Our Nature (2005)3:69-76

Grazing Effects on Species Composition in Rangelands of Upper Mustang, Nepal

A. Pokharel

Institute of Forestry, Pokhara Campus, Tribhuvan University, Pokhara, Nepal.
E-mail: anita1550@yahoo.com

Abstract

Conservation and management of rangelands require clear understanding of species composition. The objective of this paper is to show the differences in species composition, abundance, mean cover and height between the grazed and ungrazed plots in a specific pasture of Lo Manthang VDC in Upper Mustang. Two seasons' data were collected during July (wet season) and November (dry season) 2005. Species richness, Importance Value Index (IVI), cover and height of the species compared between grazed and ungrazed plots. Twenty species (17 belonging to 14 families: high-7, medium- 2, low – 6 and non palatable – 2 and 3 unidentified species) were recorded in the experimental plots. Species richness didn't show any significant difference in between the ungrazed and grazed plots in both the seasons. On the basis of IVI value, *Kobresia* spp. a highly palatable species is dominant in the ungrazed plots in both the seasons. A significant difference (χ^2, $p<0.05$, $d.f. = 7$) in cover during July indicates that the pasture has some impact of grazing.

Key words: Conservation, Grazed and ungrazed plots, Management, Rangeland, Species composition

Introduction

Rangelands in Upper Mustang have socio-economic relationship with the lives of local people as majority of the population rely on agro pastoral system. Agricultural production in the area is very limited due to scarcity of water, lack of proper irrigation, low temperature for longer periods and low rain-fall. Cattle, yaks, dzos, sheep, goats, horses, mules and donkey are the livestock reared by the local people. Existing rangeland is not sufficient for livestock as majority of the area is barren and desert like. Information concerning grazing effects and species composition is lacking from the region. Grazing takes place throughout the year and little forage is conserved as hay in the agricultural land which only sustains for only one or two months or even less in some of the areas. Researchers have identified that overstocking (overgrazing) in the rangelands is the main factor causing deterioration of rangelands (Miller 1996, Schaller and Gu 1994, Wang *et al*. 2002). Similarly it was also found that species diversity and productivity are maintained by livestock and wildlife grazing in many highland pastures (Carpenter and Klein 1995). This unique rangeland eco-system is relatively unexplored to make informed decisions about altering traditional pastoral production practices. It is essential to conduct systematic research before proposing any interventions in the name of progress (Goldstein and Beall 1990). Through this informed decisions about development planning (Miller 1995) can be made so that heavily utilized natural pastures' pressure and forage scarcity especially during winter and early springs (Jackson *et al*. 1996) can be

lessened. Therefore, the proper utilization and management of this important rangeland is crucial for long term biodiversity conservation of the area.

This paper describes how regularly grazed and totally un-grazed plots vary in species composition, abundance, cover and height of the plant species. This work is a part of the broader research on rangelands conducted during 2005 in Upper Mustang.

Materials and Methods

Study location

Upper Mustang lies between 28°47'- 29°19' N and 83°28'-84°15' E in Mustang district which is one of the sparsely populated districts of Nepal. Upper Mustang with fragile landscape drained by the main Kaligandaki River and its tributaries is a high altitude Steppe. It falls in the rain shadow area of Dhaulagiri Himal and Annapurna massif and covers an area of 2,567 sq. kms.

The present research was conducted in the Panga pasture of Lo Manthang Village Development Committees (VDCs) of Upper Mustang. Lo Manthang VDC has forty four pasture units with a total area of 257.753 sq kms. (Pokharel 2006). The altitude range of Panga pasture is 4,000 – 5,100 m. The climate of the area can be characterized as cold desert, desiccated by strong winds and high solar radiation. The climate is sub-alpine, and had a maximum and minimum temperature of 26.8°C and 9.9°C in July and 10.7°C and - 5.8 °C in November of 2005. The whole area remains under snow for 4 – 5 months from November to March. Total annual rainfall is less than 200 mm and more than half of the total precipitation occurs as snow during the winter months.

Experimental design

Assessment of the plant communities between ungrazed and grazed plots

For assessment of the plant communities three ungrazed (controlled) plots, each of size1 m x 1m, were taken which were established during 2003 and 2004 by King Mahendra Trust for Nature Conservation - Upper Mustang Biodiversity Conservation Project. For comparative assessment between ungrazed and grazed plots, a 100 m transect was drawn systematically with the help of GPS towards the north of the ungrazed plots to locate the grazed plots each of size 1 m x 1m. From each main plot, a sub plot one in north and one in south direction of size 20x20 cm were taken for study. Altogether, six subplots of ungrazed and six of grazed were studied during July and November 2005 i.e.wet and dry seasons respectively.

The floristic components in the ungrazed and grazed plots were identified and categorized as high, medium, low and non palatable species based on previous records (Chetri and Gurung 2004). Richness was calculated as the number of species recorded (Stirling and Wilsey 2001). The following quantitative characteristics of the vegetation were determined using the following formula given by Zobel *et al*. (1987).

$$\text{Frequency} = \frac{\text{No. of plots with the individual species}}{\text{Total no. of plots studies}} \times 100$$

$$\text{Relative frequency (RF)} = \frac{\text{Frequency of any one species}}{\text{Total frequency of all species}} \times 100$$

$$\text{Density} = \frac{\text{Total no. of individual species in all plots}}{\text{Total no of plots} \times \text{area of plots}} \times 100$$

$$\text{Relative Density (RD \%)} = \frac{\text{Density of a species}}{\text{Total density of all species}} \times 100$$

$$\text{Relative Coverage (RC)} = \frac{\text{Coverage of a species}}{\text{Total coverage}} \times 100$$

Importance value index (IVI) = RF+RD+RC

In addition, a comparison of the height of the species in the ungrazed and grazed plot was also made.

Results and Discussion

Assessment of the plant communities between ungrazed and grazed plots

During both wet and dry seasons i.e. July and November, grazed plots has higher number of species than then the ungrazed plots (Table 1 a, b, c &d). During July altogether 9 species (highly palatable =5, medium palatable =1 and low palatable = 3) were recorded in the ungrazed plots whereas 17 species were recorded in the grazed plots (highly palatable = 7, medium palatable = 1, low palatable = 7 and non palatable =2). Similarly in November, 11 species (highly palatable = 6, medium palatable = 1 and low palatable = 4) were recorded in the ungrazed plots whereas 13 species were recorded in the grazed plots (highly palatable = 6, medium palatable = 1 and low palatable = 6). However, χ^2- test does not show any significant difference in both the months when the number of species classified according to palatability between ungrazed and grazed plots were compared (χ^2, *p>0.05, d.f. =2, 3*).

In July, the highly palatable *Kobresia* spp. has the highest Importance Value Index in both of the plot types, 122.43 and 89.22 in the ungrazed and grazed plots respectively. A comparison of the medium palatable species *Saussurea nepalensis* showed that grazed plots have higher IVI (7.41) compared to ungrazed plots (1.94). *Saxifraga* spp. which is rarely used by the livestock has higher IVI (27.62) in the grazed plots. This species is licked by yaks especially in winter during the time of scarcity of grasses. When similar species were compared between ungrazed and grazed plots, the result indicates that IVI value of the species is higher in the ungrazed plots during July. In November also *Kobresia* spp. has the highest IVI in both ungrazed (133.73) and grazed (112.20) plots. Likewise medium palatable *Saussurea nepalensis* has IVI 6.70 in ungrazed and 7.58 in grazed and low palatable *Saxifraga* spp. has 14.74 in ungrazed and 11.40 in grazed plot. The difference in IVI is not consistent even with the different species of highly palatable group; species wise response to grazing is different.

The comparison of average cover of the highly palatable species viz. *Carex* spp., *Kobresia* spp. and *Penisetum* spp. shows that the average cover is higher in ungrazed plots than in grazed in both the months (Table 2). A significant difference was observed in July when the cover of the commonly occurring plant species (eight species viz. *Carex* spp., *Kobresia* spp., *Penisetum* spp., *Potentilla plurijuga*, *Potentilla* spp., *Saussurea nepal-*

Table 1. Relative frequency and IVI of the species in ungrazed and grazed plots during July and November 2005

a. Ungrazed plots - July 2005 (N=6)

SN	Species	Palatability	Relative frequency	Relative density	Relative cover	IVI
1	*Carex* spp.	High	0.129	13.115	4.853	18.097
2	*Gentiana ornata*	Low	0.065	4.098	0.511	4.674
3	*Kobresia* spp.	High	0.194	60.929	61.303	122.425
4	*Lancea tibetica*	Low	0.129	4.645	1.149	5.923
5	*Penisetum* spp.	High	0.129	6.831	22.989	29.948
6	*Potentilla plurijuga*	High	0.097	3.005	2.299	5.401
7	*Potentilla* spp.	High	0.097	4.645	2.043	6.785
8	*Saussurea nepalensis*	Medium	0.065	1.366	0.511	1.941
9	*Saxifraga* spp.	Low	0.097	1.366	4.342	5.805

b. Grazed plots - July 2005 (N=6)

SN	Species	Palatability	Relative frequency	Relative density	Relative cover	IVI
1	*Anaphalis* spp.	High	9.756	7.885	3.580	21.222
2	*Anaphalis triplinervis*	High	4.878	2.523	1.432	8.833
3	*Androsace* spp.	Low	4.878	0.631	2.864	8.373
4	*Bistorta* spp.	Low	2.439	0.315	0.477	3.232
5	*Carex* spp.	High	12.195	16.402	10.024	38.621
6	*Cortia depressa*	Low	2.439	1.893	0.955	5.286
7	*Euphorbia stracheyi*	Non	2.439	0.946	1.432	4.817
8	*Kobresia* spp.	High	14.634	39.743	34.845	89.222
9	*Lancea tibetica*	Low	12.195	5.362	2.148	19.705
10	*Pedicularis* spp.	Non	2.439	0.315	0.239	2.993
11	*Penisetum* spp.	High	4.878	15.455	16.706	37.040
12	*Potentilla plurijuga*	High	2.439	0.631	0.477	3.547
13	*Potentilla* spp.	High	7.317	1.893	1.432	10.642
14	*Saussurea nepalensis*	Medium	4.878	1.577	0.955	7.410
15	*Saxifraga* spp.	Low	4.878	1.262	21.480	27.619
16	Unidentified spp.I	Low	4.878	2.839	0.716	8.433
17	Unidentified spp.II	Low	2.439	0.315	0.239	2.993

c. Ungrazed plots - November 2005 (N=6)

SN	Species	Palatability	Relative frequency	Relative density	Relative cover	IVI
1	*Anaphalis* spp.	High	2.778	0.440	0.482	3.700
2	*Androsace* spp.	Low	2.778	0.220	0.241	3.239
3	*Carex* spp.	High	13.889	17.838	8.675	40.402
4	*Kobresia spp.*	High	16.667	56.818	60.241	133.726
5	*Lancea tibetica*	Low	11.111	8.369	4.337	23.817

c. Ungrazed plots - November 2005 (N=6)

SN	Species	Palatability	Relative frequency	Relative density	Relative cover	IVI
6	*Pennisetum* spp.	High	16.667	8.589	15.904	41.159
7	*Potentilla plurijuga*	High	8.333	2.422	2.169	12.924
8	*Potentilla* spp.	High	8.333	2.643	1.687	12.663
9	*Saussurea nepalensis*	Medium	5.556	0.661	0.482	6.698
10	*Saxifraga* spp.	Low	8.333	1.101	5.301	14.736
11	Unidentified spp.	Low	5.556	0.881	0.482	6.918

d. Grazed plots - November 2005 (N=6)

SN	Species	Palatability	Relative frequency	Relative density	Relative cover	IVI
1	*Anaphalis* spp.	High	8.823	11.983	9.896	30.702
2	*Bistorta* spp.	Low	2.941	0.218	0.521	3.680
3	*Carex* spp.	High	11.765	20.697	9.375	41.837
4	*Kobresia* spp.	High	17.647	39.869	54.688	112.204
5	*Lancea tibetica*	Low	11.765	4.139	3.646	19.550
6	*Pennisetum* spp.	High	2.941	0.871	1.042	4.854
7	*Potentilla plurijuga*	High	5.882	3.268	2.604	11.754
8	*Potentilla* spp.	High	8.823	2.614	4.167	15.605
9	*Saussurea nepalensis*	Medium	5.882	0.654	1.042	7.578
10	*Saxifraga* spp.	Low	5.882	1.089	4.427	11.399
11	*Thalictrum* spp.	Low	2.941	0.218	0.521	3.680
12	Unidentified spp. I	Low	2.941	0.218	0.260	3.419
13	Unidentified spp.	Low	11.765	14.161	7.813	33.738

Table 2. Mean cover of the species in ungrazed and graged plots during July and November 2005.

SN	Species	July 2005	November 2005	Palatability		
		Ungrazed	**Grazed**	**Ungrazed**	**Grazed**	
1	*Anaphalis* spp.	-	1.88	2.00	6.33	High
2	*Anaphalis*	-	1.50	-	-	High
3	*triplinervis*	-	3.00	1.00	-	Low
4	*Androsace* spp.	-	1.00	-	1.00	Low
5	*Bistorta* spp.	4.75	4.20	7.20	4.50	High
6	*Carex* spp.	-	2.00	-	-	Low
7	*Cortia depressa*	-	3.00	-	-	Non
8	*Euphorbia stracheyi*	1.00	-	-	-	Mediu
9	*Gentiana ornata*	40.00	12.17	41.67	17.50	m
10	*Kobresia* spp.	1.13	0.90	4.50	1.75	High
11	*Lancea tibetica*	-	0.50	-	-	Low
12	*Pedicularis* spp.	22.50	17.50	11.00	2.00	Non
13	*Penisetum* spp.	3.00	1.00	3.00	2.50	High
14	*Potentilla plurijuga*	2.67	1.00	2.33	2.67	High

SN	Species	July 2005		November 2005		Palatability
		Ungrazed	**Grazed**	**Ungrazed**	**Grazed**	
15	*Saussurea*	1.00	1.00	1.00	1.00	Medium
16	*nepalensis*	5.67	22.50	7.33	4.25	Low
17	*Saxifraga* spp.	-	-	-	1.00	Low
18	*Thalictrum* spp.	-	-	1.00	3.75	Low
19	Unidentified spp.	-	0.75	-	0.50	Low
20	Unidentified spp.I	-	0.5	-	-	Low
	Unidentified spp.II					

Table 3. Mean height (cm) of the species in ungrazed and graged plots during July and November 2005.

SN	Species	July 2005		November 2005		Palatability
		Ungrazed	**Grazed**	**Ungrazed**	**Grazed**	
1	*Anaphalis* spp.	-	1.25	2.00	1.00	High
2	*Anaphalis triplinervis*	-	1.25	-	-	High
3	*Androsace* spp.	-	3.00	1.00	-	Low
4	*Bistorta* spp.	-	3.00	-	3.00	Low
5	*Carex* spp.	3.00	4.80	6.20	4.00	High
6	*Cortia depressa*	-	3.00	-	-	Low
7	*Euphorbia estachyei*	-	7.00	-	-	Non
8	*Gentiana ornata*	1.75	-	-	-	Medium
9	*Kobresia* spp.	4.33	4.67	5.67	3.50	High
10	*Lancea tibetica*	1.75	1.20	2.00	2.63	Low
11	*Pedicularis* spp.	-	3.00	-	-	Non
12	*Penisetum* spp.	12.75	6.00	13.00	4.00	High
13	*Potentilla plurijuga*	3.67	4.00	5.00	2.00	High
14	*Potentilla* spp.	2.67	3.00	6.00	3.33	High
15	*Saussurea nepalensis*	2.50	2.00	5.00	2.75	Medium
16	*Saxifraga* spp.	1.00	1.00	1.00	1.00	Low
17	*Thalictrum* spp.	-	-	4.00	-	Low
18	Unidentified spp.	-	-	3.50	4.25	Low
19	Unidentified spp. I	-	1.00	-	1.00	Low
20	Unidentified spp. II	-	1.00	-	-	Low

ensis, Lancea tibetica and *Saxifraga* spp.) were compared (χ^2, $p<0.05$, $d.f. = 7$) but there is no significant difference in November (χ^2, $p>0.05$, $d.f. = 7$). A significant difference in July which is the peak growing season for most of the annual and perennial plants in the region indicates that the area has some effects of grazing. A comparison of biomass from the same experimental plot sites also indicates a significant difference in the productivity during July (Pokharel 2006). Plant cover allows a rapid assessment of plant community health and, as such, it would be a better indicator given that rapid response is a desirable feature of sensitive indicators (Meyer and Garcý´ a-Moya 1989).

The comparison of mean height of the highly palatable species viz. *Carex* spp., *Kobresia* spp. and *Penisetum* spp. (Table 3) shows that the mean height of *Carex* spp. and *Kobresia spp.* is higher in grazed plots than in ungrazed plots in July. This is just opposite in November for *Carex* spp. and *Kobresia* spp. However mean height of *Penisetum* spp. is higher in ungrazed plots in both the months. No significant difference was observed when height of the above mentioned commonly occurring plant species were compared (χ^2, $p>0.05$, $d. f. = 7$).

Plant communities' assessment showed that *Kobresia* spp. a highly palatable species is dominating both the ungrazed and grazed plots and is more abundant in the former plots. There is a difference in the cover of the species during July between the ungrazed and grazed plots which implies that the pasture has some impacts of grazing. Long term research is thought essential in order to determine the carrying capacity and to identify the indicator species i.e. grazing sensitive species for long term range health assessment in the region.

Acknowledgements

I would like to thank King Mahendra Trust for Nature Conservation for providing financial assistance for the study through its Upper Mustang Biodiversity Conservation Area Project (UMBCP). I am grateful towards Madhu Chetri, National Program Manager, UMBCP, and all the staff of Lomanthang Unit Conservation Office for helping me in the field.

References

Carpenter, C. and J. Klein 1995. Plant species diversity in relation to grazing pressure in three alpine pastures, Shey Phoksumdo National Parks, Dolpa District, Nepal. Field Report. Wildlife Studies Program, San Francisco State University.

Chetri, M. and C.R. Gurung 2004. Vegetation Composition, species performance and its relationship among livestock and wildlife in the grassland of Upper Mustang, Nepal. In: *Yak Production in Central Asian Highlands* (Eds. Z. Jincheng, Z. Xiangdong, H. Jianlin and C. Zhihua), Proceeding of the Fourth International Congress on Yak. Sichuan Publising Group, Sichuan Publication House of Science and Technology. pp. 235-244.

Goldstein, M.C. and C. Beall 1990. *Nomads of Western Tibet: The Survival of a Way of Life*. Univ. California Press, Berkeley.

Jackson, R.M., G.G. Ahlborn, M. Gurung and S. Ale 1996. Reducing Livestock Depredation Losses in the Nepalese Himalaya. In: *Proceeding of the 17th Vertebr. Pest Conf.* (Eds. R.M. Timm and A.C. Crabb), University of California, Davis. pp. 241-247.

Meyer, S.E. and E. Garcy a-Moya 1989. Plant community patterns and soil moisture regime in gypsum grasslands of north central Mexico. *Journal of Arid Environment* ***16***: 147–155.

Miller, D.J. 1995. Herds on the move .Winds of change among pastoralists in the Himalayas and on the Tibetan Plateau. ICIMOD Discussion paper series No. MNR95/2.

Miller, D.J. 1996. New Perspectives on Range Management, Pastoralism, and their implications

for HKH-Tibetan Plateau Rangelands. In: *Rangelands and Pastoral Development in the Hindu Kush-Himalayas* (Eds. D.J. Miller and S.R. Craig), Proceedings of a Regional Expert's meeting, ICIMOD, Kathmandu, Nepal. pp. 7-12.

Pokharel, A. 2006. *An assessment of Rangelands and Pastoral production systems*, *Upper Mustang*, *Nepal.* Institute of Forestry. (B.Sc. Thesis)

Schaller, G.B. and B. Gu 1994. Comparative ecology of ungulates in the Aru Basin of Northwest Tibet. *National Geographic Research and Exploration* ***10***: 266-293.

Stirling, G. and B. Wilsey 2001. Empirical relationships between species richness, evenness, and proportional diversity. *American Naturalist* ***158***: 286-297.

Wang, Y., M. Shiyomi, M. Tsuiki, X. Yu and R. Yi 2002. Spatial heterogeneity of vegetation under different grazing intensities in the Northwest Heilongjiang Steppe of China. *Agriculture, Ecosystems and Environment* ***90***: 217-229.

Zobel, D.B., P.K. Jha, U.K.R. Yadav and M.J. Behan 1987. *A Practical manual for Ecology*. Ratna Book Distributors, Kathmandu, Nepal.