Management of Tall Wet Grasslands in Dudwa National Park, Uttar Pradesh, Indian *Terai* Protected Areas–Conservation Implications

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Management of tall wet grasslands in Dudwa National Park, Uttar Pradesh, Indian *Terai* protected areas – conservation implications

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Abstract. Tall wet grasslands in the northern alluvial flood plains of the river Ganges and Brahmaputra are popularly known as *Terai* grasslands. Dudhwa National Park, Uttar Pradesh,India, is a moist deciduous forest dominated by sal (*Shorea robusta*) interspersed with numerous swamps and tall, wet grasslands dominated by *Saccharum*, *Narenga*, *Sclerostachya*, *Imperata* and *Typha* species. Common management practices used by the Dudhwa National Park Management include: (1) grass cut and burned; (2) grass cut, removed, and burned; (3) grass harrowed and burned; and (4) grass burned for tall wet grasslands. In this study split plots of 100 m x 260 m were used to assess the effects of these burning treatments. Twelve data sets covering different seasons were collected from April 1998 to January 2001 wherein 150 plots (5 treatments x 10 plots x 3 replicates) were sampled. The paper provides information on diversity, distribution, succession and the adaptive management practices of the *Terai* tall wet grasslands. The study indicated that *Desmostachya bipinnata*, a species of poor value to wildlife and local people, showed increased abundance and aboveground biomass at the cost of other preferred prominent grass species in the managed plots, particularly the harrowed-burned treatment. The resultant likely change of the Upland grassland predominated by *Imperata cylindrica* and the *Sclerostachya fusca*, *Saccharum narenga* and S*accharum spontaneum* dominated Lowland grassland to *Desmostachya bipinnata* due to repeated harrowed-burned treatment is a major management concern. This calls for a regular monitoring of the species composition and their abundance. Harrowing should be completely avoided.

Keywords: *Terai* grassland, burning, harrowing, *Desmostachya bipinnata*.

Introduction

The tall grassland habitats in the *Terai* are in a successional continuum ranging from the primary colonization of the new alluvial deposit by flood climax grass and herbaceous species and the non-flooded climax deciduous forests dominated by Sal (*Shores robusta*) (Champion and Seth 1968; Lemkuhl 1994). Since the Sal climax only forms on older, better drained alluvium, it is replaced by tropical deciduous riverine forests in areas subjected to periodic flooding during monsoons. The later typically comprises either *Acacia catechu* and *Dalbargia sisoo* communities or those with *Trewia nudiflora*. The primary succession grasslands in the area are maintained by prolonged inundation during the monsoon. Nine different grassland assemblies were identified in Dudhwa National Park (Mathur *et al.* 2003) which two main group: the upland dominated by short grass (2 m) such as *I. cylindrica,* and the lowland grasslands characterized by tall (6 m) grasses dominated by *S. fusca* , *S. naranga* and *Themeda arundanacea.* The Uttar Pradesh Terai grasslands have been extensively grazed, harvested, and annually burnt except in the Dudwa National Park where livestock grazing and grass harvesting have been officially banned for more than 20 years. However, some level of illegal grazing and harvest of grass in peripheral areas does take place and occasionally, some grasslands have been harrowed and burnt to promote new grass growth. The first major study on the tall grasslands in Terai Conservation Area (TCA) was initiated in 1998 as a part of the major WII-USDA Forest Service Collaborative Project to identify which treatments would increase dry season forage for ungulates and control competition to maintain a composition of favourable forage species.

The aim of this study was to specifically investigate the impact of the four common management practices used by the Dudhwa National Park Management include: (1) grass cut and burned; (2) grass cut, removed, and burned; (3) grass harrowed and burned; and (4) grass burned for tall wet grasslands on species dominance in the short and tall grassland types.

Materials and Methods

Site description

The Dudwa National Park study site covers 680 km^2 between latitude N $28^{o1}8$’ and $28^{o}42$’ and longitude E $80^{o}28$’ and $80^{o}42$’ in Lakhimpur Kheri district of Uttar Pradesh (Fig. 1) with altitude ranging from 150 m in the south-east to 182 m in the north. The alluvial soils range from sandy in elevated areas and along the high banks of river to loamy in the level uplands, and clays in depressions. The study area climate is typical tropical monsoon with three distinct seasons: winter (mid October to mid March), summer (mid March to mid June), and monsoon (mid June to mid October). Temperature and humidity extremes occur in different seasons; heavy dew fall during winter, frequent frosts in December to mid

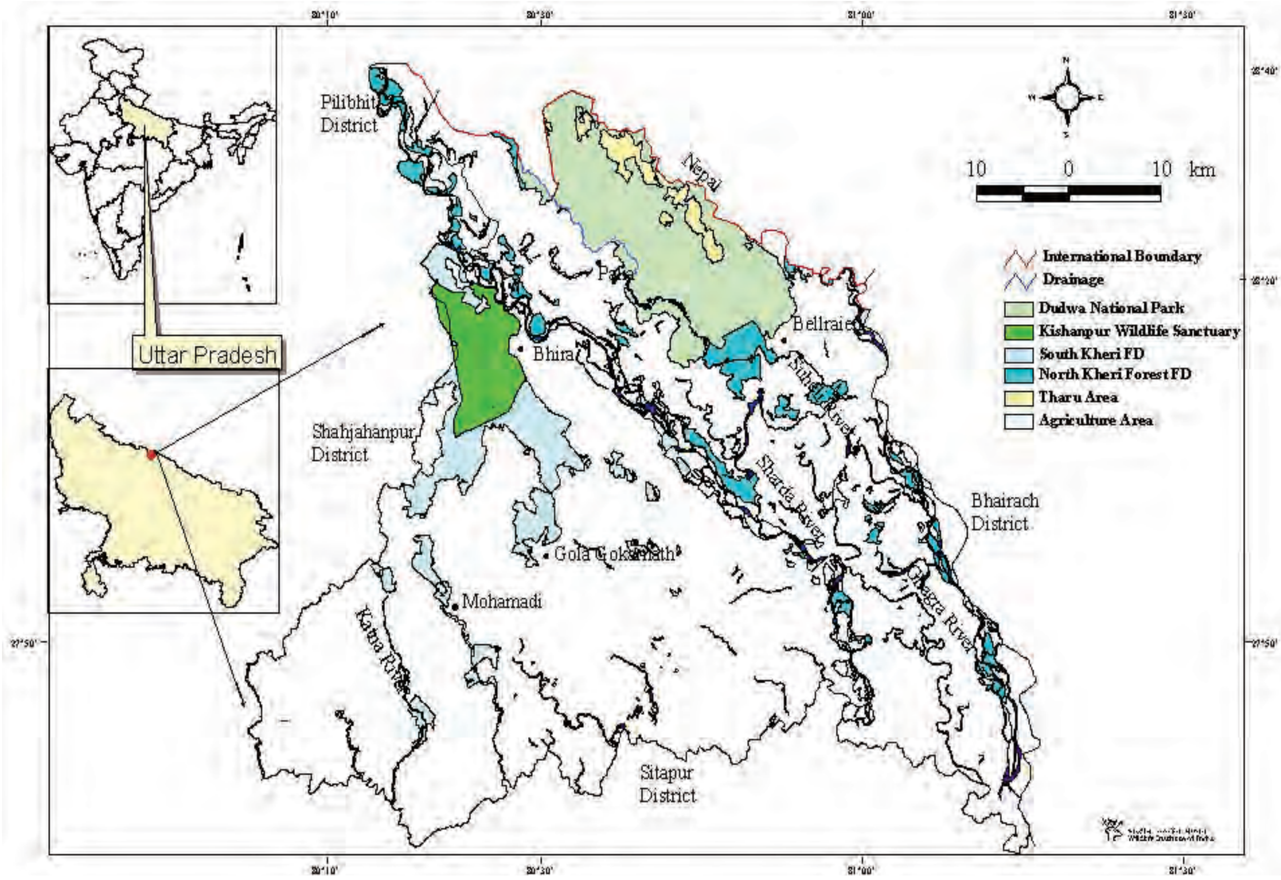

Figure 1. Dudwa National Park, Uttar Pradesh, India

February with January as the coldest month (mean maximum 19.6°C; mean minimum 8.8°C). May and June are the hottest months (mean maximum 42.7°C).

Treatments, Sampling and Data Analysis

Representative areas of the Upland (short – *I. cylindrica* – *D. bipinnata*) and Lowland (tall – *S. fusca* – *S. spontaneum*) grasslands in the Madria and Sathiana areas of the Dudwa National Park were selected to test the effects of burning.Plots of 100 m x 260 m (replicated three times) were laid out in each grassland type and split into five 100 m x 50 m treatment sub-plots for the four burning treatment plus a control block which was separated by 10 m fire-break. Before the burning treatments were applied, Quadrats were sampled to establish a baseline for plant composition, phenology, grass height, above-ground total biomass and pellet count (swamp deer and hog deer) were made in January 1998. The different treatments (*i.e.* grass cutting, removal, harrowing) were completed by 25 January and the subsequently burnt on 28 January, 3 February, and 5 February in 1998, 1999, and 2000, respectively. This provided three consecutive years of data.

Data collection was carried out in the October to December period when the majority of grasses and herbs were flowering which aided identification. Abundance based on cover for each species was rated on the Domin scale (1-10, or a "+" for solitary plants) as described by Mueller-Dombois and Ellenberg (1974). Standing biomass was assessed in 10 random 1 m x 1 m quadrats in each treatment plot. Standing biomass (live and dead) was cut at the ground level with sickles and weighed in the field. Biomass was sorted and fresh weight for each species recorded. Sub-samples (about 100 g) were chopped, transferred to separate paper bags, weighed, dried in a hot-air oven at 80°C and weighed to determine dry weight. The values for the 10 plots were averaged to provide a biomass estimate for treatment plots at each sample date.

Aboveground biomass and relative pellet occurrence data were initially analysed using 2-way Analysis of Variance (ANOVA) to investigate the effect of treatments and seasons individually. Subsequently multiple range comparisons were done for each grassland type using Tamhane's T2 Test to detect effect of interactions among different treatments and seasons. SPSS/PC+ based software was used for all analyses (Norusis, 1994).

Results

The effect of the four burning treatments on the above-ground biomass (ABG) revealed that three grasses contributed overwhelmingly to the vegetation cover and standing biomass (*I. cylindrica*, *D. bipinnata*, and *V. zizanoides* in the Upland grassland and *S. fusca* , *S. narenga* and *S. spontaneum* in the Lowland grassland). The dominance of these species was maintained under all the treatments. The only exception was the harrowed-burned treatment in the Lowland grassland where *D. bipinnata* invaded immediately after the second treatment and continued to grow and progressively dominate standing biomass till the experiment ended in 2000.

The managed (burnt) plots showed an increase in the number of shrubs, herbs, sedges and ferns. Thus, treated plots were heterogamous in composition and structure whereas the unmanaged plots were more homogeneous. The increase in number of herbaceous and other species was a result of disturbance by different burning regimes. These disturbances resulted in decreased canopy density and an increase in gaps in the managed grassland swards into which other species invaded. Earlier studied have reported a general principle that herbaceous species have a greater capacity than the dominant inferior competitors to colonize gaps in disturbed communities (Horn and MacArthur 1972; Crawly and May 1987; Peet *et al.* 1997).

Different burning regimes substantially reduced standing biomass immediately after each of the treatments. However, at the end of three consecutive years of different burning treatments, only a marginal difference in AGB values was registered in each case. Lowest AGB (16%) was under the harrowed-burned treatment given to the Upland grassland. The Lowland grassland also responded similarly to the four treatments over the three years and there was a maximum decline of AGB to the extent of 14%. Thus marked negative effect of the harrowed-burned treatment on AGB was evident in both the type of grasslands and also at all stages of the experiment.

There were significant differences between the AGB for the four treatments. However, the multiple comparisons using Tamhane's T2 Test showed that there was no significant difference between (1) cut-burned and cut – removed - burned; (2) cut-burned and burned; and (3) Cut-removed - burned and burned alone treatments on their corresponding values of AGB in the Upland grassland. Likewise, the cut-burned and cut-removed-burned treatments in the Lowland grassland also had no significant difference. This result supports earlier findings of Peet *et al.* (1997) who showed that there was no difference in cutting alone, burning alone and cutting and burning combined.

Nevertheless, the effect of four burning treatments on the species composition and standing biomass of major grass species was prominent in both the grasslands. *I. cylindrica*, the major contributor to the standing biomass in the Upland grassland declined considerable (40-53%) in its AGB in all treatments at the end of three years. The maximum loss (53%) was in the harrowed-burned treatment while the minimal loss (40%) was in burned alone treatment. The opposite effect was evident in the control block where *I. cylindrica* AGB increased by 10% by the end of experiment. In contrast to *I. cylindrica*, *D. bipinnata* increased its contribution to AGB from 1% to 37% in three treatments (cut-burned; cut-removed-burned; and cut-burned) and the control. The maximum gain was in the harrowed-burned treatment which favoured *D. pipinnata* at the expense of *I. cylindrica.*

The burned only treatment was the exception in which *D. bipinnata* declined by 4% in its AGB at the end of three years. The ldecrease of *I. cylindrica* and the increase of *D. bipinnata* can be attributed to the fact that the *I. cylindrical* is a sod-forming species that grows in dense swards (Lehmkuhl 1989) whereas *D. bipinnata* and other grasses such as *V. zizanoides, S. spontaneum* and *S. narenga* have a clumped habit, often with wide spacing between clumps. *I. cylindrica* is also known to be very susceptible to shading; perhaps the dead material on the unburned (control) plots and burned alone treatment with remnant unburned portions shaded the surface sufficiently to depress surface temperature, nitrogen mineralization and growth from basal meristems (Weaver and Rowlands 1952; Lehmkuhl 1989). Thus, on one hand the shading effect must have influenced new growth and AGB, whereas on the other hand, intense grazing and utilization of new growth by wild ungulates in the four burned treatments may explain the reduction *I. cylindrical* AGB.

D. bipinnata was definitely favoured by the open conditions created in the Upland grassland by different burning treatments except the burned alone treatment. *D. bipinnata* which was otherwise absent in the Lowland grassland prior to the commencement of experiment in January 1998 abruptly emerged and established in the harrowed-burned treatment. In contrast, *S. fusca* and *S. narenga* were adversely affected in the harrowed-burned treatment with AGB of both species significantly reduced by 47% and 53%, respectively by the end of three years.

The managed Upland and Lowland grassland plots distinctly favoured wild ungulates, particularly immediately after the treatments were applied and during summer. Thus, the management objective of promoting new growth and palatable grass during the lean season was achieved. The swamp and hog deer had greater relative pellet occurrence in the harrowed-burned and burned alone treatments in the Upland grassland. In the Lowland grassland, the harrowed-burned and cut-burned treatments were most favourable, while the burned alone treatment was for the most part avoided.

Discussion

Contemporary research has have reported deleterious effects on grassland composition resulting from disturbances *viz.,* continuous grass harvest, wide spread burning, and heavy grazing (Daubenmire 1968; Vogle 1974; McNaughton 1979; Mishra 1982; Brown 1997). However, studies by Karki (1997), Mishra (1984), Brown (1997) and Peet *et al.* (1997) have indicated that the *Terai* system is maintained in part by human intervention, and current rates of biomass removal are not adversely affecting the condition of the tall grasslands. Rather, the current practices bring benefits to both local communities and to wildlife. However, whether the practices are sustainable, and in what way they can be regulated, is open to question.

This three year study showed that there was no significant difference in the overall standing biomass among the four treatments when compared to the control plot. At the same time, earlier studies (*e.g.* Peet *et al.* 1997; Kumar *et al.* 2002) and data presented here all report the increases in abundance and AGB of *D. bipinnata (*a species of poor value to wildlife and local people) and a decrease in preferred grass species in the managed plots, particularly the harrowed-burned treatment. The resultant change of the Upland grassland dominated by *I. cylindrica* and the Lowland grassland dominated by *S. fusca, S. narenga* and *S. spontaneum* to a homogenized grassland dominated by *D. bipinnata* due to repeated harrowed-burned treatment is a major management concern unless regular monitoring of species composition and abundance is instituted.

It is also clear that ending the current practices of cutting and burning would remove the real benefit of the availability of new growth of palatable grasses to ungulates during the lean period. Grass removal by local communities and periodic burning are also helping in controlling hotter and destructive summer fires by reducing fuel loads which has a positive effect on the ecology of these grassland systems. Therefore, maintaining the *status quo*, by annual cutting and burning would provide ungulates with summer forage from the regenerating grassland also well provide important subsistence resource to local communities. Most studies have confirmed that biomass removal of whatever form (including grazing; Lehmkuhl 1989) resulted in a similar species composition, abundance, structure, and standing biomass at the time of termination of experiment. However, the harrowed-burned treatment has marked influence on the species composition, standing biomass, phenology, and ungulate use. In view of the above, it is evident that some sort of patch cutting and burning of both the grassland types would produce a mosaic of suitable habitats for the persistence of diverse faunal species in *Terai*. Staggered cutting and burning would also create different patches providing varying forage and cover conditions. However, patch size would be critical for success; a patch too large would be hard for herbivores to crop fast enough to keep the grass short, and a patch too small might be overgrazed and may not provide adequate benefits to warrant management.

Conclusion

A clear finding from this study is that harrowing should be completely avoided because it the management practice that most consistently created opportunities for more competitive yet poorer quality species to colonize into gaps created in both plant communities. While the other management practice (burning, cutting and removing biomass, grazing) maintain dominance of desirable species, it is clear that these must also be regulated. Designing patch management as part of planned strategies for using different burning practices should be seriously considered as should the establishment of a long term monitoring system to investigate changes in the composition of the Upland and Lowland grassland.

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