level of anger toward predators and feeling for retribution among affected herders (Oli *et al.* 1993). Investigators have independently concluded that retaliation may be driven more by perceived losses than actual losses; however, repeated predation almost inevitably results in some or all households seeking to hunt, trap, and kill the culprit or suspected culprits.

The available evidence indicates that all of Nepal's parks suffer from crop and livestock damage to varying degrees (Jackson 1990; Kharel 1997; Sharma 1990). Obviously, protected area management can only be effective and sustainable if the basic concerns, needs, and aspirations of local people are addressed, in parallel with those of the wildlife. Thus, park managers should place a high priority on finding acceptable and sustainable solutions to satisfy herders who have lost their stock to predators in or near a PA. Over the long term, we must ensure that the natural prey base is expanded so that predator dependency upon domestic stock is reduced, and conflicts can thereby be avoided or at least minimised. The objective of this paper is to examine the key underlying causes of livestock predation and outline, in general terms, appropriate remedial measures that could be implemented by park authorities, NGOs, and local pastoralists in a way that builds community self-reliance and strengthens their capacity for park management and wildlife stewardship.

Livestock depredation - an overview of root causes and remedial solutions
Conflict between livestock owners and predators dates back 9,000 years to the

time when animals were first domesticated by humans (Nowell and Jackson 1996): it is not a recent phenomenon caused by the establishment of nature preserves or new wildlife legislation. Before modern firearms and traps were available, herders had developed simple but effective traditional methods for minimising predation losses such as maintaining close watch over livestock while grazing on the open range, avoiding predator-rich areas, employing guard dogs, breeding sheep or goats that have well-developed anti-predator traits, and keeping livestock in predator-proof corrals at night. Erosion of traditional knowledge, reduced herder vigilance, increased livestock numbers, and changes in animal husbandry management systems have aggravated the situation. As indicated above, predation rates vary widely, differing according to the type of livestock involved: sheep, goats, young yak, and horses appear to be most at risk.

The worst-case scenario involves 'surplus killing', or catastrophic incidents involving a snow leopard which enters a poorly-made livestock pen during the night, becomes confused, and then kills as many as 50-120 goats and sheep. Ironically, such loss could be entirely avoided if corrals were properly constructed in the first place — either higher walls or wire-mesh fencing that prevents a predator from jumping into the enclosure. Typically, poor households suffer most seriously, because they cannot afford to build good corrals or pay for shepherds to look after their livestock. Some animals that escape immediate death may die later from infected wounds because of the lack of proper veterinary care — a notable problem among large-bodied livestock like yak which put up a fight when attacked, thereby repulsing the predator but escaping with deep canine punctures and claw lesions that are highly prone to septicaemia.

Although predation losses vary from site to site, year-to-year, and seasonally, winter is usually the time of greatest concern. Jackson *et al.* (1996) found that depredation was not evenly distributed, but rather associated with the nearby presence of cliffs, rocky areas, and good cover. Near protected areas, the most likely stock raiders are dispersing sub-adults seeking to establish their own home range outside already occupied areas. Snow leopards which bring their cubs to a kill may be reinforcing the taking of livestock as prey, while the tendency of snow leopards to remain at a kill and consume all available meat increases their vulnerability to human retribution.

Jackson *et al.* (1996) considered the best long-term strategy lay in combining preventative and remedial measures such as the following.

Improved guarding of livestock, especially during winter, lambing, or calving seasons and when livestock are grazing pastures with broken, cover-rich terrain at elevations in excess of 4,000m (known as depredation 'hot-spots')

Encouraging communities to hire skilled shepherds, by developing a special fund to help pay for more experienced herders and by offering subsidised veterinary care for communities which demonstrate a reduction in depredation among their holdings

Promoting the use of improved breeds of guard dogs and livestock that show a greater inclination to ward off or avoid predators

Creating core areas for snow leopard and blue sheep which are largely or entirely livestock free

Assisting herders to increase their incomes from alternative sources, such as tourism and related jobs

Offering incentives for community development projects in exchange for clearly-defined and monitored predator and wildlife protection/conservation actions by the entire community

Developing safeguards against herders or communities making fraudulent claims, killing snow leopards, or illegally poaching wildlife, particularly key prey species

Since the lack of guarding and proper supervision of herds contributes most significantly to livestock losses, herder education should be given a high priority. Much depredation could be avoided by ensuring that livestock are securely housed in predator-proof pens at night. Research into the use of guard dogs is also recommended. Programmes to provide or improve forage could help to reduce the need to graze livestock in known depredation hot spots such as areas of very broken terrain, places with an abundance of cliffs and stalking cover, and pastures located in wilderness areas.

Oli *et al.* (1994) and others have recommended the development of insurance indemnity or cash compensation schemes for compensating herders who lose livestock to snow leopards. There are many obstacles to this idea, such as fund capitalisation and herder acceptance of annual premium payments, the potentially high administrative costs, the difficulty of validating predation as a cause of death in the field, and the possibility that a high percentage of claims will be fraudulent (unless sound procedures for verifying claims are in place). Perhaps, more importantly, cash payments or replacement of lost livestock encourage even more lax guarding practices. Any programme must, therefore, incorporate species' incentives, disincentives, or restrictions to ensure that it corrects bad behaviour rather than reinforcing it.

An alternative approach

In 1996 The Mountain Institute (TMI 1997a) began to experiment with new ways of approaching people-wildlife conflict resolution in Tibet. Using participatory workshops as a forum, this approach seeks to deflect the villager's anger and desire for retribution toward a more harmonious co-existence with depredating wildlife and constructive stewardship of the land. Attended by protected area staff, villagers, and wildlife specialists, we use a highly participatory planning process called 'Appreciative Participatory Planning and Action' (APPA), that in turn draws upon traditional PRA (Participatory Rural Appraisal) tools (TMI 1997b) and a framework of Appreciative Inquiry. According to its practitioners, APPA should be "simple enough that anyone can do it, yet profound enough to change people's lives." Experience has shown that a "problem-focused approach" (e.g., crop damage is a bad thing) often ends up with stakeholders remaining centered upon the difficulties of changing the status quo.

APPA operates on two basic complementary premises: (1) What you seek is what you find — "if you look for problems, then you will find more problems" or conversely, "if you look for successes, you will find more successes"; and (2) What you believe is what matters most — "if you have faith in your vision or ideas for the future, and if these are believable, you can achieve success without waiting for government or an outside donor to help take you there." APPA is practised through a four-phase iterative process (the Four "D's"), in which participants (1) discover their strengths and the community's valued resources and characteristics; (2) envision (dream) what could be possible within one year, 5 or 10 years, and 20 years time if their community mobilised its resources and acted in concert; (3) design an action plan for guiding development over the next 12 months or several years time, based upon what the community can do for itself; and (4) then learn how to deliver the desired objectives and meet long-term goals, starting immediately rather than waiting for some future time to take action.

The dynamic APPA process is used to mobilise villagers and to begin addressing crop or livestock depredation by building a common understanding of the project's primary objectives, which in this example may be stated as follows: (1) identify and implement ecologically sound and acceptable measures to reduce or possibly even eliminate wildlife crop and/or livestock damage, while increasing crop and animal productivity within the sustainable limits set by local environmental and pasture conditions; (2) protect wildlife and habitats in accordance with existing PA regulations; (3) promote alternative but environmentally responsible and socially acceptable forms of income generation that can be implemented and sustained through existing institutions, and which foster community pride and build greater self-reliance; and (4) train villagers and park staff in participatory resource assessment, planning, and management.

The basic steps involved in developing remedial measures for livestock (or crop) damage include the following activities: (1) verify that predators are an important threat to livestock by gathering baseline information on all sources of mortality to a particular village's livestock herd; (2) consider existing and alternative measures for reducing losses; (3) identify the environmentally, socially, and economically most appropriate control measure(s) and sign reciprocal agreements with herders and communities; and (4) implement measures according to a 'best practice' work plan that details each party's responsibilities from implementation through monitoring and evaluation phases.

The APPA process is usually initiated through a workshop with community members, leaders, and/or a particular user group which is experiencing depredation problems. Following introductions and 'ice-breaking' exercises, the facilitators provide a preliminary explanation of the purpose of the proposed workshop/project and discuss the obligations expected from each stakeholder (Table 17). They then initiate an on-going process for securing the consensus from all key stakeholders of their willingness to adopt a common set of damage

Table 17.	Conditions governing community engagement and project initiation

- External investment and NGO support are only made available to prospective communities *if* project activities are implicitly linked with biodiversity conservation (Sanjayan *et al.* 1997) and if the following is true.
- Each stakeholder, (whether villager, NGO, or government) is willing to make a reciprocal (co-financing) contribution, within their means, in support of the agreed-to project activities. This may be in the form of cash or in-kind services like materials and labour, which are valued using existing market rates and prices.
- There is a strong commitment to active and equitable participation from each stakeholder group throughout the project, from planning to implementation, monitoring, evaluation, and reporting.
- The beneficiary community is willing to assume all or a significant responsibility for repairing and maintaining any infrastructural improvements that may be provided by the project.
- Stakeholders agree to identify and employ simple but realistic indicators for measuring project performance and impact.

control and project design/operational criteria to help guide any agreed-to intervention (Table 18). It may be necessary to use a 'carrot and stick' approach by proposing a package of incentives, disincentives, and penalties that will better ensure stakeholder participation and compliance. Clearly, the stakeholders will need to recognise and accept the benefits and associated costs of the proposed actions, so that it is important to view the issue from a positive rather than a negative point of view.

During the 'discovery' phase, participants ask empowering and positive questions about what is best in their community and what has worked well in their lives. Facilitators probe particular community-based activities or endeavours that people see as being most successful to discover the underlying reasons of why this is so, in effect raising the self-confidence of the villagers to act in a positive and effective manner. Rather than using formal or highly structured household questionnaires, facilitators should use informal group meetings, site visits, and other group exercises to gather relevant baseline information on livestock numbers (or crop patterns) and mortality, identify animal husbandry systems and practices (including such things as pasture locations, periods of use, guarding patterns, and estimated stocking rates), or list wildlife species and map their habitat and distribution patterns. Appendix 1 indicates the range of PRA tools available to build a village resource profile and to identify patterns of crop or livestock damage. For example, pair-wise or matrix ranking is especially helpful in identifying the relative loss associated with each type of mortality or which guarding method or deterrent is seen as being most effective in the eyes of the herders. The relative vulnerability of different kinds of livestock to each predator can be ranked by giving participating herders a pile of stones, then asking them to place one for rarely depredated livestock type, sex or age classes, five for the most frequently killed types, or no stones for

Table 18. 'Best Practice' design and operational criteria (adapted from Jackson 1998)

All agricultural and animal husbandry damage control and linked improvements must be undertaken in ways that do not adversely compromise or threaten the management goals of the PA (i.e., they must be compatible with PA regulations and/or management plans) and which are also as follow.

Environmentally sound — control measures should result in no or only very minimal harm to species, habitats, or ecosystems (for example, no overall reduction in predator numbers; no hunting, trapping or poisoning of endangered species; should lead to improvement in prey species' numbers; should avoid rangeland over-use and grazing; and should help rehabilitate disturbed areas and restore ecosystem functioning. However, it may be necessary in some situations to identify and remove or eliminate habitual livestock predators that belong to an endangered or rare species)

Economically sustainable — control actions should be affordable, contain cost-sharing mechanisms, and be capable of being sustained with minimal outside cost and technical input (communities should share in the cost of implementing and monitoring control measures; there should be minimal dependence on high-tech, expensive deterrents; control measures should be well integrated with land-use and income-generation opportunities; cost of implementation and maintenance should be reasonable, and preferably supported internally)

Socially responsible — measures should build upon proven traditional customs and 'good' animal husbandry practices (measures implemented should strengthen Buddhist precepts prohibiting the killing of wildlife; and encourage or empower local communities to act responsibly and achieve greater economic independence while operating in an environmentally responsible manner)

Embedded, with clear responsibilities and a transparent budget — Implemented based upon a signed agreement that clearly sets forth the responsibilities and contributions of each party in accordance with a mutually-agreed work-plan and budget. The work-plan should specify details such as: 'where (location); who (responsible party); what (inputs/activities); how much (quantity); when (scheduling); how implemented (method), and how monitored (indicator and process to be used)'.

those livestock that are not considered vulnerable to the particular mortality source.

These exercises are followed by frank discussions of why the various traditional guarding practices have either been abandoned or become discredited, and an evaluation of which traditional or new method could be expected to work best if properly implemented, as well as why and how closely each meets with the PA's management guidelines or promotes nature conservation. This information provides the framework upon which the team of villagers (or designated village leaders), park manager, and NGO staff can identify and develop remedial measures that meet the criteria set forth in Table 18, and upon which reasonable consensus can be reached among the stakeholders involved. Providing details of different remedial livestock damage control measures is beyond the scope of this paper, but Appendix 2 shows some indicative interventions that were developed for the Qomolangma National Nature Preserve in Tibet.

Development of detailed action plans with a budget, monitoring indicators, and a realistic schedule takes time, in our experience a minimum of a 10 to 14-day programme is needed with a relatively high level of training and facilitation. Follow-up within a reasonable time-frame, say 3 to 9 months, is also critical. Indeed, emerging evidence indicates the need for long-term (5 to 10 years or more) commitment and involvement on the part of donors, NGOs, and park staff (Sanjayan *et al.* 1997). However, coming up with alternative means of reducing wildlife crop or livestock damage should involve considerably less time, effort, and cost, as suggested by the indicative example described in the following section.

It is important to appreciate the following assumptions, amongst others, when designing a programme for alleviating wildlife crop or livestock damage. (1) The internal and external threats to snow leopard (or any other target species) and biodiversity have been correctly identified and can be addressed using existing resources; (2) the project site is biologically significant (i.e., contains good wildlife populations, worth the investment being proposed); (3) local communities have pride in their way of life and culture, but are willing to adjust certain behaviour if it negatively affects species, habitats, or ecosystems; and (4) sufficient resources and skills are available to assist willing communities to develop, implement, and monitor plans for balancing biodiversity conservation and income generation.

Local people must appreciate and accept their responsibility to watch over their livestock properly in order to avoid giving predators the opportunity to stalk and kill unwary domestic animals. Park managers can be most effective if they educate herders and work to increase the local living standard by assisting in developing sustainable, alternative income-generating opportunities. The emerging evidence indicates that monetary compensation or poorly-defined compensatory development 'hand-outs' have not reduced depredation rates or resulted in a decline in the number of complaints filed with the relevant government agency (Saberwal *et al.* 1994; Mishra 1997). On the contrary, intermediation efforts may be doomed to fail unless the commitment shown by local people is directly linked to the responsibility they are willing to assume as well as the amount of time, energy, and materials they invest in the project. Therefore, it is imperative that the responsibility for reducing livestock depredation should be shared, at least equally, between the park authority and the local people, with short-term and medium-term support coming from national or international NGOs.

Results to date

Lessons from APPA community engagement and mobilisation in TMI activities in the Himalayas formed the basis for developing the protocols described in this paper. APPA provided the process, while details of strategic wildlife damage evaluation and alleviation were developed over the course of two people-wildlife conflict resolution training workshops held in Tibet's Qomolangma Nature Preserve (QNP) (TMI 1997a).

The first workshop was conducted in the two villages of Ngora and Khoryak in 1996. Crop loss or damage by kiang (*Equus kiang*) amounted to nearly 40% of the annual production. Following partial fencing of the fields, barley production has increased by nearly 100%, with most villagers becoming self-sufficient in terms of food, rather than being dependent on annual government subsidies. Each settlement was able to significantly increase winter forage production for livestock, which should greatly ameliorate hardships like those experienced during the harsh winter of 1995-96, and more recently in 1998. Reduced time spent guarding the fields, especially at night, was another beneficial outcome of the project. Following fence placement, only four persons were required for patrolling, compared to a minimum of 20-26 persons previously. The fences help to keep livestock out of fields following the planting of barley, but this may turn out to be a mixed blessing should depredation incidents increase because livestock are being less closely tended than before. The time freed from guarding fields was used to build a school, repair houses, and construct several new livestock enclosures. As a result, many villagers reported their feelings towards wildlife had improved markedly.

In order to retain these gains, villagers will have to ensure that the fence is properly maintained. To this end, they have started a small community fund capitalised from imposed fines and income from handicraft production (with training in weaving and dying skills being provided by the project). It is still too early to report on the handicraft activities, although the community has obtained county assistance and recently opened a small production unit on the main highway, 25 km to the east. The agreement signed by each household with the preserve management authority called for setting aside an area where wildlife would receive special protection in the hopes of becoming more habituated to humans over time. This subcomponent is in the process of being implemented. It is hoped that future tourism development will offer locals opportunities to rent pack animals and horses to tourists making the special trek to the nearby Shishapangma mountain base camp, also giving visitors the chance to view wildlife along the route.

Other efforts by the International Snow Leopard Trust centre around making night-time livestock pens or corrals predator proof, in order to eliminate mass killing of livestock that is historically common to the Himalayan region from the Shey-Phoksundo National Park in Nepal to Ladakh and Tibet. Wherever possible, targeted communities are assisted to increase capture of income from existing tourist traffic and use of the area.

Conclusions

These kind of 'hands-on' training workshops could easily be replicated in other protected areas and locations. They help to build local capacity for habitat protection (thus strengthening biodiversity conservation), while also meeting important criteria like 'low-cost', reciprocal financing and shared responsibility, based upon the 'best-practice' guidelines set forth in the recently completed QNP Depredation Management Handbook (Jackson 1998). This manual was developed as a direct output from the training workshops. Written in both Chinese and Tibetan, it describes how to undertake baseline surveys, assess and prioritise damage, and then negotiate signed reciprocal agreements with local communities to link conservation and income-generation activities beneficially so that local dependence upon, and impact on, marginal natural resources can be progressively reduced. By involving local people in preserve management, QNP has been able to rally new resources to supplement core government allocations for park operations. Where possible, project activities and outcomes are tracked using indicators developed by participatory means, thus building consensus and support for increased community-motivated and directed natural resource management and development initiatives.

In Nepal, there is a pressing need for researchers, development-conservation NGOs, and the Department of National Parks and Wildlife Conservation to collect reliable baseline information on crop and livestock damage sites, rates, and patterns in order to lay a sound framework for developing site-specific and locally adapted remedial measures. Research efforts in the Himalayas should focus on how herding practices could be improved, monitoring the abundance of prey species, establishing actual livestock losses to wild predators, and assessing the ecological impacts of the expanding livestock holdings (Mishra 1997). Appendix 3 summarises key information needs in this regard.

As an internationally 'charismatic' species, the snow leopard could serve as a 'barometer' for measuring mountain environmental health, and possibly even as an indicator for alpine biodiversity. It is therefore important that preserve managers work hard to maintain sufficient habitat and prey for this rapidly declining species. Parks with snow leopards may attract world-wide attention and additional funding that chould be used to promote more positive people-wildlife attitudes and to improve the involvement of local residents in park management and stewardship.

Although governments establish national parks and nature preserves, it is the local people who must live with the consequences. They bear the cost of co-existing with predators and preserving high-mountain biodiversity, often without realising any of the potential benefits. Whether affecting many or a few families, livestock depredation angers nearly everyone, especially if it occurs with regularity. It undermines the willingness of local people to protect wildlife or to tolerate the presence of a nature reserve. This highlights the importance of preserve managers implementing procedures and policies that effectively address people-wildlife conflicts in the protected areas of the Himalayas. The lessons from the programmes described above and elsewhere are vital to building up tenable strategies for addressing the legitimate concerns of pastoralists.

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APPENDICES

Appendix 1: Some common 'Participatory Rural Appraisal' (PRA) tools for assessing crop and livestock damage (adapted from the 1997 Kyirong Workshop, The Mountain Institute).

Tool and issue explored or information generated

1. Village social and resource mapping

- Crop or livestock damage—high damage areas, households that suffer from damage and relatively how much, characteristics of the most vulnerable fields or pastures
- Natural resource distribution and use—fuelwood, fodder, and timber collection areas and usage rates, NTFP collection/distribution sites; grazing pastures; water sources; wildlife 'hot-spots' and others
- Village profile—development interventions, base map, household occupations
- Cultural sites
- Wildfires

Where wildlife damage occurs — depredation 'hot-spots' and important natural resources

2. Trend lines

a) Range or forest condition	b) Economic status
c) Education	d) Trade
e) Wildlife presence	f) Crop damage/livestock loss rates
g) Cultural status	h) Health

Past, present, and potential future conditions

3. Pair-wise or matrix ranking

- Potential income generating activities/micro-enterprises
- Potential supplementary crops
- Crop and livestock protection measures or mechanisms—traditional and potential
- Importance of various crops to household income/subsistence
- Crops damaged most (part of plant, stage of plant development most vulnerable, etc)
- Kinds and ages of livestock most often killed by predators
- Wildlife species that damage crops or kill livestock
- Damage or mortality due to other factors (weather; natural disasters; poor nutrition or soil; disease; accidents; and others)

Where community energy and interventions should most profitably be focused

4. Venn diagram

- Relative amount of damage by crop or type of livestock (supplemented by records of crop losses kg/yr; or stock animals per household; describe method used to quantify)

- Local institutions, roles and relationships (who can change the situation)
- Relative importance of natural resource by quantified use (what is most important to the village)
- Key persons/institutions for developing and implementing action plans

Important institutions and persons for affecting change

5. Seasonal calendar

- Periods of crop and livestock damage (ranked or unranked)
- Occupations (men and women)
- Favourable seasons for tourism (weather, flowers, wildlife, hazards, trails)
- Cultural activities (tourist attractions and times of community celebration)
- Trade or transboundary activities: livestock herding, wildfires, trade

Times of year with most damage and highest tourism or best trade potential

6. Flow systems diagram linking Income-generating enterprises with conservation

- What if... stories, exercises to value wildlife, forest resources, cultural resources
- Exercises linking enterprise benefits with conservation

Instilling biodiversity conservation and environmental improvement as the primary objectives

7. Mobility map

- Transboundary activities
- Trade routes, import and export of materials, resources
- In and out migration
- Future mobility map: tourism (concerns?), trade, transboundary activities, handicraft/enterprise production

Important linkages with adjacent areas and communities

8. Monitoring and evaluation

- Villager sketching, note-taking, crop and livestock damage record keeping, and related monitoring of nature areas
- Development of monitoring plan, including identification of stakeholder-based indicators
- Personal, village, and PA commitments and follow-up plans

What indicators to use for measuring project performance and long-term impact. Who will do what?

9. Participatory planning, implementation and monitoring of field activities

- Identify collective crop damage and predator deterrent exercises (e.g., locally-made fencing, improved livestock pen designs; characteristics of good guard dogs or shepherds; construction of mobiles, noise-makers, and other deterrents)

- Delivery (do it!)
- Practice monitoring and evaluation while doing and after Delivery Phase

Outlining a monitoring plan and learning how to do it

10. Future desired conditions of village (via future map and trend lines) with regard to the following.

- Reduced crop damage/livestock loss (how much? where? when?)
- Benefits from micro-enterprises for compensating families and community who suffer damage
- Resource availability
- Wildlife populations and areas of conservation
- Ecotourism: where, how much, who will benefit, potential destinations/ activities, responses to expressed concerns about economic and cultural impacts of tourism
- Transboundary management (grazing, fodder collection, timber cutting, illicit trade, other)

Enhancing community capacity for planning and self-reliance

11. Action plans (see appendix 1 for example)

- Prioritised list of short, medium and long-term activities
- Detailed (2-3) action plans for selected priority/short-term activities, including micro-enterprise development by local villagers, conservation of natural resources/wildlife, crop damage protection schemes, and monitoring of crop damage reduction and other successes.
- Action plans to include: activities, sub-activities, objectives, who, when, where, cooperative body, and approximate budget with locally committed resources/funding and required outside support, and monitoring plan
- Plan for transboundary exchange, identifying objectives and expected outputs.
- Tentative action plan commitments by protected area authority and The Mountain Institute or International Snow Leopard Trust as follow-up to identified needs for outside support, management/enforcement, and monitoring.

Tools for empowerment — assuming responsibility for improving one's living conditions and the community's environmental stewardship

Appendix 2: Suggestions for ecologically-sound control measures in the Qomolangma Nature Preserve (QNP), Tibet (adapted from Jackson 1998).

Initiatives for Herders

Keep livestock in predator-proof enclosures at night-time (if necessary, improve existing corrals by raising the height of the external wall).

Avoid grazing in a known 'depredation hot-spot', especially during peak predation periods. Hot spots occur where there is plenty of cover in the form of vegetation or rocks, or where the terrain is strongly broken by gullies and ridges and interspersed with cliffs and large rock outcrops.

Encourage herders to guard their livestock conscientiously, especially during winter, lambing, calving season, or other periods of maximum depredation risk. For example, it may be possible to adjust the birth season of some livestock to decrease their vulnerability, although this option is usually limited by climatic conditions and the need for animals to grow quickly and put on weight before the onset of winter.

Try to ensure that livestock are clumped in a relatively small area at any one time, thereby it is hoped reducing the encounter rate between predators and livestock. Herds should also be rotated between pastures to avoid over-utilising fodder.

Most village dogs are very poor at guarding livestock — train them to do true guarding.

Remove carcasses of animals dead from disease or snowfall-induced mortality to avoid attracting scavenging carnivores.

Help QNP officials to ensure that prey species are protected by reporting all incidents of poaching, whether by outsiders or other villagers.

Initiatives for QNP management authority

Train herders in improved animal husbandry techniques, including daytime guarding measures and designs for improving corrals; identification and avoidance of depredation 'hot-spots'; and the means of detecting and verifying if livestock were killed or only scavenged by predators.

Find ways of reducing contact between people and snow leopard, including husbandry practices that make livestock harder to approach and stalk.

Create core areas for snow leopard and blue sheep which are largely or entirely livestock free.

Encourage communities to share in livestock guarding responsibilities, if necessary by hiring skilled shepherds paid from a special fund.

Promote the use of improved breeds of guard dogs and livestock showing greater instinct and ability to ward off predators.

Encourage herders to ensure lambing and calving occurs under confinement, since new-born animals are very vulnerable to attack

Offer communities economic and resource management incentives in exchange for tolerating some loss. For example, provide partially subsidised veterinary care for those families who demonstrate a reduction in depredation rates. Core area households willing to reduce the number of domestic animals could be provided with alternative sources of income, including sales of handicrafts, employment as wildlife guides or forest guards, and other jobs related to tourism.

QNP could establish a special fund to compensate those poor households that are especially impacted by depredation through no fault of their own. Alternatively, such a fund could be used to establish a small livestock herd owned by the preserve from which animals could be drawn to replace livestock that are killed.

Establish village-based wildlife conservation committees to assist in preserve management and monitor damage control measures.

Implement standardised procedures for recording and documenting livestock mortality due to predation and other causes, especially in or near QNP's core zones.

Develop safeguards against herders or communities making fraudulent claims, killing snow leopards, or poaching wildlife.

Do not permit foals to range freely for days. Store grass to feed them over the critical period.

Disincentives should be applied against herders who break rules or fail to protect their livestock adequately from predators. For example, offenders could pay a fine which would be deposited in a fund used for community development or resource management.

Appendix 3: Basic information requirements for developing depredation alleviation action-plans.

Knowledgeable herders, village leaders, and heads of households should be interviewed and questioned on the following items, using fully participatory techniques and the more widely accepted PRA tools.

Number of animals lost to disease and predators during the past 12 months (previous year) by each household. What was the age class, sex, and type of livestock lost to each kind of mortality (predators, disease, poisoned plant consumption, accident, theft)? How many animals succumbed to poor fodder or excessive winter snowfall last year or the year(s) before?

What is the current size and composition (number, type, sex, and age-class) of the livestock herd owned by the person being interviewed? The objective is to develop an unbiased profile of stockholding in the target community to serve as a basis for computing percentage lost or predation rates, birth and herd growth rates (trend), and economic value with respect to the various kinds of livestock and their productivity from interviews of different households and knowledgeable persons. Government records or statistics can be used to supplement these data on the livestock population of the particular community or village.

Identify during which season (month or months) most losses occur due to disease, predators, snowfall, and other factors. This is best done by asking herders to prepare a ranked matrix showing month and relative loss rate due to each major mortality factor. During which months are losses lowest or highest? Interventions should concentrate on the times of greatest loss or vulnerability for each major source of mortality.

Ask herders if they know during what time of night or day (dawn, midday, dusk) predators usually kill livestock. Determine the relative proportion of losses that result while animals are out grazing on the open range versus being housed in a corral (i.e., number of kills due to a predator entering into the corral). This will help determine if and when guarding by shepherds is most appropriate.

Determine the locations (in or near the village, summer or winter pasture) where losses occur and if possible identify the name and geographic location of all known depredation "hot-spots." Maintain maps of kill sites by each major predator species. Where possible, these areas should be avoided during periods of known depredation.

Identify each species that is causing damage, and which predators are the most destructive in this regard. During which months are predators closest to the village? Try to determine if villagers think that a particular individual is responsible for the spate of killings, based on some identifiable feature like physical distinctiveness, or track size and characteristics. Depredating species often vary from one locality to another, and one year to the next.

Ask local residents about wildlife population trends in the targeted area (while realising that such information may not be especially accurate or reliable, but it is nevertheless useful for park management and for involving people in conservation activities). What is the status of natural prey species in the area? Have they decreased or increased since establishment of the particular park, and what evidence do local people have for these trends?

What are the current and traditional practices used by villagers to prevent or reduce depredation loss? How effective are these, and how can such measures be improved upon? Have local herders become lax due to a change in attitude from one generation to the next, or the lack of manpower? Which of the techniques described in Appendix 2 would work best and do these comply with the PA's laws and regulations or management plan?

What is the cost of preferred preventative measures in terms of materials, labour, and maintenance? Would there be any negative impacts on the environment or community if these measures were to be implemented?

What matching or reciprocal arrangements and responsibilities would villagers, government, and other donors be willing to commit to?

Identify and discuss what indicators may best be used to measure the effectiveness of the project from an impact viewpoint. Obtain suggestions from the villagers for indicators that they would consider useful in determining the effectiveness of a particular invention (e.g., 50% reduction in number of livestock killed by predators; 'observable' increase in the number of blue sheep, no livestock killed in night-time corrals over a five-year period, etc). Try to use several indicators. For example, a reduction in the depredation rate may be balanced with monitoring of snow leopard or natural prey species' numbers or relative abundance (such as number, frequency, and location of sightings of animals or their signs). Determine how monitoring can be made as participatory as possible and how it can be accomplished on a regular basis at low cost.

B

Status of Grasslands in Mountain Protected Areas: Management Issues and Gaps

Status Paper of Langtang National Park

Jhamak Karki
Department of National Parks and Wildlife Conservation
Colleen McVeigh
Ph.D. Candidate, Department of Anthropology, Cornell University

Abstract

The Langtang National Park, gazetted in 1976, covers a total area of 2,130 sq.km in the Himalayan mountain region of Central Nepal. The park has an extremely varied vegetation, which ranges from upper tropical forest to alpine grass and shrub. Over 3,000 people reside within the park, and close to 17,000 people are estimated to depend on park resources to varying extents. Economically, local residents still rely primarily on agriculture and livestock herding, and are permitted to graze animals and gather dead wood within the park. Other human activities, that affect rangeland resources include burning, hunting, and trade in medicinal plants. Features of current local management practices include defined user groups with associated access rights and decision-making patterns; pastoral management strategies including transhumance, rotational and deferred grazing, and adjustment of stocking rates; burning to promote desired herbaceous growth; and religious beliefs and practices geared at promoting the pastoral sector. Future park management strategies should include registration of livestock owned by park residents, strict monitoring of wild plant harvesting and the development of a local policy on trading of medicinal plants, increased coordination between the District Forest Office and local park authorities, and the participation of local herdsmen and harvesters in policy development and enforcement.

Introduction

The Langtang National Park (LNP), first proposed by C. Caughley in 1969 and later endorsed by J. Blower in 1974, was formally approved by HMG in 1971 and gazetted in March 1976 as the first mountain park in Nepal, with an area covering 1,710 sq.km. In 1998, an additional 420 sq.km was added to the park as a buffer zone. The Langtang National Park is currently the third largest protected area in Nepal and one of the only five strict nature reserves within the country (Heinen and Kattel 1992).

Located in north-central Nepal, the park's southern boundary extends to just twenty miles north of Kathmandu. It is bounded by the Nepal-Chinese border to the north and east and the Bhote Kosi-Trisuli River to the west, and is bisected east-west by the Gosaikund Lekh-Dorje Lhakpa range.

Park objectives

The main objectives of the park as outlined in the 1977-82 management plan (DUHE 1977) are: to conserve the central Himalayan ecosystem, to regulate tourism, to conserve and manage habitat for endangered fauna such as the red panda, to perpetuate the local culture, and to regulate the use of natural resources by local communities residing within the national park.

Ecological attributes

Encompassing an altitudinal range of over 6,450m, the LNP is distinguished as having one of the greatest elevational ranges within its boundaries among the protected areas in Nepal (DUHE 1977). The wide altitudinal change accounts for the extremely varied vegetation found within the park, which ranges from upper tropical forest to permanent snow and ice. Though classified as a mountain park, a full complement of middle hill flora and fauna are found within the Langtang National Park borders (Heinen and Kattel 1992). Approximately 25% of the area is forested, and slightly over 30% is under permanent ice and snow, with the rest consisting mainly of alpine grass and scrub (Borradaile *et al.* 1977 in Heinen and Kattel 1992:64). The park's climate is typically monsoonal, though a rainshadow effect is produced north of the Gosaikund Lekh-Dorje Lhakpa range.

Over 1,000 plants, 160 birds, and 30 mammal species have been recorded in the park, including the *Larix nepalensis* (Himalayan larch), the only deciduous conifer in the region, and five threatened mammal species including the red panda. Endangered species such as the snow leopard and clouded leopard were also recorded in 1977, though no recent sightings have been reported (Heinen and Kattel 1992:64).[25] Other major wildlife species include Himalayan tahr and black bear, leopard, musk deer, barking deer, wild dog, wild boar, goral, and serow.

Socioeconomic attributes

The LNP encompasses parts of Rasuwa, Nuwakot, and Sindhupalchowk districts (56%, 6%, and 38% respectively) and houses twenty-six separate village development committees.[26] According to Heinen and Kattel (1992), over 3,000 people reside within the park, though close to 17,000 may depend on park resources to varying extents, with most of the latter living in villages on the southern boundary of the park.[27] The local population of both the park and its buffer zone area is culturally and ethnically heterogeneous, with both Hindu castes (e.g., Brahmin and Chhetri) and Buddhist groups (e.g., Tamang, Sherpa, and Tibetan) represented.

Rangelands and their use

Rangeland data for the Langtang National Park, including the identification of plant communities and the impacts of use activities on them, are conspicuously sparse. The original management plan (DUHE 1977), written over 20 years ago, still provides the most detailed information and is the basis for subsequent descriptions found in more recent publications. According to this report, LNP plant species fall into the following zones: upper tropical (below 1,000m), subtropical (1,000-2,000m); hill (2,000-2,600m); mountain (2,600-3,000m), sub-alpine (3,000-4,000m); and alpine (4,000-5,000m). Although the alpine

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25 Note that Heinen and Yonzon (1994)report that there is no evidence that Great Tibetan sheep (*Ovis ammon hodgsoni*) occur in the park as reported by Shrestha in 1981, and doubt the presence of wild yak (*Bos grunniens*) anywhere in Nepal.

26 Of the 26 VDCs, 13 are from Rasuwa, 5 from Nuwakot, and 8 from Sindhupalchowk. Only 7 VDCs are completely bounded by the park, though all are considered as buffer zone area. The 7 VDCs situated within the park house a total of 45 villages.

27 Like other mountain parks, Langtang is zoned to exclude village areas which instead are designated as buffer zone.

zone accounts for the highest percentage of the park's area (25%), the subtropical zone is said to be the greatest affected by man (DUHE 1977).

Below 2,000m, *Pinus roxburghii* and *Schima wallichii* occur in small pockets along the Langtang Khola (DUHE 1977:26). *Michalia champaca*, which is one of only two forest species found within the LNP that is protected by federal law[28], grows near Dunche and may occur in the lower Langtang Valley (Narendra Pradhan, pers. comm.). Shrubs occur only in the driest, rockier habitats, where a small number of species, including *Eupatorium adenophorum*, *Artemisia bulgaris*, and *Berberis asiatica*, dominate. Because these species are favoured by grazing (DUHE 1977:26), it is often assumed from their presence that overgrazing occurs . However, simply because these species exist in the area does not indicate degradation *per se*. Throughout the Himalayas, small areas are cleared within the forest by graziers to use as camping sites; these can be dominated by these species, although they occur only sporadically in neighbouring forest (C.E. Richard, pers.comm.).

Between 2,000 and 3,000m, *Pinus excelsa* and *Rhododendron arboreum* forest dominate. In 1977, the DUHE team remarked that the presence of livestock in spring and autumn had degraded natural forest resulting in shrubby growth forms where *R. arboreum*, they claim, is at a selective advantage (1977:27). They also noted that drier habitats are transformed into pastures where grazing-resistant species flourish, including *Anaphalis*, *Anemone*, *Potentilla*, and *Gentiana* spp.

Referring to the Langtang Valley only, Miller (1981) noted that between 2,500m and 3200m, *Andropogon tristis* is the most commonly encountered grass, and is replaced by *Arundinella hookerii* in areas that have been heavily grazed. He wrote, "The prevalence of a 'climax' species such as *Andropogon tristis* is indicative of good rangeland condition and dispels fears of serious overgrazing"[29] (Miller 1993, Annex 1, p.5). In drier sites in the sub-alpine zone, extensive areas are dominated by *Danthonia schneideri*, and replaced by *Agrostis inaequiglumis* and *Agrostis pilosula* in degraded areas (Miller 1981). Miller does not mention where these degraded areas are located, so it is impossible to say why they are so. Altitudinally, the area does correspond with the settled zone so that deterioration may be associated with overgrazing by domestic livestock during the winter months, but it is not clear.

On the south-facing slopes of the Langtang Valley at 3,000-3,600m, the DUHE survey noted *Hippophae rhamnoides salicifolia* and a community of *Caragana nepalensis* and other shrubs (DUHE 1977:28). According to Dobremez (1972), the latter is a plagioclimax community where the forest has disappeared and overgrazing has probably taken place for many years (cited in DUHE 1977:28). Others, however, argue that *Caragana* shrub is a natural community that occurs in dry areas, and thus is expected on south-facing slopes at high altitudes, such as those in the rain shadow areas of the upper Langtang Valley. These south-

28 The other is *sal* (Narendra Pradhan, pers. comm.)

29 He goes on to note that rangelands at 2,700 to 3,000 m are estimated to produce 1,500 to 1,800 kg of dry matter per hectare (Miller 1993: Annex 1, p.5).

facing slopes are warmer and drier than north-facing slopes, which are typically cool and moist, and will exhibit characteristics of Trans-Himalayan flora (C.E. Richard, personal communication).

Hay lands are reportedly dominated by *Elymus* and *Dactylis glomerata*, while *Medicago falcata* is found in both hay lands and abandoned fields around Langtang village (Miller 1992). These are located in various places throughout the subalpine zone, and their harvesting is regulated by the community.

Betula utilis—Rhododendron arboreum forests occur on north-facing slopes up to approximately 4,050m and mark the upper timber line. Above the birch-rhododendron forests, alpine meadows used as summer grazing stretch up to the present glacier margin, which reaches about 5,100m. (Odo and Sadakane 1986:103). The zone between 4,000 and 4,500m is described as rich in shrub species, which are dominated by juniper in dry areas like the upper Langtang Valley. *Ephedra gerardiana* and *Spiraea arcuata* are also found.[30] In 1977, large areas of *Salix* spp. were also reported, which are seldom seen in the more southern regions of the park. On riverside gravels and flats, *Myricaria rosea* and *Hippophae tibetana* were also found, though the latter is restricted to drier areas, extending on to old, colonised moraines. Only grasses, herbs, and cushion plants are able to grow in the upper alpine zone (4,500-5,500m) (DUHE 1977:29).

Animal husbandry

Economically, local residents still rely primarily on agro-pastoralism, of which animal husbandry is an essential component and an integral part of the social, economic, and religious life of the area. It also remains one of the main sources of cash income for many residents, particularly those affected by the government-run cheese factories.[31] Communities located in the more northern regions and higher altitudinal ranges of the park rely more heavily on animal husbandry than their southern neighbours. The relative importance of animal husbandry to individual households is governed by many factors, including the availability of summer and winter pastures and a reliable fodder supply.

Livestock are kept for their meat, milk, wool, hide, manure, and draught power. Domestic livestock found within the Langtang National Park include buffalo, lowland and highland cattle, yak and yak-cattle crossbreeds, sheep, goats, and horses. Though buffalo, cattle, and yak are reared in all three districts, specific herd compositions vary throughout the park, depending on factors such as altitude and availability of grazing and fodder resources. Cattle predominate in most VDCs but, in three, (Golche, Dandagaon and Sikharbensi) the percentage of buffaloes is higher. Langtang is the only VDC where the yak dominates, though the percentage of yaks is also high in Timure, Thuman, Jumla, Chilime, and Syabrubensi (DUHE 1977).

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30 The DUHE report notes "The Upper Langtang Valley is more related to Stainton's 'Dry Alpine Scrub' due to its sheltered, semi-arid environment" (1977:29).

31 A study conducted in the Langtang Valley by Borradaile *et al.* (1977), for example, revealed that because the land produced only enough food for three months of the year, earnings from pastoral activities were necessary to purchase food for the remaining nine months.

Since herd composition determines grazing patterns and feeding requirements, the associated impact on rangeland resources also varies. For example, because buffalo and lowland cattle are kept at lower altitudes, tethered near homes and stall fed, they have a greater impact on forest cover near permanent settlements. Yak and cross-breeds, on the other hand, generally depend more heavily on natural pastures in high-altitude areas, and thus rely more on fragile alpine communities.

Wild plant harvesting
Wild plants are collected from a wide altitudinal range within the LNP, and are harvested for both their subsistence and their commercial value (McVeigh in progress; Yonzon 1993; DUHE 1977). Both resident communities of the national park and people from outside the region collect wild plants, which are used for a variety of purposes. Yonzon, for example, notes that of 172 useful plants known within the park, more than half have medicinal value, 22.7% are used as food, 13% as fuelwood, nearly 6% as fodder, and 3.5% for religious purposes (Yonzon 1993).

Very little is actually known about wild plant harvesting and its impact on plant communities in the Langtang National Park.[32] Our literature review found only one recent article on the topic, addressing specifically the commercial harvesting of medicinal plants. According to Yonzon (1993), entire species are threatened as a result of a growing trade in plants for herbal medicines, particularly those which are popular, rare, slow-growing (such as those at high altitudes), and/or habitat specialists. He notes that for a significant number of species, the entire plant is destroyed during harvesting, suggesting the potentially devastating impact of harvesting on a commercial scale.

Burning
Over 20 years ago the Durham University team reported that summer pastures within the LNP were often burned during the winter in an attempt to remove undesirable shrubs from pastures (DUHE 1977). Forest in lower altitude areas was also reported to be burned, to increase both herbaceous growth and the extent of available pasture, especially in the conifer zone. More recently, Miller (1992) noted the burning of shrub lands in the Langtang/Helambu region, though information as to the extent and reason for this practice was not reported. Though burning practices appear to be beneficial in the short term, their effects in the long term are not clearly understood.

Rangeland Management

Indigenous pasture management systems
Research conducted in several areas of the Langtang National Park suggests that resident herders are not only using but managing pastoral resources in their

32 HMG's Department of Medicinal Plants conducted a survey of medicinal plants in the Langtang Valley in the 1970s, and the 1977-82 management plan has a short section on forest products which includes medicinal plants. However, both of these studies are now over 20 years old and very little recent information seems to be available.

areas.[33] Though pasture lands lying outside of designated village areas are technically owned by the state, communities recognise *de facto* rights held in common by local residents on which basis indigenous pastoral management systems can and do operate.

Throughout the park, there is enormous variability in herd management strategies, both within and between communities. Factors such as social organization, land tenure arrangements, livestock composition, degree of dependence on agricultural products, interactions with outside groups, and labour availability all play a role in determining how individual families and entire communities allocate and manage pastoral resources. Features of local pastoral management systems in the Langtang National Park include: defined user groups and associated access rights; specific decision-making patterns and conflict management strategies; pastoral management strategies including transhumance, rotational grazing, deferred grazing, and adjustment of stocking rates; burning practices to promote desired herbaceous growth; and religious beliefs and practices geared at promoting the pastoral sector.

DNPWC policy and management initiatives

By law, only livestock owned by national park residents are allowed to graze inside park boundaries, and then only with the appropriate permits. In some sensitive areas, such as the Red Panda Conservation Area (Cholang-Dokache area), grazing regulations have been implemented that reduce the number of effective grazing days allowed in the area. For the most part, however, the DNPWC does not actively manage grazing within park boundaries, and grazing permits are not sought by local residents. Also, people living outside the park, namely residents of Yarsa VDC, still seasonally graze within park borders without interference.

Issues and Impacts

The following are the main practices affecting rangeland resources in the Langtang National Park.

- Animal husbandry
- Wild plant harvesting (both for commercial and subsistence use)
- Cheese-making (both by the government-run factories and local individuals)
- Tourism
- Hunting/poaching
- Burning
- Fuelwood collection

The following are the main issues of concern related to these practices.

- Over-grazing/over-harvesting with associated changes in floristic composition
- Soil erosion and compaction
- Trampling
- Forest degradation and loss of tree cover
- Loss of wildlife habitat
- Competition with wildlife for grazing resources

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33 See, for example, Cox (1985) and McVeigh (in progress) for descriptions of the indigenous pastoral management system in Langtang VDC, and Fox *et al.* (no date) for information on Syabru VDC.

Research and Management Gaps

To ensure that the rangelands remain productive for livestock and wildlife alike, viable pastoral development strategies and range management programmes need to be implemented in the Langtang National Park, based on current, up-to-date information.

Research gaps	Research needs
• Local harvesting of wild plants and its impact on plant communities is poorly understood. More data are needed, and whatever information is available needs to be updated. There is also a lack of information differentiating local vs. outside impacts/practices, commercial vs. subsistence use, and the impacts of specific harvesting practices (e.g., is the whole plant being destroyed?).	• Park wide ethnobotanical survey of indigenous plants, including an inventory of local names, uses, and harvesting practices; resident dependence on plant species; and determination of critical population sizes. Need to monitor the resilience of local species to harvesting practices, which in turn needs to differentiate between subsistence vs. commercial harvesting, as well as harvesting by local residents vs. outsiders.
• Lack of up-to-date information on rangeland resources and conditions throughout the entire park, and the impact of current practices on them. Available information is out-dated.	• Detailed survey of all grazing grounds inside the park identifying 1) active grazing areas; 2) animal user groups (both domestic and wild) including numbers, origin, and time of grazing; and 3) plant species' composition, including seasonal variations and their response to different user groups (including herbivores) and user activities.
• Lack of current data on fodder use and management	• Research on livestock feeding practices differentiated according to ethnic group, location, and herd composition.
• Lack of information on the long-term effects of current burning practices	• Research investigating both the short- and long-term effects of burning in alpine grassland and forest areas.

Management gaps	Management needs
• Ineffective management of wild plant collection and suppression of smuggling (see Yonzon 1993).	• Strict monitoring of wild plant harvesting, particularly by outside groups • Greater coordination between the District Forest Office and the DNPWC • Development of local policy on trading of medicinal plants • Participation of local harvesters in policy development and enforcement.
• Lack of monitoring of livestock numbers and pasture use	• Registration of livestock owned by people from each settlement within the park.

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Projects undertaken in the LNP

- Expansion of local school (with funding from the British Education Trust)
- Micro-Hydro Electric Project and associated activities (Japanese funded)
- Langtang Ecotourism Project (The Mountain Institute)
- Livestock Fodder Development Project (HMG)
- Quality Tourism Project (UNDP)
- Snow and Glacier Hydrology Project (Department of Hydrology and Meteorology, HMG)

Status Paper of Kanchenjunga Conservation Area

Fanindra R. Kharel
Department of National Parks and Wildlife Conservation

Abstract
The Kanchenjunga Conservation Area (KCA) has been declared recently with the aim of ensuring the sustainable, productive use of natural resources by local people concomitant with the protection of threatened habitats and species through the establishment of a system of community participation in natural resource management and conservation. Transhumant pastoralism, whereby herders migrate with cattle or sheep herds according to season from low to high altitude pastures and back is one of the most important economic activities practised by the people within the KCA, and a major source of income . A management model that neglects biodiversity conservation interlinked with pastoralism could result in a deterioration in the condition of existing grazing lands and rangelands. To address this problem, a two-week exploration trip was made to temperate and alpine zones within the KCA. This paper highlights the findings of the trip. Potential solutions discussed here emphasise the need for the KCA to organize participatory research programmes to address rangeland resource management issues.

Background

The Kanchenjunga Conservation Area (KCA), located in Taplejung District in north-eastern Nepal, was formally declared by the His Majesty's Government of Nepal (HMG/N) on July 21, 1997 (HMG/N 1997a). A total of 1,700 sq.km of the Kanchenjunga massif and the watershed located in Taplejung District was included in the KCA. Later, the Conservation Area was extended to 2,035 sq.km to include areas covered by the Olangcung-Gola, Lelep, Tapethok, and Yamphudin Village Development Committees (VDC) of Taplejung District, which was notified by HMG/N in the Nepal Gazette of September 14, 1998 (1998).

The altitude of the KCA varies from 1,200m along the banks of the Tamor River at Chiruwa, to 8,586m at the top of Mt. Kanchenjunga, the third highest mountain in the world. The KCA contains a dramatic landscape including 11 mountain peaks over 7,000 masl and some of the world's largest glaciers. The KCA is bordered by the Sikkim State of India to the east and the Tibetan Autonomous Region of the Peoples' Republic of China to the north. As a result of its strategic location, the KCA provides an unparalleled opportunity for trans-boundary conservation.

Because of KCA's location directly north of the Bay of Bengal, it receives comparatively more rainfall from the summer monsoons than other parts of Nepal. As a result of its climatic conditions, combined with steep elevation gradients, it supports a great diversity of plants and wildlife habitats. There are at least 2,500 species of flowering plants, including many varieties of rhododendron growing up to 4,000 masl and rare forests of larch, juniper, fir, oak, birch, and bamboo. The wildlife in the area include snow leopard (*Uncia uncia*), musk deer (*Moschus chrysogaster*), Himalayan black-bear (*Selenarctos thibetanus*), wolf (*Canis lupus*), blue sheep (*Psedois nayaur*), ghoral (*Nemorhaedus goral*), serow (*Capricornis sumatraensis*), and common leopard (*Panthera pardus*) etc.

Although KCA accounts for nearly 60% of the land area of Taplejung District, less than two per cent of the total area of the KCA can be classified as arable. About 5,000 people inhabit the fertile bottom land and steeper hillsides of the region's four main river valleys: the Tamor, Ghunsa, Simbuwa, and Kabeli. The KCA's rich mosaic of ethnicity includes Limbu, Rai, and Bhotia as well as various Hindu castes. The area contains a number of culturally significant landmarks including centuries-old Tibetan monasteries and sites of Hindu pilgrimage.

The people of Kanchenjunga combine traditional agriculture, pastoralism, and trade to survive. Transhumant pastoralism is practised by Tibetan, Sherpa, and other ethnic groups (from outside the KCA) in the upper parts of the Simbuwa, Ghunsa, Tamor, and Kabeli river valleys within the KCA. They process dry cheese, clarified butter, and sheep's wool for sale. High altitude pasture is regulated as a common property resource. Access to summer pasture lands is regulated by the respective VDCs. Grazers pay a grazing fee to the VDCs and the VDCs use the collected fees to finance other development activities, including trail improvement, within the VDC boundary.

Grasslands: Status and Use

Transhumant pastoralism is a very important economic activity within the KCA and the major source of livelihood. In this context, the sub-alpine and alpine zones used by the herders for summer pasture within the KCA can be considered as rangeland according to the definition: "land on which the native vegetation is predominantly grasses, grass-like plants, forbes or shrubs" (Valkeman 1998a). Similarly the sub-temperate and temperate zones used by pastoralists within the KCA fall in the category of grazing land (synonymous with pasture land): "a collective term that includes all lands having plants that are harvested by grazing without reference to land-tenure, vegetation types, and management practices" (Valkeman 1998b).

Rangeland Management Issues

A growing local population, poaching of wildlife, shortened cycles of swidden (slash and bum) agriculture, and encroachment on forests combined with transhumant pastoralism are potential threats to the KCA's ecosystems. However, transhumant pastoralism is a very important economic activity within the KCA and the major source of cash income. The importance of keeping livestock is not likely to decrease.

Movement of a relatively large number of sheep and cattle herders was observed by the KCA's Project Manager during the two-week field trip to the alpine and sub-alpine zones of Olangchung-Gola, Lelep, and Yamphudin in July 1998. From interviews with the herders, it was clear that many came from outside the KCA for summer pasture.

Frequent use of the same traditional pastures in the alpine zone and forested areas of the temperate zone by transhumant herders has a potential negative impact on forest regeneration in the mixed broad-leaved forest of the temperate zone. For example, the lower part of the temperate zone, with a dominance of mixed-oak forest, is under double use pressure. In summer, low altitude cattle go up to this zone to graze and in winter high altitude cattle come down to the zone to graze.

Research Gaps/Needs

It is difficult to assess any overall changes in the condition of resources resulting from the impact of grazing in the KCA because of lack of data. No research has been carried out by the KCA management authority on the identification of the grazing area; identification of users and their grazing area management practices; or preliminary assessment of the condition and biodiversity situation of the grazing areas within the KCA.

An ecological site description should be prepared by organizing a research study to assess the impact of grazing on KCA's biodiversity, both to improve the socioeconomic situation of the grazing area users and to ensure sustainable grazing area management. It has been recommended that participatory research programmes are organized to address the issues of grazing land and rangeland resource management in the KCA.

Management Recommendations

The KCA has the established objectives of sustainable, productive use of natural resources by local people, and protection of threatened habitats and species. Ensuring the sustainable use of rangeland and forest resources is a pre-condition for local development.

As one of KCA's management objectives is to conserve biodiversity by minimising the impact of grazing on vegetation and wildlife, grazing area management should be introduced through formal grazing user groups, to protect use rights and to increase conservation awareness through collaborative management. Community-based grazing user groups should be initiated and established in all VDCs within the KCA through formation and mobilization of Conservation Area Management Committees (CAMC). These should ensure that biodiversity conservation receives its proper place in the system of rangeland management. The returns include the protection of watersheds and wildlife habitats and conservation of biodiversity, while optimising the economic benefits of the livestock herders through grazing area management. To achieve these multiple objectives, the KCA authority should introduce a concept of joint grazing area management through the development of a forum for collaboration between herders and the KCA management authority.

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Status Paper of Dhorpatan Hunting Reserve

Ramchandra Kandel
Department of National Parks and Wildlife Conservation

Abstract

The Dhorpatan Hunting Reserve (DHR), located in the high mountain physiographic region of western Nepal covers 1,325 sq.km and comprises alpine, sub-alpine, and high temperate types of vegetation. It is surrounded by settlements in eleven Village Development Committees (VDCs) of Rukum, Baglung, and Myagdi districts to the east, west, and south. Pasturelands occupy more than 50% of the total area of the reserve at higher elevation. The reserve is affected by human pressures from grazing, wood harvesting, poaching, and unauthorised collection of medicinal plants. More than 100,000 livestock belonging to about 5,000 households are brought to the reserve for grazing each year. People from adjoining and neighbouring VDCs of three districts enter the reserve to let their livestock graze from mid March to October. As a privilege, people from distances as far away as three-days' travel (Palpa district) are allowed to continue livestock grazing in DHR, although access is supposeddly controlled through the local VDCs. Problems may be minimised if the carrying capacity of the grassland is improved in a scientific and strategic manner. A database needs to be maintained that can be used to help in making better management decisions. Participatory management practices in DHR can be a successful tool for pastureland management in this mountain region.

Background

The Dhorpatan Hunting Reserve (DHR), located in western Nepal, includes parts of Rukum, Baglung, and Myagdi districts in the Dhaulagiri Himalayan range. Putha, Churen, and Gurja Himal form the northern boundary of the reserve; to the south the reserve is bounded by the Uttar Ganga River; Darkhani, Jhalke, and the ridges of Lama Kyang form the eastern boundary; and Khariwang khola, Pelma khola, Ulta vanjyang, and Jagala vanjyang the western boundary. The higher elevations remain snow-capped throughout the year. The altitude of the reserve ranges from 3,000m to more than 7,000m.

The reserve covers 1,325 sq.km and has the distinction of being the only hunting reserve in Nepal. It is renowned for its blue sheep (*Pseudois nayaur*) population. Other species hunted are goral (*Naemorhaedus goral*), serow (*Capricornis sumatraensis*), Himalayan thar (*Hemitragus jemlahicus*), barking deer (*Muntiacus muntjak*), and wild boar (*Sus scrofa*). Apart from large game species, other species found in the reserve are lynx (*Felis lynx*), red panda (*Ailurus fulgens*), musk deer (*Moschus chrysogaster*), wolf (*Canis lupus*), snow leopard (*Uncia uncia*), common leopard (*Panthera pardus*), mouse hare (*Ochotona royeli*), rhesus macaque (*Macaca mulatta*), langur (*Presbytis entellus*), and wild dog (*Cuon alpinus*), and the birds danphe (*Lophophorus impejanus*) and chir (*Catreus wallichii*). Endangered animals in the reserve include musk deer, wolf, and red panda, and endangered birds chir and danphe. Common plant species include fir (*Abies spectabilis*), pine (*Pinus wallichii*), birch (*Betula utilis*), rhododendron (*Rhododendron arboreum*), hemlock (*Tsuga dumosa*), oak (*Quercus semecarpifolia*), juniper (*Juniperus indica*), and spruce (*Picea smithiana*).

The reserve was established in 1983 and gazetted in 1987. The management objectives of the reserve allow sport hunting and preserve a representative high altitude ecosystem in west Nepal. The alpine meadows above the tree line (4,000m), locally known as 'patans', are important for animals like the blue sheep. The reserve is characterised by alpine, sub-alpine, and high temperate vegetation, and comprises high and rocky mountain ranges. Located in front of moderately high saddle connecting the high Dhaulagiri and Hiunchuli, and shielded by several ridges south of the Uttar Ganga, the reserve area receives less precipitation than other parts of Nepal's mid lands (Stainton 1972). Extrapolating from (Dobremez and Jest 1971) and Hagen (1961), total annual precipitation is somewhat less than 1,000 mm, of which one half falls as rain in the summer monsoon months, and the rest as snow, mostly in January and February. This dry climate, which favours grass vegetation at higher altitude, may partly explain the presence of blue sheep so far south of its central range in the rain shadow of the Himalayas (Dolpa, Mugu, Humla, Mustang, and Manang, in Nepal) (Dobremez and Jest 1971).

The majority of the local residents are Magar and Kami, with some Nauthar caste and some Tibetan refugees. Their major occupation is agriculture and livestock, but Tibetans are also involved in business in Tibet. Potato, buckwheat, and barley are the main crops produced.

Grasslands: Status and Use

Traditional grazing practices

As the reserve is surrounded by the settlements of 11 Village Development Committees (VDCs) in 3 districts (Table 1), the area has been greatly influenced

Table 1: **Village Development Committees (VDCs) in the Buffer Zone around DHR**

District	VDCs	Households	Population	Livestock	Names of office and field posts
Rukum	1. Ranma maikot	900	4977	19800	1. Mahikot Post
	2. Hukam	352	2187	8800	2. Taksera post
	3. Kol	150	840	3300	
	4. Kakri	162	934	3560	
	5. Taksera	716	3847	31217	
Baglung	1. Nisi	870	4814	8551	1. Niseldhor Post
	2. Bobang	900	5850	19800	2. Headquarters (Dhorpatan)
	3. Adhikari chaur	340	1250	7922	
	4. Bunga dovan	180	995	3960	
Myagdi	1. Lulang Khoriya	228	1381	1446	1. Gurja ghat Post
	2. Gurjakhani	146	878	2117	2. Gurja khani Post

by the activities of local people. There are many pasturelands scattered throughout the reserve (Table 2). They occupy more than 50% of the total area of the reserve at higher elevations.

Table 2. **List of alpine ('patan') and lower pasturelands in various blocks**

Block Name	Name of the pasture lands
Surtibang	Balegri, Surttibang, Bayali, Thari, Khalikhola, Chuha, Mahabhas, Chauribuki, Mani, Marpes, Hile, Dum, Nepane, Patalethari, Pokhara, Jurgun, Barulakharka, Simpani, Mulkharka, Kalidhand, lasunban, Marpani deurali, Ratamata, Pangrsbsn
Barse	Gurjaghat, Shivaodhar, Rughachaur, Naulakhola, Kharbayali, Nimthala, Thalkharka, Thulomela, lammela, Surkemela, Dayamela, Dallejur Sasarmul, Chokte, Dhuka, Sechun, Phaliyaghar, Simthari
Fagune	Tikethara, Rajban, Dahakharka, Khubribanlasune, Chaundul, Ratabhir, Phurse, Kiteni, Fagune, Satban(Murchula), Kholathari, Thangur, Simkharka, Jalaapa, Bhedachaur, Lamdanda, Mandi, Ripla, Kanspur Bhimpa, Niseldhor, Nebhang, Daha, Majhdhara, Rithekharka Karichaur, Paleti, Hanirahulo, Tarabang, Pattigaira, Ranikharka, Nursing buki, lasune, Drubathari, Ghakalibang, Dotho, Dharkharka, jauleghati, Jaulebisauna, Chamale, Thalkharka
Ghustung	Mansungmela, Naure, Chaluke, Parvimarvi, Nayaban, Newabang Hinggoi, Kayamdanda
Dogadi	Wollochalike, Psllochalike, Puthaban, Tiser, Lamsar
Seng	Pupal, Ghurang, Purbabg, Panidhal, Naure, Jangalapas, Bhedacharan, Nautale, Darlanwa, Tallosim, Upallosing, Ngangabas, Dule, Khani
Sundaha	Ankhe, Pape, Daple, Chaurikhark, Kultavanjyang

The major season for livestock grazing varies from mid March to mid October. Animals are brought to 'buki', highland pasture where alpine grasses dominate, from mid May to August. Herds move down to the lower pastures in late August and reach Dhorpatan by September. By the end of October, they have returned to the lowlands. Tibetan livestock remain in Dhorpatan throughout the year. During severe winters, the larger stock are used to transport goods in the region. Generally, men of 25-40 years are engaged in livestock grazing. Milk and butter are the main products from the cattle. Milk production from buffaloes ranges from 1-2 to 4-6 litres per day. The milk is consumed by the local communities themselves. None is sold for cash income. About 5,000 households are directly involved in livestock grazing. Each of them owns 20 livestock units (LU) on average, which shows that about 100,000 livestock graze within the area (Heinen and Kattel 1992). The type of livestock grazing varies in the different blocks (Table 3).

Table 3. **Types of livestock grazing in different blocks**

Grazing Site	Animals	District	Remarks
Fagune	All**	Rukum, Rolpa, Baglung	Sheep only from Rukum
Barse	All	Myagdi, Baglung	Mainly mules and horses
Ghustung	All	Myagdi, Baglung	Buffalo from Myagdi and sheep, goat, cows, mules, from Baglung
Surtibang	All	Dolpa, Rukum, Baglung	Sheep, goats, and cattle only from Dolpa
Seng*	Mules, horses, sheep, goats	Dolpa, Rukum	
Sundaha*	Sheep, goats, buffalos	Rukum	
Dogadi	Sheep and goats	Rolpa, Rukum, Baglung	Few from Baglung

* The Seng and Sundaha blocks are rich in wild animals.
** Sheep, goat, cattle, mules, horses

An understanding was established with the local VDCs to allow only people from VDCs in the Buffer Zone (BZ) area to graze their livestock inside the reserve. Furthermore the local people have a good understanding with the reserve authority that the livestock should only be brought to the *Buki* from mid May to the end of August. From May 1999, the local people have decided to restrict horses and mules belonging to hunting groups. However, these arrangements ignore the traditional rights of those coming from other areas.

Management Practices in DHR

Management of hunting

To manage hunting so as to regulate the objectives of the reserve, the area is divided into seven hunting blocks with a specified quota system (Table 4). At present, sport hunting is organized by two companies: Wildlife Adventure Nepal and Himalayan Safari Nepal. There is a system of block reservation, and the hunters take a separate permit for each animal.

Management of the grazing cycle

An agreement has been reached between the local VDCs in the buffer zone and the DHR to control livestock belonging to outsiders (communities beyond BZ areas). A discussion programme is held once a year among reserve managers and local herders to discuss problems and sustainable grazing practices. Previously, the head of the reserve office used to collect a charge from livestock holders for grazing inside the reserve; but due to the lack of strict regulations, this ceased. At present, the adjoining VDCs in the BZ collect a charge from all livestock grazers who come from other areas. However, this is leading to a higher livestock pressure inside the park, and VDCs have even been found to be engaged in financial irregularities.

Table 4. Hunting blocks, area, and quota system for professional hunting			
Blocks	Area (sq.km)	Annual quota of blue sheep	Authorised Agency
Sundaha Seng	145	4	WAN
Dogadi	138	4	HSN
Ghustung	199	6	HSN
Fagune	201	4	WAN
Barse	327	4	WAN
Surtibang	167	4	WAN
	148	not practised	-
Total	1325	26	

Research Activities
Some experts have conducted research in this area. The reports include:

1. a blue sheep status survey (Wegge 1976);
2. an overall assessment of DHR (Bajimaya 1990); and
3. Survey and management proposals for the Himalayan Shikar (Hunting) Reserves (Wegge 1976).

Management Issues
Grazing—Excessive grazing can lead to vegetation loss, soil exposure, and disturbance of wild animals. Although blue sheep often graze and live among herds of domestic goats and sheep, there is concern that local people affect the young and old blue sheep. There is a potential risk of transfer of diseases (Table 5) from domestic to wild animals, although no research has been conducted to show this transference. The recent introduction of mules and horses for hunting purposes may be displacing blue sheep along the ridges.

Livestock affects wild lands most severely when large tracts of forest are cleared for pastures. In the absence of intensive management in DHR, there is concern among PA managers that some pastures have lost their productivity owing to soil erosion, compacting by cattle hooves, depletion of nutrients, and invasion by noxious and unpalatable plants. This warrants further investigation to substantiate such concerns with follow-up action on the part of the local herders and PA managers.

Table 5. List of diseases possibly communicable from domestic livestock to wild ungulates	
Name of Disease	
Nepali Name	English name
Luto	Menge and scabies
Khoret (FMD)	foot and mouth disease
Mokhma mala jasto khatira	-
Vyakute	Haemorrhagic septicaemia (HS)
Phila sunnine and cracking with bleeding	-

Encroachment—During the grazing season, herders sometimes cultivate the open land for agricultural crop production and eventually claim this land. If these claims are accepted, it would result in a reduction in the size of the reserve area, degradation of site quality, and loss of grassland ecosystems.

Over harvesting of wood and timber—People use timber products for making houses and livestock sheds, and for cooking without taking permission to harvest from the reserve authority. They also girdle trees to make harvesting easy in the coming year. Blue pine (*Pinus wallichiana*) resin is heavily extracted for lighting purposes.

Collection of herbs—Many people are engaged in collecting herbs for local treatment and selling to outsiders. Trade of non-timber forest products (NTFP), especially of medicinal plants, is well established. Local dealers are in touch with local communities illegally for collection. The herbs are sold in Burtibhang, then to Tamghas, Pokhara through Beni, Rolpa, and Rukum.

Hunting/poaching—With the presence of so many herders, it is difficult to identify whether a man is a poacher or not. Poachers mainly poach musk deer for trade. Herders have traditionally hunted wild animals such as blue sheep for meat and hides by trapping.

Settlements inside the reserve—People inside the reserve delineate their area illegally and use it for cultivation and settlement, which influences the reserve. Herders, resident communities, and poachers sometimes threaten reserve personnel.

Staff shortages—The limited number of reserve staff cannot be deployed effectively given the diverse demands on their time.

Food deficiency—Valuable foodstuff is now given to mules and horses, and this could lead to food shortages or heavy reliance on purchased grain.

In summary, DHR faces several problems similar to those facing other protected areas in Nepal. These challenges include the following.

1. Local peoples' dependence on forests to meet fuelwood, timber, fodder, and heating needs, resulting in degradation of forest resources, especially in the critical, high altitude areas
2. Over-grazing of pasture by livestock and increased competition for forage between livestock and wild ungulates, resulting in habitat degradation
3. Conflicts between local communities' agricultural and animal husbandry practices and management of the protected areas
4. Lack of trained natural resource managers and inadequate infrastructure for management of the area
5. Inadequate knowledge about and planning for the impacts of tourism and grazing in culturally and environmentally sensitive region
6. Poaching and illegal trade of wild and endangered protected species

Research Gaps

The protected area Manager in Dhorpatan Hunting Reserve would like to answer two types of questions about the species in the reserve.

1. What species of plants and animals occur within the protected area, where and in what numbers?
2. What are the population trends of wild animals over time?

The authority of the reserve is concerned about the gap between the database of the reserve and the database needed to develop a strategy for effective management of the reserve. There is not only a lack of systematic surveys, inventories, and studies of fauna and flora (especially threatened species), there is also insufficient information about local uses of natural resources, including non-wood products and the illegal exploitation of herbal plants.

It is usually said that grazing, browsing, and trampling by domestic animals affect various ecological processes. For example, there can be a modification of the natural succession leading to a dominance of unpalatable species and reduction of palatable species. Excretion of dung can make vegetation unacceptable to wildlife, although it also fertilizes pasture land. Similarly, natural decomposition processes are circumvented by the grazing animal cycle as the increase in herbage intake results in a lower production of litter and low rates of decomposition. Exposure of the soil surface causes increased surface runoff leading to soil erosion. Although all these events may potentially be devastating to natural ecological systems within the reserve, no systematic study has been conducted to date on these aspects of livestock grazing.

Any change in the distribution in abundance of species is of major significance for management. These are usually determined by periodically measuring similar samples, i.e., by recording trends over time. In monitoring, the manager has to be very selective and should restrict observations to indicator species or key phenomena.

Monitoring usually aims at recording three different features of biological resources.

1. Trends in population of key plants and animal species over time, including historical evidence where possible
2. The measurement of reproductive success or productivity of a species
3. Assessment of the quality or condition of species and habitats, which can involve examining soil loss and water runoff patterns, measuring total biological productivity, or assessing species' composition.

Recommendations

If grazing is allowed in a protected area, the PA manager must maintain some degree of control over grazing rights. As soon as the desired level is reached, the manager must have the authority to regulate access. The effects of grazing by domestic livestock should be carefully monitored to ensure that the protected area does not lose any of its original value due to the presence of livestock.

Fostering a land ethic through conservation awareness programmes can be the remedy for ecologically damaging land-use practices, where they exist. Once adopted by society, a land ethic would discourage irresponsible land use through social pressure. In some cases, active manipulation of an ecosystem is not only permissible but vital for its successful management. Taking this into consideration, the following recommendations have been made for the sustainable management of grassland in Dhorpatan Hunting Reserve (DHR).

1. In some forest areas, absence of livestock grazing may result in invasion by undesirable shrubs and tree species, thus reducing the forage base for native ungulates as well as livestock. However, in other areas, such as alpine or drier shrub communities, cattle and other livestock may displace wildlife from natural grasslands and, in the absence of proper range management, may degrade these lands. To address these varied responses to grazing, studies should be conducted on the impacts of livestock grazing in different ecological zones within the hunting reserve. In addition, support for livestock development loans should be contingent on sustainable management of grazing lands by herders.
2. To regulate the livestock grazing in DHR, rights to graze sheep and goats should be authorised for traditional users only (both within the BZ and beyond). Similarly, a system of identity cards should be applied for BZ dwellers to control grazing by those outside.
3. Studies should be conducted to determine the degree of competition between livestock and wild herbivores in order to reduce potential conflicts in DHR. Follow-up management could be done that matches domestic animals with wild species that have different food habitats. If well managed in specific grazing sites, the different or combined productivity of both game and livestock can be boosted beyond that of either separately.
4. It is necessary to perform compulsory health checks of domestic livestock.
5. To avoid overgrazing in lower forest areas, stall feeding should be encouraged, at least partially. For this purpose, fodder trees should be planted on farmland by communities in the lower elevation villages and in BZs. In addition, improved breeds of cattle with limited numbers should be promoted, provided that the benefits in terms of improved animal performance exceed the costs of maintaining such animals.
6. Local people, especially herders from both the BZ and beyond, should be organized and made aware of their rights, while simultaneously increasing their conservation awareness through their participation in management. They should be empowered to make decisions for proper grassland management by means of discussion and participatory planning.
7. To reduce the dependency on livestock rearing, alternative employment such as apple farming, processing of apples, potato cropping, and development of handicraft skills. should be provided to the local communities. Another activity could be the development of the area as a tourist region.
8. The unarmed game scouts of the reserve have no chance against armed poachers. They should be supplemented with separate armed forces which could be handled by the reserve administration.
9. Adequate budget and staff are required for effective management of the reserve.

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Status Paper of Khaptad National Park

Nilamber Mishra
Department of National Parks and Wildlife Conservation

Abstract
The Khaptad National Park (KNP) represents a unique landscape of rolling plateau with grasslands, rich in mid-hill flora and fauna. It encompasses various religious sites including Khaptad Swami's hermitage, temples, and stone statues, and Khaptad Lake. These plateaus are the traditional grazing land of people living in the surrounding areas. The grazing pressure in the Khaptad plateau is intense during the summer season (April/May-July/August), and illegal grazing is common towards the periphery round the year. This has resulted in the degradation of grasslands, increased soil erosion and gully formation, and a decrease in the number and variety of flowering plants. Wildlife populations such as musk deer (Moschus chrysogaster) are decreasing rapidly as a result of poaching and disturbances caused by livestock grazing. Little research has been done on the grasslands, and a study on the impact of grazing on grassland composition is needed. In addition, a pilot study is recommended on controlled burning of grassland to increase nutrient quality and reduce unpalatable species.

Background

Before the Khaptad National Park (KNP) was established in 1984, the local people had traditionally divided the grassland areas among themselves and grazed their livestock in their respective areas (Achham, Bajhang, Bajura, and Doti districts). However, the gradual increase in human population exacerbated grazing pressure and human encroachment for settlement, and exploitation of forest resources by cutting and burning also degraded the quality of the natural habitat. KNP was established to prevent further degradation of the natural resources and to conserve a mid-hill ecosystem.

Ecological attributes

Khaptad National Park represents the mid-hill flora and fauna of Nepal. It is situated at the cross point of four districts, Achham, Bajhang, Bajura, and Doti. It covers an area of 225 sq.km. The altitude varies from 1,450m (Chauki danda) to 3,300m (Shahasralinga). The KNP has innumerable sources of mid-hill biodiversity, including 21 mammals, some of which are rare and endangered such as musk deer (*Moschus chrysogaster*), Himalayan black bear (*Selenarctos thibetanus*), and leopard (*Panthera pardus*). From the park area, 270 species of birds, more than 15 species of butterflies, 192 species of flowering plants, and various medicinal plants have been recorded. Important attractions of this park include various religious sites such as Triveni, Sahasralinga, the Ganesh temple, and Khaptad Lake-including the *ashram* of the famous holy man, the Khaptad Baba. The park was established in 1984 on Khaptad Baba's initiative.

Grasslands: Status and Use

There are about 22 patches of grassland on the plateau within the Khaptad National Park. These grasslands cover more than 25% of the total area. In these grasslands, the Park allows grazing for four months from March/April- July/ August. The number of livestock grazing inside the park ranges from 3,200 to 3,700 (Table 6).

Table 6. The trend of cattle population in KNP pastures in the last five years		
Fiscal Year (B.S.)		Livestock Number
2048/49	1990/91	3,250
2049/50	1991/92	3,650
2050/51	1992/93	3,700
2051/52	1993/94	3,200
2052/53	1994/95	3,450

After the establishment of the park, local people were encouraged to use the resources through the provision of park permits for harvesting *nigalo* (*Drepanostachyum* sp.) and thatch grass and extracting wood, firewood, and fodder. The number of permits given for the harvesting of these products is increasing every year.

Research Activities

So far no research on grassland management has been carried out in KNP. A demonstration plot to study the grazing impact inside and outside of the enclosure is planned to be conducted in the year for which the proposal is under preparation.

Grassland Management Issues

The following are some of the issues of rangeland resource management seen by the park management and the local people.

1. The livestock population is increasing annually as a result of the growing human population in the local (proposed Buffer Zone) community.
2. During the summer and rainy seasons, there is no alternative pastureland outside the park for grazing livestock.
3. The quality of pastureland is being degraded. (Pers. and observation)
4. The population density (biomass) of flowering plants in the grassland is decreasing (Pers. and observation)
5. Because of the degraded grasslands, gully formation and soil erosion are increasing.
6. The wolf population is gradually decreasing in the park, the reason is unknown.

Research Gaps/Needs

- Up-to-date information on the number of livestock grazing in the Khaptad National Park area is needed.
- The effect of controlled burning on grasslands has not yet been studied.
- The impact of grazing on the species composition and productivity of the grassland should be studied.
- Research on the impact of livestock grazing on the wild animals is lacking.

Management recommendations

1. Grazing should be prohibited at religious sites.
2. The time allocated for grazing (4 months) should be reviewed if any adverse impact of grazing is found by the research.
3. If controlled burning in this area is proven beneficial by the research, it should be applied on a rotational basis.
4. Grazing of horses and donkeys should be banned if any adverse impact is seen from the research.
5. Awareness programmes on grassland management and sustainable utilisation of resources need to be conducted to create awareness among grazers and local communities. Such programmes can include mass meetings, extension programmes, establishment of demonstration plots, and similar.
6. Alternative plans should be prepared for self-reliance to encourage local communities to plant fodder and grass species on their private land and marginal community land.
7. Local people should be encouraged to reduce the number of livestock by phasing out unproductive cattle.

Status Paper of Rara National Park

Gopal Bahadur Ghimire
Department of National Parks and Wildlife Conservation

Abstract
Rara, the smallest National Park in the country, was established with the objective of maintaining the natural beauty of Rara Lake by protecting its watershed area. As a result of the implementation of strict conservation practices, the majority of grasslands in the National Park have been invaded by pines, while some other parts are experiencing illegal livestock grazing. The impact of grazing on biomass production, species composition, and livestock-wildlife competition has to be studied in detail in order to manage the grasslands more efficiently.

Introduction

Rara (RNP), the smallest National Park in the country covering an area of 106 sq.km, is located in the Mugu and Jumla Districts of the Mid-western Development Region of Nepal. The unique Rara Lake and the beautiful landscape around the lake are the main attractions of the park. A few ungulate species found in Rara NP such as barking deer (*Muntiacus muntjak*), ghoral (*Nemorhaedus goral*), jharal (*Hemitragus jemlahicus*), and musk deer (*Moschus chrysogaster*) are also important. This is the only park in the country established after the evacuation of local people from the area. The main objective behind the establishment of RNP is to maintain the natural beauty of Rara Lake and protect it from sedimentation and other adverse impacts of human activities.

The park is surrounded by nine Village Developments Committee areas (VDCs) from two districts. The second major activity of the local population is animal husbandry. Although the local people have no right to graze within the national park area, occasionally livestock do enter the park and graze and thus have some impact on the grasslands within the park.

Grasslands: Status and Use

Rara National Park is small and only about 20% of the area is covered by grassland. After the establishment of RNP, livestock grazing was legally prohibited. As there are only a few wild herbivores within the park, part of the grasslands has remained unused ever since. However, in some areas people graze their livestock inside the park, and these areas show signs of overgrazing.

Grassland Management Activities

Apart from protection from illegal grazing, no management interventions have so far been carried out.

Management Issues

Livestock-wildlife competition

In the southern part of the park, i.e., in Jumla District, there are a few spots where local people keep cattle-sheds next to the park border and graze their livestock inside the park. People around the park are compelled to graze their cattle within the park area because there is no buffer area outside the park boundary. Although there is no peruse information available on the change in biomass production and number of grass species, personal observation shows that towards the Bota side of Jumla District and around Ghuchchi, there might be overgrazing and grazing competition with wildlife.

Invasion by tree species

Invasion of the grassland by pines in some places is the major management issue of the park.

Trampling effect

During winter, a few local people use the route along the grasslands to take their livestock to drinking water, causing severe trampling effects in the grassland areas.

Research Gaps

Although livestock grazing takes place within the park area, no research has been done on the impact of grazing on species' composition and biomass production in the grasslands. There may be competition between livestock and wildlife for food, at least in some parts of the grasslands, and this needs to be studied in detail. Similarly, the reason for the invasion of the grasslands in some areas by pines is not well understood. The presence of only a few wild herbivores within the park coupled with the exclusion of livestock grazing from most of the park areas, could be the cause. But this needs to be confirmed.

Management Recommendations

1. Once research has been done to discover whether livestock grazing is an essential part of grassland management in the park appropriate steps will need to be taken.

2. Water resources in the buffer zone area outside the National Park should be managed so that livestock do not need to be taken through the National Park to drink. This will avoid any negative impact from trampling.

3. If the research shows signs of competition between wild herbivores and livestock for food, appropriate measures should be taken to prevent the problem.

4. Controlled burning has been shown in many areas to suppress the invasion of grasslands by tree species, thus it needs to be applied in Rara National Park.

Status Paper of Shey Phoksundo National Park

Tulsi Ram Sharma
Department of National Parks and Wildlife Conservation

Abstract
Shey Phoksundo National Park is the largest park in the country and represents the Trans-Himalayan ecosystem. As a result of the extreme climatic variation, the park has more than 1,300 species of plants, 30 species of mammals, 200 species of birds, 6 reptiles, and 1 amphibian species. Aproximately, 2,600 people live within the park boundary and 5,000 around the park in the buffer zone. The local economy is mainly based on highland agro-pastoralism. Livestock rearing is the main source of income, food, and transportation. Over 70% of the park area is covered by grassland, of which nearly half is estimated to be inaccessible as a result of the steep rocky topography. Grazing and livestock-wildlife competition are important management issues. During summer, local residents graze their cattle in specific pasturelands delineated according to traditional norms. This paper discusses whether grazing competition between livestock and wildlife, and grazing by livestock, can function as a management tool or not.

Introduction

Shey Phoksundo National Park (SPNP), legally gazetted in 1984, is located in the Dolpa and Mugu districts of the Mid-western Development Region of Nepal. It covers an area of 3,555 sq.km, is the largest national park in Nepal, and represents the Trans-Himalayan ecosystem. As in Langtang and Sagarmatha National Park, local people inhabit the park. More than 2,600 people reside within the national park and nearly 5,000 in its buffer zone area.

Animal husbandry is the second major activity in Dolpa after agriculture and is more popular in the northern part of the district. Livestock are an integral part of the social, religious, and agro-economic life. There are an estimated 1,300 households in and around the national park. The average animal holding per household is estimated to be 2.2 cows, 8.9 sheep/goats, 0.15 buffalo and 1.0 yak (Dhakal 1998). People residing in the park and buffer zone graze their cattle both within the park and the buffer zone. The people of Kaigaun, Rimi, Pahada, Tripurakot, Raha, and Dho VDCs in the buffer zone have traditionally used different pasture areas within and around the SPNP. At the same time, these areas are equally important for wildlife populations. The common herbivorous species found in SPNP are ghoral (*Nemorhaedus goral*), jharal (*Hemitragus gemlahicus*), great Tibetan sheep, Tibetan antelope (*Pantholops hodgsoni*), bharal or blue sheep (*Pseudois nayaur*), and possibly wild yak (*Bos grunniens*).

Grasslands: Status and Use

Grasslands cover about 70% of the total area of the national park. However, most are inaccessible as a result of the steep, rocky topography (Mandal 1990), the remainder are used by local people to graze their livestock.

Grassland Management Practices

The common practice of pastureland management is rotational grazing managed according to traditional norms. The pasture areas needed by people residing within and around the park were separated historically. Each settlement has its separate pastureland for grazing livestock at different times. The cattle graze on different pastures in different seasons. Livestock grazing during summer facilitates shrubs and forbs, which are the winter diet of blue sheep. If unchecked, forbs and shrubs would degrade pasture quality reducing regeneration of grass for livestock because of their priority effects. In several places, blue sheep and livestock graze together, and yak protect blue sheep from other predators, which suggests a positive relationship between livestock and blue sheep.

Management Issues

Wildlife-livestock interaction

Grazing and livestock wildlife competition are the important management issues in SPNP, and have been discussed widely (Miller 1987; Bajimaya 1990; Yonzon 1990). The main question is how severe the situation is? Observational evidence suggests that wildlife –livestock competition for grazing is not very marked.

- There is a relatively low density of livestock (compared to pasture area) and decreasing number, probably as a result of the changing socioeconomic conditions (Pandey 1996) and increasing frequency of predation by wildlife (pers. comm.).
- The unit area biomass and number of pasture species are higher in lower Dolpa (18 to 21 species) than in upper Dolpa, (13-17 species). This shows that there is a sustainable grass supply for the present livestock and wildlife populations (Basnet 1996).
- Except in a few small spots in the Shey Gompa, Perikapuwa, Pungmo, and Jagdulla areas, where livestock are kept continuously for several weeks during the summer months, there are no overgrazed and degraded pastures. Rather, a positive relationship seems plausible (Basnet 1996).
- Pasture productivity (biomass per unit area) and vegetation cover are quite high (Basnet 1996).
- The common herbivorous species (like blue sheep) are well adapted to the very steep, rolling, and broken alpine terrain near rugged cliffs (Schaller *et al.* 1994; Wilson 1981), and they graze in the upper meadows where the majority of livestock are rarely healthy. During winter, blue sheep congregate on snow-free slopes and forage on the shrubs and forbs which emerge after livestock grazing. Livestock grazing alters the community structure and composition resulting in higher numbers of the shrubs and forbs that compose the winter diet of blue sheep (Basnet 1996).
- Stable populations of blue sheep in the Shey Gompa area (Yonzon 1990), Perikapuwa (Richard 1994), Naure, Namdo, and Kagmara (personal observation) also suggest that the competition between blue sheep and livestock is not pronounced.

Despite these observations, it is known that people residing in the buffer zone area occasionally graze their animals inside the park though they do not have the right to do so. This may result in competition for food between livestock and wildlife in these border areas.

Table 7. The common pasture species particularly used by wildlife and livestock

Species used by both wildlife and livestock	Major winter food species for blue sheep)
Agrostis sp.	*Anaphalis contorta*
Arundinella nepalensis	*Berberis* sp.
Deschampisa nepalensis	*Caragana brevifolia*
Pedicularis siphonohphyta	*Cotoneaster microphyllus*
Danthonia schneideri	*Ephedra gerardiana*
Plantago sp.	Ferns
Festuca sp.	*Juniperus* sp.
Poa pagophila	*Lonicera spinosa*
Potentilla atrosanguinea	*Polygonum* sp.
Potentilla sp.	*Rosa sericea*
Potentilla phurijuga	*Rumex nepalensis*
Potentilla cuneata	*Sumex nepalensis*
Potentela fruticosa	*Thermopsis barbata*
Primula sikkimensis	
Pterocephalus lepidotum	
Sedum sp.	
Senecio sp.	
Spirea arcuata	
Thalictrum sp.	
Trisetum sp.	

Research Gaps

Research has been conducted on the following topics.

- Baseline survey of SPNP
- Socioeconomic tourism survey of SPNP
- Biodiversity survey
- Sustainable use of medicinal plants
- Traditional system of grazing in highland pasture

The findings of the above research programmes were not well documented and are not available in the park office. In addition, follow-up research and monitoring should be carried out.

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About the Editors

Ms Camille Richard is a Rangeland Specialist working in the Mountain Natural Resources' Division of ICIMOD, Nepal.

Dr Khadga Basnet is the Ecoregion Coordinator at Tribhuvan University and the WWF Nepal Program, Kathmandu, Nepal.

Mr Jay Prakash Sah is a Lecturer at the Central Department of Botany, Tribhuvan University, Kathmandu, Nepal.

Mr Yogendra Raut is a Research Assistant in ICIMOD's Regional Rangeland Programme.

Participating Countries of the Hindu Kush-Himalayan Region

Afghanistan

Bangladesh

Bhutan

China

India

Myanmar

Nepal

Pakistan

International Centre for Integrated Mountain Development (ICIMOD)
4/80 Jawalakhel, GPO Box 3226
Kathmandu, Nepal

Telephone
+977 1 525313

Facsimile
+977 1 524509
+977 1 536747

email
distri@icimod.org.np

web site
http://www.icimod.org.sg

Cable
ICIMOD Nepal