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Evaluation of impacts of livestock grazing intensity on plant biodiversity in the western Chang Tang National Natural Reserve , Tibet , China

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Introduction In an arid or semi-arid region , such as the western Chang Tang area of the northwest Tibetan Plateau , herbivore grazing could be expected to have little impact on plant biodiversity if the system exhibits non-equilibrium characteristics at a large scale (Behnke & Scoones 1993) . However , in some places where high mountain ranges are located , such as in the Aru Basin (33°45′-34°25′N and 81°55′-82°40′E) , wetter microclimates occur within arid regions . Here the system would possibly be in a state of equilibrium , and the plant species richness should vary significantly along a grazing pressure gradient . To understand how livestock grazing intensity affects local plant biodiversity is therefore important for identifying ecosystem properties and can inform selection of appropriate policies for managing the ecosystem .

Materials and methods Grazing gradients radiating out from nomad summer camps were used to examine the effects of livestock grazing pressure on vegetation . Ten transects of 200 m length each were randomly placed in low and highly grazed areas . Twenty quadrats , each 0 .25 m^2 , were spaced at 10 m intervals along each transect for vegetation measurements . Vegetation data were separated into three categories , total , graminoids , and forbs (including dwarf shrubs) . Soil samples collected from low and highly grazed sites were analyzed for chemical composition .

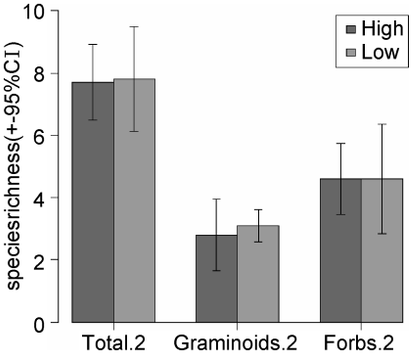

Figure 1 *Bar plot with 95% of confidence intervals (CI) illustrating differences in species richness (numbers of species along a 200 m transect) for total species , graminoids and forbs between the highly grazed and low grazed areas in the western Aru Basin on the northwest Tibetan Plateau .*

Table 1 *DCA with Monte Carlo Permutation test results for conditional effects of environmental variables .*

Variable	Var .N	λ	F-ratio	P value	variance explained
Elevation	18	0 .21	4 .00	0 .002	0 .21
Forb species richness	25	0 .12	2 .40	0 .008	0 .12
Species richness	7	0 .11	2 .38	0 .006	0 .1
Grass species richness	24	0 .07	1 .56	0 .098	0 .07
Slope	17	0 .05	1 .32	0 .19	0 .05
Grazing intensity	2	0 .06	1 .5	0 .114	0 .06
Aspect	16	0 .05	1 .23	0 .265	0 .05
Latitude	19	0 .03	0 .77	0 .594	0 .03
pH	8	0 .03	0 .8	0 .548	0 .03
N	9	0 .03			
K	10	0 .03			
P	11	0 .03			
Organic material	12	0 .03			
Total N	13	0 .03			
Total P	14	0 .03			
Total K	15	0 .03			

A total of 490 permutation tests were performed by setting options in Canonical Correspondence Analysis (CCA) using Canoco for Windows 4 .5 .

Results and discussion All comparisons between high and low grazing sites indicated that grazing intensity is not a significant factor impacting plant biodiversity (Figure 1) . A Monte Carlo Permutation test showed that elevation was the most significant abiotic environmental variable in explaining floristic variation (Table 1) . Moisture and elevation gradients were also important .

Conclusions This study indicates that grazing intensity has a limited impact on plant species richness , suggesting a domination of non-equilibrium rangeland vegetation characteristics in what is probably one of the moistest parts of the western Chang Tang plateau . Thus , the efficacy of current rangeland management policies , which are based on equilibrium ecosystems characteristics , should be questioned . A more realistic approach , using flexible and opportunistic strategies , needs to be formulated to manage livestock and wildlife in this non-equilibrium ecosystem .