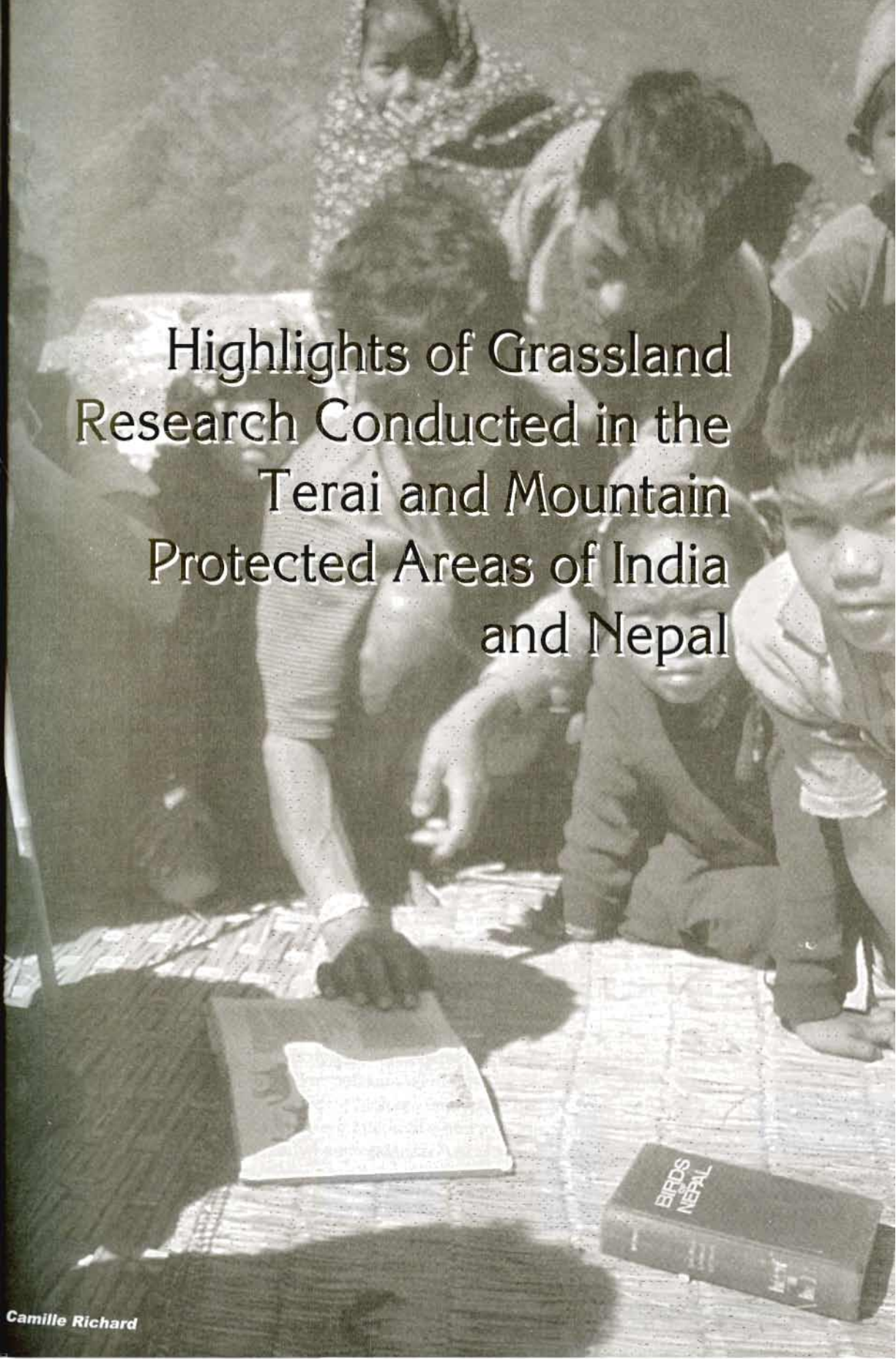
Highlights of Grassland Research Conducted in the Terai and Mountain Protected Areas of India and Nepal



Camille Richard

Terai Grasslands[2]

A Landscape Approach to Managing the Indian *Terai* Ecosystems with Reference to Uttar Pradesh, India

Vishwas B. Sawarkar

This paper addresses some of the broad issues relating to the management of *Terai* grasslands which are considered to be among the most threatened ecosystems in India. Historically, the National Forest Policy of 1952 included most grasslands in the category of village forests in recognition of their utility as grazing areas for cattle and production of fodder, otherwise, they were included in unclassed or vested forests, in ignorance of their biological values and ecological functions.

The *Terai* grasslands, which are unique in their biological and physical attributes and ecological functions, cannot be seen in isolation from the matrix of forests (woodlands) and other categories of land use within which they are located. This area has 21 types of forest belonging to five sub-groups. The forests are mainly upland woodlands, whereas the grasslands occupy the lowlands amidst interspersed seasonal and perennial swamps. Both the forests and the grasslands are parts of a landscape that has rich agricultural, human habitation, livestock, and other land uses.

Current inventories highlight the rich biodiversity of the area; 75 tree species, 37 shrubs, 20 species of climbers, 179 species of aquatic plants, and 77 species of grasses have been recorded among the plants and 56 species of mammals (12 endangered), 455 species of birds (29 endangered), 16 reptiles (5 endangered), 19 amphibians, and 79 species of fish among the animals. Many of these animals are strongly dependent upon the maintenance of the *Terai* grasslands.

The first attempt to bring wildlife management under a specific Wildlife or Protected Area Plan came about in 1972. However, it is only very recently that the concept of buffer zones outside the PAs have enabled the wildlife planners to extend management outside PA boundaries where strategies are normally covered by eco-development plans. In practice, the current strategies to manage buffer zones chiefly address the management and reduction of social and economic pressures on PAs and forest resources.

In a landscape approach to ecosystem management, principles of landscape ecology constitute an intersection between all disciplines of wildlife science, viz., ecology, geography, forestry, wildlife biology, landscape design, sociology, and economics. In other words, they are integrative and inte disciplinary. Various issues in the *Terai* have already been addressed using a landscape approach. For example, when many tigers were killed in the seventies, it was found that the pattern of kills conformed to the intensity of spatio-temporal activity of

[2] The full papers are presented in Volume II of this Workshop Series

people and the increasing presence of immigrant labour in an unfamiliar environment. Thus, to reduce the propensity of encounters, an integrated approach was recommended which included strong anti-poaching strategies, maintenance of thatch grass patches outside the park, maintenance of corridor links, maintenance of fuelwood reserves, and management of fish resources in swamps and rivers outside the PAs.

The opportunities to resolve the issues surrounding a single wide-ranging species and the interests of the people mainly lay in planning land use over a large tract outside the park. For example, the northern swamp deer (*Cervus duvauceli duvauceli*) is an obligate species of the *Terai* grasslands and is one of the most endangered deer species in the world. The same factors that affected the tiger have affected the swamp deer. Thus, to secure its future, the whole flood plain grassland habitat, extending well beyond the wildlife sanctuary, needs planned attention. Similarly, it is suspected that elephant herds now range over much larger tracts than it was thought in the past. This has increased the problems for conservation of elephants, and for maintaining economic security of people across the range of elephant movement. These problems underpin the need for landscape/regional planning.

It is clear that most species use more than one habitat. The forest or wildlife departments may not have jurisdiction over such large areas, but they can identify opportunities and accomplish the desired set of practices through building partnerships with other agencies. It is clear that eco-development or buffer zone management cannot succeed without partnerships with motivated and willing stakeholders, among whom the local communities are most important. Furthermore, the procedures also need to set the terms of bilateral cooperation between countries. The landscape planning approach admittedly has many miles to go. The important need is that wildlife managers, planners, and decision makers need to be walking on that road.

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

Pradeep Kumar Mathur

India possesses a rich diversity of natural ecosystems as a result of its strategic location at the confluence of different bio-geographic realms. India has been divided into 10 bio-geographic zones, of which one is the *Terai*, the west-east stretch of the northern alluvial flood plains of the rivers Ganga and Brahmaputra. This area once harboured dense vegetation dominated by sal (*Shorea robusta*) forests with interspersed tall grasslands and numerous swamps. The area is now fragmented as a result of abrupt changes in land-use policy, uncontrolled expansion of agriculture and large-scale reclamation of grasslands and swamps, heavy deforestation, and factors like fire, grazing, and floods during the post-independence era. However, even in its present form, this woodland-grassland-wetland ecosystem complex still harbours a wide variety of flora and fauna, including several endemic and endangered species of mammals and birds. Because of the series of changes, mostly resulting from

human activities, the *Terai* has become one of the most threatened ecosystems in India.

As a result of the ongoing positive moves for the conservation of this valuable ecosystem, several large remnant patches of *Terai* forest and grasslands in different states of the country have been declared protected areas, although protected areas in the *Terai* still cover only two per cent of the total area in comparison to the average of 4.5 per cent for the country as a whole. The average size of the PAs in the Indian *Terai* is about 185 sq.km., and, like the majority of the PAs in India, they are isolated islands of wildlife habitats surrounded by people and incompatible land uses.

Extensive research has been done on various aspects of the *Terai* ecosystem. Most of the existing information on this ecosystem is in the form of checklists, inventories, biological surveys, community ecology studies, and species' oriented research on selected, endangered mammals and birds. However, some sporadic studies have been made for selected PAs on resource mapping, socioeconomics, and changes in land use. Baseline information was gathered during the preparation of Forest Working Plans, which largely provide information on the type and extent of forests, taxonomic checklists (plants, birds, and mammals), forest management practices, habitat management, and, to some extent, socioeconomic profiles. In addition to this, several floristic and faunal surveys have been undertaken throughout the *Terai* by survey organizations such as the Botanical/Zoological Survey of India and other scientific institutions.

In the case of grasslands, only preliminary research is available on grassland succession and habitat dynamics. Although extensive areas of the grasslands are affected by a variety of weed plants, little research has been conducted on this aspect. Only general accounts have been provided of the effect of grazing, grass cutting, and burning of grasslands on the species of concern. Furthermore, many studies and reports advocate annual grassland burning, but such recommendations are rarely based on actual experimental studies. Most of the few studies done fail to provide any insight into ecological relationships and interactions among plants, wild animals, livestock, and humans. Despite the fact that the entire *Terai* region is under tremendous pressure as a result of ever—increasing biomass demands by local people and intensive agricultural development, only a few sporadic studies have been done on land-use changes using remote sensing. In addition, only a few socioeconomic profiles have been compiled and preliminary assessments of resource dependence made in selected villages.

Wildlife or protected area management research is of comparatively recent origin in the Indian *Terai*, and the majority of investigations or research studies have been of short duration, at the most three to four years. Thus, a well organized long-term rigorous scientific research and integrated monitoring programme is needed to enhance benchmark knowledge; facilitate decision-making; reduce overall management costs; and enhance ecological integrity through increased public awareness and participation–and thus help PA management.

The recommended topics for priority research include flood plain dynamics, grassland surveys, management-oriented, long-term experimental studies in grasslands, biological control of weeds, genetic study of endangered species, resource dependencies and park-people conflicts, and the impact of changing scenarios, policies, and programmes. A comprehensive, integrated, long-term monitoring programme needs to be designed and developed based on multidisciplinary research inputs. In short, research, monitoring, and management need to be blended. Participatory research and monitoring activities involving local people should be emphasised and given high priority.

Managing the *Terai* Grasslands in Nepal: Recent Research and Future Priorities

Nic Peet, Diana J Bell, and Andrew R. Watkinson (Presented by Nic Peet)

This paper summarises some of the research and management priorities identified as a result of a recent research project in the *Terai* grasslands. The project investigated botanical diversity across four protected areas, animal species-plant assemblage associations, the effects of cutting and burning on *Imperata cylindrica* dominated grassland, the spatial and temporal responses of ungulates to cutting and burning, and the socioeconomics of grassland harvesting.

Nine grassland assemblages were identified in the four *Terai* protected areas. Early successional grasslands are dominated by **Typha elephantina**, **Phragmites karka**, and **Saccharum spontaneum**. Assemblages on drier and better-developed soils are dominated by **Narenga porphyrocoma**, **Saccharum bengalense**, and **Themeda arundinacea**. '*Phanta*' grasslands occur on old village sites and abandoned agricultural land within the protected areas and are dominated by **Imperata cylindrica**. Chitwan has the highest assemblage diversity, whilst Bardia and Shukla *Phanta* are of particular importance for their **Imperata cylindrica** grasslands. Assemblages in Koshi Tappu are limited to early successional grasslands resulting from flooding.

Research activities should be prioritised that will lead to a better understanding of successional processes in the grasslands. The priorities should be investigating and predicting landscape dynamics, quantifying rates of successional change at all seral stages between bare alluvium and early successional flooded grassland and forest, and gaining a better understanding of the role of fire, cutting, and grazing in the successional process. The exploratory models described by Lehmkuhl (1989) to predict changes in river course and alluvial deposition in Chitwan, should be developed further and extended to Bardia and Shukla *Phanta*. Reports indicate that the rates of change between grassland types and between grassland and forest are generally influenced by disturbance, particularly fire. Thus, long-term experiments should be undertaken to examine the influence of fire and cutting on successional change in a variety of different assemblages.

Research on faunal associations with one or several grassland assemblages has concentrated primarily on larger mammals. There is a clear need to extend the

understanding of associations to more faunal groups and to seasonal changes in assemblage utilisation so that the effects of ephemeral forage resource on ungulate populations, and those of cutting and burning on smaller cover-dependent species, can be assessed. Similarly, the results of a management experiment conducted in Bardia indicate that if management of the grasslands is to reflect the conservation of biodiversity other than ungulates and their predators, then it is important for managers to consider leaving uncut and unburned refugia. This would mean leaving patches of grassland unmanaged on a rotational basis. This is of particular importance for grasslands that are not influenced by flooding. The remaining *Imperata cylindrica* dominated '*Phanta*' grasslands are becoming smaller as a result of succession to tall grassland and forest. Thus immediate steps should be taken to monitor encroachment and remove invading tree saplings. Because the most suitable methods for maintaining patches of shorter grassland within the tall grasslands are currently unclear, priority should be given to investigating experimentally methods of preventing succession to tall grassland.

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

John F. Lehmkuhl (invited paper, not presented at the workshop)

This paper highlights the results of research on the ecology of a tall grass and riverine forest mosaic in the eastern portion of Royal Chitwan National Park, Nepal, during the period from 1985-1987. The experiment focussed on the landscape dynamics in riverine grasslands, the productivity of natural grasslands and village pastures, the effects of fire and herbivores on production, and quantification of human use.

Approximately two-thirds of the study area was sampled with a 188 relevé of 8.5 m x 8.5 m plots in grasslands and 11m x 11m plots in the understory of riverine and sal forest. Black and white aerial photographs from 1964 and 1981 were used to quantify landscape patterns, then model landscape dynamics. Similarly, experiments were conducted in stands dominated by *Imperata cylindrica*, *Saccharum spontaneum*, and *Narenga porphorycoma* to estimate the effects of fire and wild ungulate herbivores on annual production. Primary consumption by rhinoceros (*Rhinoceros unicornis*) and domestic elephants (*Elephas maximus*), and the dominant ungulate herbivores was estimated by multiplying the number of animals by the per capita harvest. The quantification of the human use of grasses was done by multiplying the number of grass cutting permits by per capita harvest.

Results showed that the landscape was not stable but a 'shifting mosaic', with constant properties. Analysis of the photographs and model simulations indicated that three sub-systems of landscape change existed in the area. Those were eroded land, increased area of *Saccharum spontaneum* floodplain, and reclaimed agricultural land succeeding to natural vegetation.

In the study area, ten grassland associations with six phases and three forest associations were identified. Fluvial action was considered as the controlling force of community organization at the landscape level. Similarly, soil moisture development and fire were the primary factors underlying community organization and succession, whereas large mammalian herbivore feeding and fodder cutting for domestic elephants were secondary factors.

Above-ground net primary production of Chitwan's grasslands appears to be among the highest in the world. Fire and grazing had significant effects on the standing biomass of *I. cylindrica*, whereas no significant grazing effects on production were found with *N. porphorycoma*. In both stands, however, early burning without grazing produced the greatest biomass. Both stands received different degrees of human disturbance. Model simulations indicated little change in *I. cylindrica* biomass availability, a 28 per cent decrease in mixed tall grass biomass, and a 15 per cent increase in *S. spontaneum* biomass over 20 years, based on 1987 data. In the village pastures, *Chrysopogon asciculatus, Cynodon dactylon* and *I. cylindrica* dominated the grazed pasture composition; grazed production was 39 per cent less than the ungrazed production inside the exclosure.

Grass consumption by animals was estimated using a value for the average daily intake of fodder per elephant of 45 kg DW (dry weight). About 60,000 grass cutting permits were sold for human use, and there were about 216,000 visitor-days during 1985 and 1986. The harvest of thatch grass and canes for house construction was 6,406 tonnes and 4,726 tonnes, with monetary values of NRs 4.6 million and NRs 5.4 million, respectively.

Results from the experiment showed that staggered burning could foster the formation of pasture-like grazing lawns by concentrating grazing pressure on limited areas. Grazing lawns would produce high-quality forage year-round, may decrease crop depredation by attracting wild herbivores away from agriculture, and would increase herbivore carrying capacity. Similarly, patch burning would also increase cover for wildlife, but patch size would be critical for success.

In conclusion, an increase in the *S. spontaneum* grassland type is good for park management since this type of grassland represents perhaps one of the highest quality habitats in the Park. The species can also be used by the local people, via grass cutting permits, to make paper fibre. The demand for *I. cylindrica* is also extremely high. Thus, a programme to mechanically break up extensive tall grass stands that were formerly *I. cylindrica* into a patchwork of tall grass and I. *cylindrica* might benefit wildlife.

Finally, the concept of adaptive management, which is ideal for testing new grassland management treatments where results are uncertain, for example, the effects of patch burning or mechanical treatments on productivity and ungulate use should be emphasised as a strategy to manage *Terai* grassland for conservation and compatible human use.

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, Morten Odden (invited paper, not presented at the workshop)

This paper describes types of grasslands, their origin, utilisation by the people, role in the conservation of mammals, and mapnagement practices in the lowlands of Nepal, and gives guidelines for their sustainable management. There are two general types of grassland: a) riparian tall grass floodplains and b) wooded grasslands and *Phantas*. The floodplain grasslands, which consist of tall, perennial grasses, are natural in that they become established and are maintained by fluvial action and flooding, but they are successional since they will develop into forest if periodic flooding ceases and the soil substrate stabilises.In contrast, the wooded grasslands and *Phantas* consist of shorter perennial species that originated following human intervention (forest clearing, burning, grazing of domestic stock, and cultivation); and they occur on more or less stabilised soils.

Both types of grasslands have traditionally been utilised by local villagers for different purposes. The tall grasses in the floodplain are mainly cut and harvested for canes, whereas the wooded grasslands and *Phantas* were previously grazed by domestic stock. Grasses are cut and harvested for a variety of local uses. Grazing is now prohibited within the protected areas, but grass harvesting is permitted once a year for one to two weeks in the winter. In addition, both types of grasslands are periodically burnted intentionally, either by the protected area managers or by the local people.

Field studies in Koshi Tappu, Chitwan, Bardia, and Shukla Phanta have documented the crucial role that both types of grasslands play in the conservation of several wild mammalian herbivores, and thus in the conservation of their carnivore predators. The recent census data from the western part of Royal Bardia National Park (RBNP) shows that the total density and biomass of wild herbivores (excluding megaherbivores) in the mosaic of grasslands and grassland-related habitats are among the highest recorded in Asia. They have attributed the mosaic of different habitat patches to the extraordinarily high density and also diversity of ungulates in the grassland-related habitats of RBNP.

Recent investigations have disclosed a higher density of tiger in the mixed habitat complex of RBNP than in the Royal Chitwan National Park (RCNP) or most tiger reserves elsewhere. Since several of the species that occur in the south-western part of Royal Bardia National Park belong to categories endangered or threatened internationally, this region of the park should be considered a bio-diversity 'hot spot', requiring special attention by management.

The two types of grassland mentioned above need different management interventions. If the strategy of no intervention is adopted, some scenarios can be predicted. These scenarios include successional changes from different types of grassland to forest, or from forest to grassland, and their impact on the population of mammals such as hog deer, rhinoceros, wild elephants, chital, tigers, and nilgai. Such scenarios further predict that a reduction of prey biomass through loss of wooded grasslands and *phantas* through natural succession would also intensify the food competition between tigers and leopards. A likely consequence is that leopards would be further displaced to the periphery of the park and increase their predation on small livestock, which could intensify park-people conflicts.

The Park authorities are already practising a moderate human intervention management policy, however. Until recently, this consisted of permitting some 35,000-40,000 villagers to enter the park during a short period in the early dry season to cut and harvest grasses in both types of grassland, and of burning large parts of the grasslands shortly thereafter. Recently, a programme for maintaining the wooded grasslands and *phantas* has also been initiated in which encroaching shrubs and trees are removed through uprooting and cutting. Both of these interventions (grass cutting and *phanta* management) provide benefits to the local communities. Similarly, the recently initiated intervention of mechanically removing encroaching shrubs and larger trees, in order to maintain *Imperata* dominated grass cover on the wooded grasslands and *phantas*, seems well justified ecologically and is probably required in order to maintain the high diversity and density of wild ungulate biomass as a food base for the predator community.

The management guidelines for short grassland types (both cutting and burning), suggested by Moe (1994) and Peet et al. (1997), advise rotational cutting and burning, with patch burning spread over a longer time during the dry season. Less work has been done on the ecological effects of cutting and burning of tall grasses in the floodplain. An equilibrium may be maintained between the relative coverage of grass-dominated communities and later tree-covered successional stages as a result of the regular re-creation of new grassland by river action. Thus a non intervention policy may not cause any loss of these natural grasslands. The continuation of the present practice of cutting and burning by the local people is recommended, but these activities should be fully guided in the interest of conservation principles and the natural integrity of the protected areas.

It is recommended that smaller wooded grasslands and *phantas* should also be developed within the surrounding sal forests in the park. Such an intervention may at first glance appear rather drastic, and not readily acceptable. However, in order to conserve viable sub-populations of tiger and provide a dispersal habitat between existing protected areas, it is necessary to provide sufficient natural prey not only in core areas within the park, but also within remaining forests outside the protected areas.

Further research should be conducted on the ecological effects of cutting and burning in the tall-grass floodplain. and the long-term effects on the productivity and mineral balance of the wooded grasslands and *phantas*. Research is also

needed on grazing lawns and grazing pressure, and on the proposed experimental clear felling of mature sal (*Shorea robusta*) and asna (*Terminalia tomentosa*) forest to create wooded grasslands and *phantas*.

Koshi Tappu's Treasure: Grasslands or Wetlands?

Jay Prakash Sah

In the Koshi Tappu region, located in the eastern *Terai* of Nepal, the dry grasslands are considered by livestock herders as a treasure that will never be exhausted. At the same time, the wet grasslands with their associated lakes, swamps, and marshes are both the ideal habitat for the remaining population of wild water buffalo (*Bubalus bubalis*) and of international importance in terms of staging and wintering sites for different varieties of Trans-Himalayan migrating birds. Thus, it has remained a matter of controversy whether Koshi Tappu is more important for the preservation of grasslands or of wetlands. The author describes the extent of grasslands and wetlands in the Koshi Tappu region, their relative significance, and their management issues and makes recommendations for the integrated management of wetlands and grasslands using a participatory approach.

The areas of grassland and wetland in the Koshi Tappu region were calculated from a land-use map prepared with the help of aerial photographs and Landsat TM Imagery. The significance of grasslands and wetlands in Koshi Tappu were assessed on the basis of their use by local people and the ecological functions they perform. To assess the use value, a household survey was carried out in the villages adjacent to the reserve. Finally, grassland and wetland management issues were identified after formal and informal discussions with reserve authorities, groups of local people, and personal observations.

Grasslands and wetlands together cover almost 92 per cent of the total area in the Koshi Tappu Wilidlife Reserve. There is some difficulty in differentiating between wetlands and grasslands as they occur along a soil moisture gradient from very wet to very dry conditions. Thus distinctions were made under the sub-headings wetlands, wet-grasslands, dry-grasslands, and savanna.

In the Koshi Tappu Region, the major wetlands are rivers, streams, barren floodplain, oxbow lakes, marshes, and swamps. The extent of total water area and regularly flooded barren floodplain changes continuously as a result of shifting of the riverbed. The most important oxbow lakes are the 'kamal pokhari', meaning 'lotus pond', located in the far west of the reserve, and three lakes in the eastern part of the reserve along the eastern embankment. An extensive marshy area lies along the fringes of these lakes, and there is a seepage stream with a 100-250 m wide strip of marshes on its fringes located east of this embankment. There are also other swampy areas covered with combinations of *Phragmites*, *Saccharum*, *Typha*, and *Vetiveria* in different associations. The grasslands in relatively dry areas comprise associations of *Saccharum-Imperata*, *Imperata*, and *Saccharum-Cymbopogon*. This type of area is subjected to frequent burning and livestock grazing. In addition, some portions of the grassland represent a savanna habitat, mainly grasslands with trees scattered throughout.

Both the wetlands and grasslands in Koshi Tappu are important resources, i.e., they possess use values that typically involve some human interaction with the resource. They also have an 'existence value', a form of non-use or non-economic value. The major use values of the wetlands in Koshi Tappu are related to fishing, livestock grazing, fuelwood collection, irrigation, recreation, and the use of wetland plants for supplementary food and other commercial products. The major existence values are as the habitat of water buffalo, the rich biodiversity, and the cultural heritage. The results of the household survey showed that more than two thirds of the local people residing in the vicinity of the reserve considered the grasslands of Koshi Tappu to be an important unlimited resource that would never be exhausted, and they wanted to use the resources for different purposes. The grasslands have use values for livestock grazing, fodder collection, fuelwood collection, thatch grass, and other minor products. They are also rich in biodiversity. Thus there are differences in the relative importance of the wetlands and grasslands in terms of their use and existence values. The grasslands are more intensively used by the local people than the wetlands; the wetlands seem to have more existence values than the grasslands.

Both the wetlands and grasslands have been threatened by natural calamities as well as by anthropogenic disturbances. The problems in managing the wetlands and grasslands in the Koshi Tappu region are flooding and sedimentation, livestock grazing, grass harvesting, fishing, developmental activities, disturbances in the transitional zone, and socio-political interference.

The wetlands and grasslands in Koshi Tappu are important in terms of both use values and existence values. However, the use values, especially consumptive use, should be carefully handled without compromising the goals of conservation, since promoting the consumption of the resources may lead to their deterioration. It is the existence value of the wetlands in the Koshi Tappu region that has drawn naturalists from the international community to include this region on the list of Ramsar Sites (Wetlands of International Importance). But the type of area for which the region is best recognised lies mostly outside the reserve in areas such as the reservoir and marshes near the barrage and a seepage stream with marshes at its fringes to the east of the PA. Thus the extension of the wildlife reserve up to the barrage is widely advocated.

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

Harish Kumar

This paper highlights the results of ongoing research in Dudwa National Park (DNP), Uttar Pradesh, India. The tall grassland habitats in the *Terai* of India are described as stages in the successional continuum between the primary colonisation of new alluvial deposits by flood climax grass and herbaceous species, and the non-flooded climax deciduous forest, which is predominantly composed of sal (*Shorea robusta*). These grasslands are maintained by

inundation during the monsoon and/or by fire and grazing. Current management in the grasslands of the park involves annual burning during the early dry season, grass cutting, and harrowing. This study aimed to assess grasslands, different management practices, and their use by wild ungulate species.

The grasslands of Dudwa National Park constitute more than 15 per cent of the entire PA and can be broadly classified into two types: wet, tall grasslands characterised by *Sclerostachya fusca - Saccharum spontaneum*, and dry, short grasslands dominated by *Imperata cylindrica - Veteveria zizanoidis*. For this study, four treatments were laid out in a split block design in the two different grassland communities: i) grass cut and burned; (ii) grass cut, removed, and burned; (iii) grassland harrowed and burned; and (iv) standing grass burned. The initial plant species' composition, phenology, grass height, phytomass, and pellet counts for swamp deer (*Cervus duvauceli duvauceli*) and hog deer (*Axis porcinus*) were measured. Altogether four measurements were made: one before the initiation of the experimental study and treatment, and three at periodic intervals after the treatment.

In both types of grassland, the harrow and burn treatment had a different effect on the sprouting of grasses, particularly of *Imperata cylindrica* and *Veteveria zizanoidis*, the senescence of I. imperata, and the ungulate grazing pattern than did the other three treatments. Grazing seemed to be heaviest in harrowed and burned sections. Hog deer grazed more heavily in short grassland communities following harrow and burn or simple burn treatments, whereas swamp deer grazed more heavily in tall grassland communities subjected to harrow and burn treatment.

In the short grassland community, the above ground biomass (AGB) was the same in all the different treatment areas at the onset of the study. In April, the AGB in the harrowed and burned areas was low compared to the other treatment areas. It was still lower in July, but by the end of monsoon season the biomass in all the treatment areas was more or less the same again. Treatments and seasons had no interactive effect on biomass. The grass was quite a height before starting the treatments, but during the early months after the treatments the grasses were short and palatability was high.

In the tall grassland community, the above ground biomass was also similar in all treatment areas at the start of the study. By April the above ground biomass (AGB) in the directly burned area was higher than that in any of the other treated areas, the difference was less by July, and, after the monsoon, the AGB was more or less the same in all the treated areas. Interactions between treatments and seasons did affect the AGB in the tall grass systems.

This study is a long-term endeavour and will address the basic question of the impact of grassland management practices on grassland diversity and productivity, and the effect of burning in the protected areas, as more long-term data become available.

Impacts of Grassland Management Practices on Grassland Communities at Royal Bardia National Park, Nepal

Jhamak Bahadur Karki

Grassland management has been practised for the benefit of humans and wildlife ever since the Royal Bardia National Park (RBNP) was established as a Royal Hunting Reserve in 1969. The park encompasses several *phantas* (Baghaura *Phanta*, Khauraha *Phanta*, and Lamkauli *Phanta*) that have undergone many years of intensive management, the primary objective being to protect and conserve some of the endangered wildlife species such as black buck (*Antilope cervicapra*), swamp deer (*Cervus duvauceli duvauceli*), Bengal florican (*Eupodotis bengalensis*), and the sarus crane (*Grus antigone*).

These *phantas* have a varied history of *ad hoc* grassland management. Following the removal of resident populations in the late 60s, communities outside the park were allowed access to cut thatch. However, the timing and frequency of grass cutting has not been consistent. For example, from 1969 to 1979, local people were allowed to cut and carry thatch and forage for seven days per year. Subsequently, the period was increased up to fifteen days during 1980 through 1984. However, from 1995-99, it was reduced to ten days per year, and in 1999, it has been reduced again to seven days per year. Annual burning of these grasslands has also been conducted for a number of years. Some *phantas* have even been ploughed to control shrub and tree invasion. Annual grass defoliation has been estimated to remove about 46 per cent of biomass from the three *phantas* and is believed to cause incessant removal of nutrients from the system, although no research has been conducted to evaluate nutrient losses.

The *phantas* contain patches of very short grazed grassland, called 'grazing lawns', intermingled with tall and short stature grassland patches.Wild ungulates congregate heavily in these grazed patches, but despite their obvious importance for ungulates, little research has been conducted to elucidate their ecology. This study was undertaken with two objectives: 1) to gain a better understanding of the overall impact of the different management practices that have been adopted for defoliation and their impact on ungulate habitat; and 2) to gain a better knowledge of the ecology of grazing lawns. The study was conducted from November 1996 to July 1997. One homogenous grassy area was selected visually in each of the three *phantas*. A completely randomised block design was used to fence the study areas, and four blocks were designated for one of four management treatments: cut+burn (CB), burn (B), cut (C), and control (IN). Each management treatment was also subjected to three different types of fertilizer treatment: di-ammonium phosphate (DAP), urea, and control. Sample plots of one square metre were selected randomly within each of these fertilizer, management, and grazing treatment areas (fenced and unfenced) after one, two and three months following the treatments. The following parameters were measured: green above ground biomass (AGB), species' composition, grass height, grass cover, number of species, and ungulate use. In addition, six fenced areas were erected in the middle of Baghaura *phanta* to study the effect

of grazing on the grazing lawns. Similar parameters were measured for these areas. Laboratory analyses were made of nutrients and minerals in all samples.

One month after treatment, above ground biomass (AGB) was highest in the control areas, followed by the C treatment, the CB treatment, and the B treatment in that order.Utilisation by ungulates was highest in the C treatment areas. After two months and three months, B plots had the highest AGB, followed by C plots, then CB plots. Fertilizer treatment had no effect. Grazing reduced the AGB in C treatment plots in the first month, in CB and B treatment plots in the second month, and in the control plots in the third month.

Grazing lawns had greater species' richness and diversity than the adjacent taller grassland, with broad-leaved herbaceous species contributing more biomass. Grazing lawns also differed substantially in community structure and morphology. The grass growing on grazing lawns tended to have prostrate morphological characteristics, forming a dense mat near the soil surface.

The crude protein content in all species sampled was significantly higher following CB treatments in all three months. Samples from grazing lawns also contained higher crude protein levels, than did samples from the neighbouring taller grass patches. *Oxalis* sp grew abundantly on grazing lawns and had higher concentrations of Na. This dicot species appears to contribute a higher proportion of Na than grass species on grazing lawns, thus accounting for the high total Na in the patch community as a whole, compared to adjacent grassland. Grazing lawns appear to provide more nutritious forage per unit area than the neighbouring taller grassland patches. Thus, they are more attractive to ungulates, who in turn fertilize the grazing lawns with urine and dung, thus promoting plant growth.

Disturbances like fire, flood, and high intensity grazing by mega-herbivores such as elephant (*Elephas maximus*) and rhinoceros (*Rhinoceros unicornis*), open up tall grasslands to form a dynamic patchy mosaic in equilibrium with the prevailing timing and frequency of such disturbances. Grazing lawns are maintained by continuous grazing by these ungulates. It appears that they do not need management intervention as they provide high levels of nutrients and minerals to grazing animals. These important forage resources merit long-term study to provide better understanding of grassland succession and of mechanisms for nutrient and mineral enrichment and maintenance of grazing lawn communities.

It appears that the current management practices of grass harvest and subsequent burning do not have a negative impact on the quantity and quality of grassland. These grasslands presumably sustain the current level of nitrogen loss through additions from rainfall, flooding, fixation from soil microbes and legumes, and from ungulate dung and urine. However, little research has been done to assess losses from the ecosystem resulting from erosion and leaching. Mosaics of grass patches are required to maintain bio-diversity, some areas should be left uncut or unburned on each grassland for cover-dependent ungulates. In addition, the long-term effects of management on lower fauna should be investigated immediately so that loss of endangered/rare species from management actions like harvesting and controlled burning can be avoided.

Importance of Tall Grasslands in Mega Herbivore Conservation

Shanta Raj Jnawali and Per Wegge (presented by Shanta Raj Jnawali)

Tall grasslands were once distributed throughout the floodplains of the Ganges and Brahmaputra river systems of the northern Indian sub-continent but are now confined within the boundaries of protected areas both in Nepal and India. In Nepal, they are now restricted to the river basins of four protected areas in the *Terai*. Tall grasslands provide refuge for a large number of wild mammals, including the greater one-horned rhinoceros (*Rhinoceros unicornis*), wild elephant (*Elephas maximus*), tiger (*Panthera tigris tigris*), swamp deer (*Cervus duvauceli duvauceli*), and wild water buffalo (*Bubalus bubalis*). Besides, a remarkable number of mammals, both birds and reptilian species, use this ecosystem as a refuge. The main objective of the work described in this paper was to assess the importance of the tall grassland ecosystem in mega herbivore conservation with special emphasis on the greater one-horned rhinoceros.

The data presented in the paper were collected from two national parks, Royal Chitwan National Park (RCNP) and Royal Bardia National Park (RBNP). Both areas have a similar climate and more or less similar vegetation types. Of the habitat types common to both areas, Sal Forest, Tall Grassland, and Bushy Pasture are floristically similar in the two areas, whereas Riverine Forests differ in species' composition with *Trewia nudiflora* dominating in Chitwan and *Mallotus phillippinensis* in Bardia. Similarly, the tall floodplain grasslands are dominated by *Saccharum spontaneum*, *Saccharum bengalensis*, and *Phragmites karka in both areas*, but whereas *Themeda arundinaceum* grows in large tracts in Chitwan between the Churia foothills and Rapti river, it does not grow in Bardia's floodplains; *Narenga pophyrocoma*, which is one of the dominant tall grass species in Chitwan, only grows in a localised area in Bardia in the northern section of the floodplain; and *Arundo donax* is more common in Bardia's floodplain than in Chitwan..

The fauna in both parks are similar except that some species are confined only to particular areas. Uncommon mammals include nilgai (*Boselaphus tragocamalus*) and swamp deer (*barasingha*) in RBNP and gaur (*Bos gaurus*) in RCNP. Bardia contains a small sub-population of rhinoceros translocated from Chitwan during 1986 and 1991.

Micro-histological analysis of faeces from Bardia and Chitwan rhinos was used to calculate Relative Importance Values (RIV) for each plant species observed in the faecal sample and thus assess the importance of grasses in conserving rhinoceros. The rhinoceros foraged a wide range of wild food plants, but, in Bardia, nine species, including five grasses and four browse species, contributed more than 70 per cent of the total volume in the annual diet, and, in Chitwan, seven species, including three browse species, made up 85 per cent of the total volume in the annual diet.In both areas the diet was dominated by grass species dominating the Tall Grassland vegetation type. Their proportion was higher in Chitwan (73%) than in Bardia (63%). Browse species made up about 20 per cent of the diet, and agricultural crop plants greater than six per cent in both

areas. Other food plants, mainly herbs, forbs, climbers, horsetails, and pteridophytes, constituted approximately eight per cent with a slightly higher proportion in Bardia.

Both the annual and the seasonal diets of rhinoceros in Bardia and Chitwan were dominated by grass species primarily growing in the tall alluvial floodplain grassland.*Saccharum spontaneum*, a dominant grass species in the floodplain, made the highest volumetric contribution in the diet of both populations. When grasses become coarse and less palatable during the winter season, rhinoceros compensate by foraging on the green leaves of browse species, mainly *Callicarpa macrophylla*, *Calamus tenuis*, and *Mallotus phillippinensis* in Bardia, and *Murraya paniculata*, *Coffea bengalensis*, and *Litsea monopatela* in Chitwan.

In both the protected areas the grasslands are being invaded by different tree species. In Chitwan, *Trewia nudiflora* is aggressively invading grasslands, whereas, in Bardia, *Dalbergia sissoo* is the primary invader in newly established *Saccharum spontaneum* dominated grassland, and *Murraya koinigii*, *Callicarpa macrophylla, and Lantana camara* in association with *Dalbergia sissoo* and *Acacia catechu* the invaders of older tall grasslands. Several management efforts are being made by the park authorities to control invasion by tree species, but so far no interventions have been made to manage the tall floodplain grasslands needed to accommodate the increasing number of megaherbivores and floodplain-dependant ungulates in the two areas. Regular burning of grassland is mostly regarded as an effective tool for controlling invasion of woody vegetation. However, although the current practice of burning helps to some extent to control invasion of woody vegetation into *Narenga*-dominated patches, , it has a very limited effect in Bardia where the *Saccharum* dominated floodplain has a relatively high substrate moisture, and the species sprouts all year round.

The dynamics of the floodplain ecosystem are still poorly understood, since no long-term scientific research has been conducted to understand its ecological processes. Therefore, a comprehensive scientific research effort is needed before any management prescription can be made.

Grassland Management Impacts on Small Mammals

Tika Ram Adhikary

Cutting and burning grass in the protected areas of the lowlands of Nepal arrest plant succession, thereby promoting the growth of new shoots and providing ungulates with an important forage resource from the regenerating grasslands. However, its affects on small mammals have not been studied in detail. Small mammals are an integral component of grassland communities, contributing to energy flow and nutrient cycling, and they have an extremely important role as seed predators, and dispersal and pollination agents in grasslands. Thus, it is very important to review the impacts of grassland management on small mammals with reference to the *Terai* grasslands of Nepal and provide recommendations for conservation.

Past research done elsewhere on the biology and conservation problems of the hispid hare (*Caprolagus hispidus*) and the pygmy hog (*Sus salvanius*) indicated that both species were confined to patches of unburned tall grassland along streams where, without this protective cover, they were vulnerable to predation. Thus, the long-term survival of the hispid hare and pygmy hog populations remains at risk as a result of the current management policies where tall grassland is burned or harvested for thatch and cane during the dry season. Livestock grazing can also affect small mammals directly by trampling of burrows, compacting soil, or competing for food; or indirectly by altering the structure or species' composition of vegetation in a manner that influences habitat selection by small mammals. However, it is very difficult to generalise the effects of grazing on small mammals. Usually, the variety and abundance of small mammal communities depends on how grazers have used the grassland.

Widespread cutting and burning together with grazing can have a significant effect on disturbance-intolerant or cover-dependent small mammals. However, fire not only reduces litter inputs, it can lead to increased floristic diversity and also appears to benefit other small mammal species. Thus a patch management system may be an effective way of maintaining a variety of habitats for various species,. Finally, little is known about the response of small mammal species to management prescriptions and the ecological consequences, and further studies should be conducted on small mammal populations.

Impact of Grassland Management on Avian Fauna

Hem Sagar Baral (invited paper, not presented at the workshop)

Grasslands in the *Terai* are an important habitat of many bird species. This paper highlights preliminary research conducted to assess grassland bird diversity using linear transects of varying length in three protected areas in the *Terai* (Chitwan, Koshi Tappu, and Shukla Phanta) during the years 1996-98. During each visit, data were collected on species, number, sex, location, and behaviour of birds, as well as several environmental parameters such as species' composition, phenophase, average height of grasses, soil moisture, bare ground percentage, percentage of other vegetation cover, proximity to water and forest, and grazing, burning, cutting, and other disturbances..

Fire, floods, cutting, grazing, and disturbance are the major ecological factors that effect avifaunal life in grasslands. In the study, a total of 219 species of birds were identified, 10 of which were species that are globally threatened and exclusively depend on lowland grasslands. Chitwan and Koshi Tappu contained the largest number of globally threatened species among the three protected areas. However, Shukla Phanta appeared to be the most outstanding grassland reserve of Nepal, followed by Chitwan, from the point of view of harbouring populations of globally threatened species. At the national level, Chitwan and Shukla Phanta seem to be the most outstanding grassland reserves of Nepal.

Partially burned grasslands away from forests (>100 m) showed slightly increased bird diversity but significant increase in abundance. Unburned and

totally burned grasslands showed less diverse bird communities and lower abundance. Flooding mainly affects the sedentary grassland specialist birds. Low and moderate levels of grazing may be beneficial for bird communities, but cutting and ploughing generally contributed to decreased avian diversity.

The present grassland areas are not sufficient to maintain the population of several globally and nationally threatened taxa. Therefore, internationally important grasslands in Chitwan and Shukla Phanta should be declared grassland reserves. In addition, open lands in some parts of the extension area of Shukla Phanta should be converted to a grassland area of outstanding importance for birds, as well as for mammals. Finally, the current practice of grassland management, which is mainly aimed at increasing the population of large mammals but overlooks the threats to other smaller taxa, should be changed.

Discussion

After the presentation of technical papers on *Terai* Grasslands, the presiding chairperson, Sushil Bhattarai, opened the floor for discussion.

The key points raised are listed below.

- A regional approach to the study of grassland ecology and management practices in protected areas in both Nepal and India is needed, rather than addressing individual protected area(s).
- There is a concern that continuous burning of grasses could result in nutrient losses and change the composition of the grassland. However, it was agreed that disturbances such as burning, grazing, and flooding are vital to the maintenance of habitat and promoting of nutrient cycling. Leaving unmanaged biomass with no nutrient cycling could have far worse effects.
- Nepal and India have adopted different strategies with respect to cut and burn practices in the grasslands. In India, PA managers have completely banned local communities from harvesting grasses and grazing livestock, as a result of the park-people conflicts that arose. In Nepal, PA managers allow local grass harvesting as a tool for managing the grasslands.
- The question was asked whether an agro-ecosystem approach could be applied in *Terai* PAs. It was reiterated that land in the *Terai* has a greater potential to produce biomass than land at high elevation, and thus better potential for land-use intensification, for example, growing thatch grass near villages. An agro-ecosystem perspective is perfectly suited to the *Terai*, as the land-use practices in the area are changing fast and, without understanding those changes, sustaining a protected area will be difficult.
- The management in Bardia has initiated activities with local people regarding collaborative efforts between park and buffer zone communities to manage forests outside the *Terai* PAs. Forests outside the park could eventually be developed as corridors for wildlife species for their movement, although managed through mobilisation of the buffer zone communities. Indian protected areas were experimenting with joint forest management practices to improve the rural economy. The aim was not only to conserve endangered and other wildlife species but also to improve forest quality. There was general consensus that it was difficult to manage grasslands and forests

outside protected areas unless there was support from stakeholders such as other government departments and the local communities.

- On the question of the use of fertilizer to treat grasslands, it was agreed that PAs should not be managed like a garden, although fertilization could be carried out on a controlled basis as an experiment.
- Confusion arose over the use of the term 'semi-natural grassland'. The term as explained has management implications, as it is a grassland community that is maintained by anthropogenic activities such as burning and grazing that otherwise would revert to forest. Alluvial grasslands would not be considered semi-natural as they are maintained by a natural hydrological process, not a primarily anthropogenic one, although humans do have an impact.

Mountain Forests and Rangelands[3]

Indigenous Livestock Management Systems in Upper Slope Forests of Central Nepal

Santosh Rayamajhi, Don Messerschmidt and Bill Jackson
(paper invited, but not presented at the workshop)

The upper slopes of Nepal, with their rich biological and cultural resources, are defined as the area lying between 2,000 and 4,000 masl, and are located in the High Himalayan and High Mountain physiographic regions. They possess a rich wealth of grasslands and forests that can sustain sizeable populations of livestock. Strategically, livestock management is considered to be the most viable option in natural resource management for the upper slope communities. This paper describes the outcome of research on indigenous livestock management systems of upper slope communities in Central Nepal. The research was done by a multidisciplinary team during January to June 1996 in Sindhupalchowk and Kabhrepalanchowk districts. The paper specifically deals with the upper slope's demographic, socioeconomic, and bio-physical settings; the impact of livestock herding on the natural resources and environment of the upper slopes; and the strategy of the livestock management system in response to the changing demographic, socioeconomic, and bio-physical settings of the upper slopes.

The upper slopes are also called *'lekh'*. 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. Tamangs and Sherpas are the majority populations living in these areas. Secondary and tertiary users of upper slope resources reside at lower altitudes and represent a wider and more typical range of hill ethnic and caste groups.

There are three main land-use type categories: agricultural, forest, and shrubs and non-agricultural, including grasslands. The forest and shrub category can be

[3] Full papers are presented in Volume III of this Workshop Series

further divided into four broad vegetation types: coniferous forest, broadleaf forest, mixed forest, and shrubs and the non-agricultural land category into grasslands and other. The distribution of vegetation types mainly reflects climate, topography, altitude, and aspect.

The upper slope environment contains a vast wealth of natural floral and faunal resources, but these resources are heavily impacted by human and livestock utilisation. The particular 'hot spot' for management attention is the transition zone (2,500 to 3,000 masl) where lower altitude and higher altitude livestock herding overlaps.

Nepal's highland people have developed some unique lifestyles and cultures which, in the modernising national economy of Nepal, are in danger of losing their distinct identities. The paper briefly deals with the people's culture in the highlands in Sindhupalchowk and Kabhrepalanchowk Districts. Transhumant livestock 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. Three styles of livestock management are found in the upper slopes in Sindhupalchowk and Kabhrepalanchowk Districts, full transhumance, semi-transhumance, and stall-fed (non-transhumance). The first two are based on seasonal transhumant movements of herds on the *lekh*, and are distinguished by variations in livestock type, altitudinal range, seasonality, and ethnicity. The third focusses on stall-fed animals in villages. These three distinct patterns of livestock management are clear indications of the strategic response of the herders to resource scarcity.

The indigenous livestock management systems in the highlands have recently been influenced by several factors. These include 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 clean water supply, and new or expanding opportunities for migrant labour and small business investment in and out of Nepal.

Despite various social and political constraints, traditional livestock systems are still prevalent in some locales and those practising them are making every effort to rationalise resource use by extra-legal restrictive measures under community or communal pasture management systems. Various characteristics of these systems that would facilitate effective collaboration in forest conservation initiatives are discussed.

Alpine Vegetation of North Western India: An Ecological Review

Gopal S. Rawat

This paper presents a reviewed report of the major ecological work related to the alpine vegetation of the Greater and Trans-Himalayas within north-west India. The vegetation characteristics in terms of major physiognomic and community types, factors influencing the species' richness, and biomass

production are discussed together with major conservation issues. The implications, the different research findings for the conservation, and management of alpine ecosystems are also mentioned.

The vegetation of the alpine region has been described under two broad headings: a) alpine vegetation of the Greater Himalayas[4], and b) vegetation of the Trans-Himalayan regions. Nearly 1,500 to 1,600 species are estimated to occur exclusively in the alpine region; the species' richness in the Greater Himalaya is higher than that in the Trans-Himalayas.

The alpine zone within the western and north-western 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; a) Alpine Scrub, b) Alpine Meadows, and c) Scree slopes and moraines. In addition, timberline ecotone and sub-alpine (anthropogenic) herbaceous formations, which gradually merge with the alpine communities, are also included under high altitude vegetation. The Trans-Himalayan areas are generally devoid of forest vegetation. However, a few patches of *Juniperus macropoda* and *Salix* woodlands can also be seen in some parts. The major formations in this area include; a) Steppe Formations, b) Herbaceous and Grassy Meadows, and c) Cold Deserts.

The alpine habitats are, perhaps, the most heterogeneous and fragile. The vegetation in these areas exhibits a complex mosaic of succession. Basically, two parallel courses of succession are found: meadow succession and forest succession. In the first, several annual herbaceous formations are considered as the climax community; in the latter the birch-rhododendron (*Betula utilis - Rhododendron campanulatum*) community is considered to be the most stable vegetation.

Vegetation in the alpine zone has also been affected by several human activities. Livestock grazing, collection of medicinal herbs, collection of fuelwood, and wildlife use are the main conservation issues in these areas. An increased number of livestock and overuse of certain pastures can lead to degradation of high altitude grasslands, including the habitats of wild herbivores. However, as livestock grazing has a differential impact on various plant species, the practice cannot be seen as completely negative. In contrast, overexploitation has led many species of medicinal herbs to be in danger of local extinction causing concern among conservationists. Extraction of fuelwood, particularly from the low productive areas of the Trans-Himalaya, is one of the major issues in the conservation of steppe communities. Some of the options are management of grazing areas and livestock in the Trans-Himalayan zone, partial grazing in the protected areas, practice of site specific or species' specific conservation plans for management of rare plants and their habitats, management of degraded areas, research and monitoring, and peoples' participation in the conservation process.

[4] Synonymous with the High Himalayan Physiographic Zone in Nepal. Please note only when referring to well-defined geological regions will the Sanskrit term Himalaya be used (Ed).

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

Som Ale

Livestock are vital for the economy of communities residing in the remote high altitude valleys of Nepal. Many of the traditional pastoral systems, however, are currently in the process of substantial change as a result of external influences related to modern developmental activities, and this is affecting the age-old balance between herbivores and plants, and thereby the whole predator-prey system. This is the situation in upper Manang, which is a dry alpine valley and a transition zone between the moist southern Himalayan slopes and the high deserts of Tibet. The abundant pastures of upper Manang have long supported the traditional herding of yaks, yak-cattle cross, cattle, sheep, and goats. Over the past several decades, however, major changes have taken place that have greatly affected the lifestyle and land use of the people, as well as the array of wildlife that occurs.

Since the 1990s, the valley has drawn the attention of both government and non-government agencies. The Ghenjyang Irrigation Project and the large Buddhist monastery under construction in Ngawal are two examples. The Annapurna Conservation Area Project (ACAP) of the King Mahendra Trust for Nature Conservation (KMTNC) extended its work in Manang in 1993 and has now successfully established a cohesive partnership with the local populace which involves from planning to implementing arrays of activities directly or indirectly related to nature conservation. There are a several pressures on the valley. It has been one of the most popular trekking routes in Nepal for the past two decades. At the same time several households have recently returned to Manang following a stint of international trading, and most of them now maintain livestock herds in response to tourism and local demands. There is a growing concern that the pressure on wildlife habitat is increasing. Thus it is vital to monitor the potential impact of changing numbers of wildlife and livestock on the vegetation composition and productivity of these remote wild lands, and thereby on ecosystem functioning.

Rangelands comprise approximately 12 per cent of the total area of Manang District. The rangelands consist of scrubland vegetation and alpine grasslands. Scrublands are dominated by such genera as *Juniperus, Rosa, Berberis,* and *Lonicera*, whereas the alpine grasslands are dominated by sedges, such as *Carex* and *Kobresia,* and grasses such as *Calamagrostis* and *Stipa* .

In Manang Valley, grazing is an important land use and has a functional relationship with the existing agricultural, economical, social, and religious activities, as well as influencing the survival of the region's wildlife. Such old indigenous practices may also explain the existence of large herds of blue sheep (*Pseudois nayaur*) on high pastures in the valley. The present numbers of livestock in some parts of the valley have been reported to be three times higher than those of blue sheep, suggesting unavoidable livestock depredation and direct conflict between the local populace and predators. On the other hand,

livestock may be helping to sustain the population of predators such as snow leopards (*Panthera uncia*) in the valley.

In a landscape of marked relief where cultivable ground is scarce, cropping for direct human consumption takes precedence over fodder cultivation. Nevertheless, hay fields are maintained throughout the valley. Even so, supplementary feeding in the form of hay and crop residues is small and not enough to last the winter, so livestock must depend on what the land offers. The area is semi-desert, so, although summer grazing is luxuriant, the most important constraint is the availability of winter feed. This essentially means that animal numbers must be regulated in accordance with the limits of winter feed. In Manang, the response of farmers and pastoralists has been to create a detailed set of social rules and regulations for grazing.

The strategies that are associated with pastoralism are seasonal movements of livestock, multi-species' diversification, and the maintenance of large herds as insurance against losses from disease and unpredictable storms. In order to practice these strategies, the community schedules livestock movement. The key to effective control is the *tohsom* system, literally meaning 'field-watcher'.The *tohsom* system maintains rotational grazing between high pastures located between 4,000 and 5,000 masl and the fields around the villages, thereby maintaining the balance among the existing scarce forage resources.

Research and monitoring activities are essential for assessing the impact of the ACA project and providing adequate feedback to make corrections and refinements. The long-term goal of research and monitoring should be to support ACAP's database and help to better conserve and manage the endangered snow leopard, its prey species, and their remote and fragile high altitude habitats. The major scientific contribution of the proposed research project would be to test ecological theories of food-chain dynamics in field conditions and help develop other theories related to the Himalayan alpine ecosystem. It is clear that one of the factors affecting biodiversity and rangelands in Manang Valley is the changing pastoral system. Thus the proposed project will address basic ecological questions such as range-use patterns by wild and domestic ungulates, selection of grazing habitats, and anti-predator behaviour. Blue sheep may be used as an indicator species for the alpine and sub-alpine grassland habitats in Manang.

Grasslands in the Damodar Kunda Region of Upper Mustang, Nepal

Rita Arjel Koirala, Rinjin Shrestha, and Per Wegge
(Presented by Rita Arjel Koirala)

Himalayan grasslands are complex; they contain a mosaic of vegetation communities along a steep altitudinal gradient combined with a myriad of topographical features. The region provides habitats for a unique assemblage of large wild ungulates, like naur (or blue sheep) (*Pseudois nayaur*) and argali (*Ovis ammon hodgsonii*). In addition, the area also provides a livelihood for

mountain people. Information on the floristic composition and other habitat features is a prerequisite for land-use planning and management. The objectives of the study described here were to describe and compare different plant communities and habitats used by the rare Tibetan argali, the more common naur, and domestic goats. The study was carried out in the Damodar Kunda region of Upper Mustang.

The general physiognomy of the study area is that of high elevation cold desert, and the vegetation is desert steppe vegetation of the Trans-Himalayas. The grasslands have been used for a long time by pastoralists to graze domestic stock.

After a preliminary survey, the study area was delineated into three zones (argali, naur, and goat) for a detailed study of vegetation types and forage availability. Community structures were determined by placing 474 quadrats along transects in five different vegetation types. The percentage cover of individual species was estimated in each quadrat. The species were classified into three lifeform classes, graminoids, forbs, and shrubs and into palatable and unpalatable categories based on interviews with herders and secondary sources. The phenological stages were recorded in the form of vegetative/sprouting, flowering, and senescence. Physical parameters like altitude, aspect, slope, and percentage of bare ground or scree were noted to assess the general habitat characteristics. Prominence values were determined and then weighted in order to obtain an expression of species' abundance in the total study area. Finally, the species' richness value (SRV) in the different zones was determined.

The three zones differed in landscape pattern, spatial arrangement of vegetation types, and distribution of ungulates. The argali zone was situated at the highest altitudinal range and consisted of three vegetation types; a) Desert Steppe, b) Dry Meadow, and c) Dry Grassland. The naur zone was located on the south side of the Namta River at lower altitude and consisted of three vegetation types; a) Dry Grassland, b) Wet Meadow, and c) *Lonicera* Community. The goat zone was located in the area of moderate topography and luxuriant vegetation. It consisted of three vegetation types and was dominated by the *Lonicera* Community with Wet Meadow and Dry Grassland as subordinate communities.

Of the five different vegetation communities, the Dry Grassland type was distributed in all three zones, Desert Steppe and Dry Meadow vegetation types were only found in the argali zone, and Wet Meadow and *Lonicera* types were found in the naur and goat zones. Most of the plants were in the flowering stages in all three zones. Some plants were in the early growing stages and a few species in senescence. The important palatable species included *Kobresia pygmea, Kobresia sp, Saussurea graminifolia,* and *Stipa* and *Elymus nutans* in the argali zone; *Kobresia* sp., *Stipa* sp. and *Lonicera rupicola* in the naur zone; and *Lonicera rupicola, Stipa, Kobresia,* and *Elymus nutans* in the goat zone. The species' richness in terms of total number of species was higher in the goat and naur zones than in the argali zone. The total available forage was lowest in the argali zone and highest in the naur zone. Both graminoids and forbs were most available in the naur zone, whereas shrubs were most available in the goat zone. Thus the argali zone, which covered the largest area, was poorest in total available forage.

Because the three ungulates were spatially separated with distinct differences in summer diets, 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. Extending domestic stock grazing into the Tehchang watershed of the argali zone should not take place until the seasonal habitats of Tibetan argali are better known, as increased summer grazing may have negative effects on the winter pastures of this wild sheep species.

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 bio-diversity 'hot spot' and requires special management programmes for the conservation of this asset. Pasture condition was found to be good, as indicated by a healthy breeding population of argali and naur, and low coverage of unpalatable species, thus the idea has been raised of promoting increased livestock husbandry in the region. However, grazing by domestic stock during summer may limit forage availability during winter for wild ungulates if the latter 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. Hence, studies of the seasonal habitat use by argali, and of pasture condition, particularly 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.

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

Yashveer Bhatnagar, Gopal S. Rawat, A.J.T. Johnsingh, and M. Stüwe
(Presented by Yashveer Bhatnagar)

In recent years, the perceived pressure on the Himalayan rangelands and protected areas resulting from the rise in livestock populations has led government agencies to prohibit livestock grazing within wildlife protected areas in India, as per the Indian Wildlife Protection Act 1972. Several observations show that agro-pastoral communities in the Himalalyas have no place other than in protected areas to graze their livestock. Thus it is important to assess whether livestock in a protected area are actually detrimental to the ecosystem before prohibiting grazing. In this study, we attempted to quantify the extent of habitat separation between sympatric populations of ibex, the primary wild ungulate in Pin Valley National Park, and resident livestock.

Pin Valley National Park, located in the Lahul and Spiti district of Himachal Pradesh, India, is characterised by a cold, arid climate with a short plant growth period. Approximately 1,250 people live in 17 villages located in the buffer zone in Pin Valley where people graze their livestock in the park between May and December every year. The study was limited to the possible competition between ibex and livestock in that area. The main techniques used in the study

were local interviews, counting livestock in the field, survey of the habitat used by livestock along the trails, and monitoring radio-collared ibex.

Resident livestock in Pin Valley were grouped into two categories; a) species dependent on human settlements, i.e., the livestock that were directed to pastures every morning and herded back into pens in the evening; and b) species independent of human settlements, i.e., those that could have been herded back into pens, but which 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 were grazed within the national park and adjacent tracts that formed the study area. About 200 to 250 ibex in the Parahio watershed shared the area with the *ca.* 350 resident livestock between May and December each year, i.e., more than 1.4 livestock per ibex, indicating a clear possibility of competition pressure.

The livestock showed seasonal differences in the use of terrain type, aspect, distance to escape terrain, and altitude. There were, however, no seasonal differences in the use of slope categories. The ibex also showed seasonal differences in habitat use. There was a high degree of spatial overlap between ibex and resident livestock in spring. In summer, however, ibex moved to higher elevations, while most livestock remained along the valley bottom, resulting in spatial separation.

There was some overlap in the use of altitudes, terrain types, and aspect by ibex and livestock during spring and autumn. However, the separation between the two was clear regarding the use of slope and distance to escape terrain during all seasons. The separation between ibex and livestock was highest during summer when they differed in the use of altitude and terrain type. Ibex and livestock could potentially compete for resources during spring and autumn, while during summer the possibility of either 'exploitation' or 'scramble' competition is excluded as a result of the spatial separation.

In most natural communities, competition usually leads to niche partitioning in such a manner that species can co-exist. Sympatric animals using similar resources may separate at the spatial level, at the level of use of habitats, and/or at the level of selection of plant species or plant parts. Even during the spring and autumn months, the ibex in Pin Valley separated from resident livestock in the use of habitat. They used steeper areas and areas closer to escape terrain. During summer they used higher altitude. The question is whether ibex separate into such areas owing to competition from livestock, or independent of this. The results showed that the two groups were usually separated by over 500 m in altitude, with little overlap, and there was also a considerable magnitude of difference in the use of slope and distance to escape terrain. Thus it is likely that at present, resident livestock use the largely 'vacant area' that ibex rarely use owing to their adaptations and are unlikely to pose a direct threat to ibex.

The other question is how summer foraging by livestock limits the availability of forage during winter, the period when they were not present in the area. It seems unlikely that summer grazing by resident livestock depletes winter forage for ibex, because most of the grazing areas used by livestock are covered by

heavy snow during winter and are not used by ibex, which prefer steep, snow blown rocky outcrops. Thus, even during this period, resident livestock probably do not adversely impact forage availability for ibex.

In conclusion, although there is likely to be no adverse impact of resident livestock on ibex at present, the situation could change if people increase their livestock holdings. Thus intervention by owners to regulate the number of livestock and pastures for livestock grazing is an effective compromise towards conservation goals in protected areas in the Trans-Himalayas that have a scarcity of pastures. Research should be performed to determine whether resident livestock may pose a threat to ibex through transmission of contagious diseases, and whether habitat use by migratory livestock and fuelwood removal from the park needs to be controlled to ascertain the long-term conservation of ibex in the Pin Valley National Park.

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

Camille Richard and Colleen McVeigh (Presented by Colleen McVeigh)

Rangeland ecosystems of Nepal are experiencing rapid socioeconomic changes that are influencing the way people use resources and herd their livestock, often resulting in reduced land for grazing and overexploitation of forests, thus leading to over-grazing and degradation.. In order to understand and address such complex issues it is necessary to use an inter-disciplinary and participatory approach, but although this is often talked about it is rarely actually done. In countries such as Nepal, people's participation in conservation management is actually mandated by law. Despite the rhetoric and legislation, however, true participation in resource management and forestry and conservation practice is far from satisfactory. This stems mainly from a lack of institutional capacity to implement participatory approaches and a lack of understanding of what is truly meant by the term **participation**.

Participation is a process based on a philosophy of empowerment that facilitates the active involvement of stakeholders in decision-making and gives credence and value to all stakeholders' knowledge, including both scientific and indigenous knowledge. True participation offers a number of advantages, such as:

- building rapport among stakeholders;
- bridging the gap between scientific and indigenous knowledge;
- improving conservation awareness among stakeholders;
- facilitating interdisciplinary data integration;
- strengthening local capacity for planning, implementing, evaluating, and continuing activities;
- expediting the project implementation process;
- increasing research and project planning transparency; and
- ensuring project continuity.

Although it has its limitations, the benefits far outweigh the disadvantages, so such approaches make sense from both a managerial and economic point of view.

Developing action plans for participatory rangeland research and management require adopting particular operational methodologies. First is the need for an **agro-ecological perspective**, taking into consideration the different ecosystems and associated farming systems in the region. **Participatory action research (PAR)** is then used as the framework for assessment, planning, and implementation. This approach helps determine future courses of action through community empowerment and collaborative decision-making among communities, government entities, and other relevant stakeholders.

The paper further elaborates on PAR as a methodology. In summary, PAR requires a series of phases to assess and plan for interventions in rangelands, starting with a diagnostic phase intended to define local conditions and to identify key stakeholders. When designing the initial participatory action research plan for a particular protected area, consider these preliminary steps.

- Consider your resources in terms of available funds and capacity
- Collect and collate the existing information on the PA
- Identify knowledge gaps
- Present the gap analysis to various stakeholder groups for feedback
- During group meetings, set initial priorities and objectives for research based on mutually shared issues and concerns
- Select the initial Core Team to conduct diagnostic phases based on group interest
- Conduct a diagnostic rapid assessment using an agro-ecosystem framework with methods such as participatory rural appraisal (PRA) or rapid rural appraisal (RRA)
- 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

The primary goal of a participatory approach is to link stakeholders so that solutions and options are mutually identified and planned and all involved have ownership of conservation initiatives. Although sometimes difficult to initiate, in the long term, the results of such an approach lead to a dynamic two-way channel of information flow that will facilitate conservation of Nepal's rich biodiversity. The next paper offers an example of this dynamic process.

Managing People-Wildlife Conflict on Alpine Pastures in the Himalayas

Rodney Jackson (paper invited, but not presented at the workshop)

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 respective 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 targetted protected area. This paper summarises the methods used and results obtained thus far. It 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.

Conflict between livestock owners and predators is not a recent phenomenon that is caused by the establishment of nature preserves or new wildlife legislation. Before modern firearms and traps were available, herders had developed simple but effective methods for minimising losses from predation such as maintaining close watch over livestock, 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 depredation problem. Although losses vary from site to site, year-to-year, and seasonally, winter is usually the time of greatest concern. Depredation is not evenly distributed, but rather associated with the nearby presence of cliffs, rocky areas, and good cover.

The best long-term strategy lay in combining preventative and remedial measures such as: improving guarding of livestock, especially in depredation 'hot-spots'; encouraging communities to hire skilled shepherds; promoting the use of improved breeds of guard dogs; 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; offering incentives for community development projects in exchange for predator and wildlife protection/conservation actions by the community; and developing safeguards against herders or communities making fraudulent claims, killing snow leopards, or illegally poaching wildlife.

The dynamic *APPA* process is used to mobilise villagers to adopt these remedial measures and to begin addressing crop or livestock depredation by building a common understanding of conservation objectives. In the case of the projects discussed in this paper, these objectives are: (1) to identify and implement ecologically sound and acceptable measures to reduce or possibly even eliminate wildlife crop and/or livestock damage, while simultaneously increasing crop and animal productivity to the extent possible; (2) to protect wildlife and habitats in accordance with existing PA regulations; (3) to promote alternative but environmentally responsible and socially acceptable forms of income,

implemented and sustained through existing institutions, which foster community pride and build greater self-reliance; and (4) to 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.

Among the assumptions important to appreciate when designing a programme for alleviating wildlife crop or livestock damage are the following: (1) the internal and external threats to snow leopards (or any other target species) and biodiversity have been correctly identified and can be addressed using existing resources; (2) the project site should be biologically significant (i.e., contain 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.

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 expanding livestock holdings.

Discussion

Following the presentations on mountain forests and rangelands, the presiding chairman, V. B. Sawarkar, opened the floor for discussion. The salient points raised during the ensuing discussion were as follow.

- It is a misconception that erosional landscapes in the desert areas of the Trans-Himalayas are a result of overgrazing. They are the result of natural processes and showing photos of such landscapes gives the wrong impression about livestock and their impact. However, it was argued that livestock can accelerate the erosional process.
- There was a question on grazing issues in alpine grasslands and concern that these areas might not be able to sustain livestock grazing. However, the question was raised whether it was practical to remove livestock from alpine meadows, given the importance of this grazing resource for local husbandry systems. In many areas of the Trans-Himalayas, livestock and wildlife have

co-existed for centuries and impacts are minimal, it was argued. For example, in Shey Phoksundo National Park in the Trans-Himalayas, people had ready access to protected area pastures, but, as the herds of livestock are small, there has not been much disturbance. While the blue sheep grazed at higher elevation, livestock mostly grazed at a lower elevation in the valley, as was also found in Pin Valley National Park for ibex and livestock.

- Careful planning was strongly urged for these high elevation areas. For example, pressure from grazing might mount in ecologically sensitive zones such as the transitional tree line zone.
- Despite the common belief that all alpine areas of the Himalayas are subject to livestock grazing, the point was raised that there are alpine areas in Bhutan and Arunachal Pradesh that have never experienced livestock grazing. The takin, the Bhutanese national animal, graze there without any disturbance from livestock.
- In reply to a question on whether there were rules and regulations guiding the grazing of livestock in Pin Valley National Park, and about users' rights to such pastures, it was said that under current law resident communities have limited access. However, the local people do not appear to be degrading the habitat, as livestock and ibex are grazing together with little overlap. Often habitat can be enhanced by livestock grazing, and ibex may be following fresh sprout in the spring season as a result of grazing.
- Socioeconomic changes affect the way people herd their livestock and the types of livestock they keep. For example, if tourism is introduced into an area, local people would start using livestock more for transportation purposes.
- Retaliation against snow leopards because of livestock depredation varies among communities. In upper Manang, even though there is a high level of livestock depredation by snow leopards, reprisal killing is low because of religious restrictions.
- Hunting of ibex for sport, as in Pakistan, is not possible in India where all hunting has stopped, it is prevented by both religious sentiment and government laws.