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

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Abstract

A study on grassland management practices and their impact on wildlife habitats was started in Dudwa National Park in 1998-1999. In this area the tall wet grasslands are maintained as a natural community by annual flooding and higher moisture regimes together with the synergistic influence of fires. These grasslands are burnt annually during the early dry season (January-February). As a result of floods during the monsoon and the associated deposition of silt and high moisture content, these grasslands do not burn properly. Different management practices are undertaken by the park management to improve the habitat quality including cutting of grass, cutting and removal of grass, harrowing prior to burning, and burning. In this paper I describe the effect of four treatments on these grasslands: (i) grass cut and burnt; (ii) grass cut, removed, and burnt; (iii) grass harrowed and burnt; and (iv) grass burnt as standing. The treatments were tested on two different types of grassland: wet, tall grasslands– *Sclerostachya fusca-Saccharum spontaneum;* and dry, short grasslands– *Imperata cylindrica-Veteveria zizanoides*. A split plot design was used in these two different grassland communities to study the different burning practices with six replicates, three in each grassland community. Data are presented on phenology, plant species composition, grazing intensity, phytomass, and ungulate use (based on pellet counts). The above ground phytomass was lower after harrow and burn treatment than for the other treatments, but the relative pellet occurrence was higher when this treatment was performed during April 98 and July 98. After the monsoon there was no significant difference in phytomass or height after the different treatments. The study is long term and will address basic questions related to the impact of grassland management practices on grassland diversity and productivity and the effect of burning in the protected area.

Introduction

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)* (Champion and Seth 1968; Dabadghao and Shankarnarayan 1973; Lehmkuhl 1989 and 1994). Since the sal climax only forms on older, better-drained alluvium, it is replaced by tropical deciduous riverine forests in areas such as those subject to periodic flooding during monsoons. The latter typically comprises either Khair-sisso communities (*Acacia catechu* and *Dalbergia sisso*) or those with *Trewia nudiflora*. The primary successional grasslands in the area are maintained by prolonged inundation during the monsoon, and the seral grasslands by periodic inundation and by fire or grazing. Current management in the grasslands of Dudwa National Park involves annual burning during the

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early dry season (January-February) (Rodgers and Sawarkar 1988; Rahmani *et al.* 1990; Kumar and Mathur 1998). It is believed that the early burning of the grasslands promotes the growth of new shoots, which are a preferred food item for different herbivores; serves to prevent the loss of grassland habitats through the invasion of woody species or encroachment of grasslands by climax forest habitat; and reduces the incidence of spontaneous and more damaging large scale summer fires by removing accumulated combustible fuel. At the same time there has been regrettably little research into the effects of burning, or indeed any of the other disturbance factors like grazing and harvesting, on tall grassland habitats to support the above claims (Rodgers and Sawarkar 1988; Kumar and Mathur 1998). Grassland programmes are now needed to increase the amount of premium *Imperata cylindrica* to help meet the demand for thatch grass. Management would emphasise the creation of a mosaic of tall-grass patches and short *Imperata cylindrica* grass patches, rather than converting large areas of tall grass into an *Imperata cylindrica* monoculture. The extensive tall grass stands are little used for foraging by wildlife, but they have a high cover value. Short grass stands are worthless for cover for large animals, but provide more palatable forage than tall grasses for a longer period during the year. The increased edge effect provided by a more diverse landscape mosaic would be likely to increase the diversity of other wildlife at a site (Lehmkuhl 1994).

The investigations in this paper aimed at assessing grasslands, different management practices, and wild ungulate relationships. Four treatments are being tested: a mosaic of cut and burned grasses; grasses cut, removed, and burned; selective harrowing of grassland patches followed by burning; and grass burned as standing.

Study Area

The present study was carried out in Dudwa National Park (DNP). The area represents one of the few remaining examples of the highly diverse and productive *Terai* system and falls under the *Terai*-Bhabhar biogeographic sub-division of the Upper Gangetic Plains biotic province and the Gangetic Plains biogeographic zone (Rodgers and Panwar 1988). The DNP lies between 28° 18' and 28° 42' N and 80°28' and 80° 42' E. The foothills of the Himalayas lie 30 km to the north (Figure 6). The altitude ranges from 150 masl in the farthest south-east to 182 masl in the extreme north, a rise of just 32 m. Several streams and tributaries drain through the DNP. The northern boundary of the park is contiguous with the international India-Nepal border and is largely determined by the Mohana river.

The most significant attribute of the DNP forests is the predominant and valuable moist deciduous sal (*Shorea robusta*) forest with interspersed tall, wet grasslands and numerous swamps. Sal forest occupies the major portion of the DNP, ca. 50%, while grasslands constitute more than 15%. The grasslands can be broadly classified into two types: the tall, wet grasslands in low-lying areas dominated by *Sclerostachya fusca, Saccharum spontaneum, Phragmites karka,* and *Arundo donax;* and the short, dry grasslands occupying higher grounds and dominated by *Imperata cylindrica, Veteveria zizanoides,* and *Desmostachya bipinnata*. The number of species currently documented include 77 grasses and grass-like plants, 79 aquatic plants, 75 trees, 21 shrubs, 17 climbers, 40

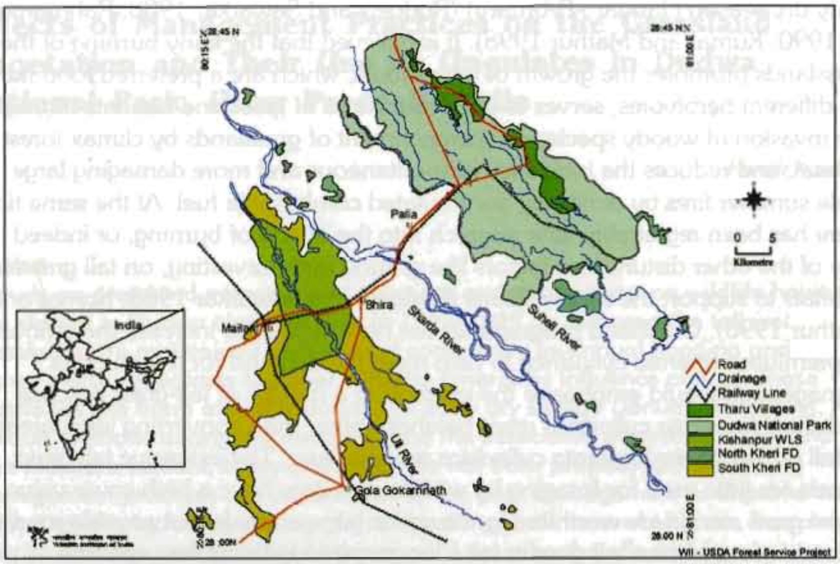

Figure 6. **Map of *Terai* Conservation Areas in Uttar Pradesh**

mammals, 90 fishes, 15 amphibians, 25 reptiles, and nearly 400 birds. The area harbours a significant population of tigers (*Panthera tigris*). Beside this, the most notable feature is the existence of five species of deer including a relict population of the highly endangered swamp deer (*Cervus duvauceli duvauceli*). The DNP is also home to other critically endangered species including the hispid hare (*Caprolagus hispidus*) and the Bengal florican (*Hubaropsis bengalensis*).

In the study area, the tall wet grasslands are maintained as a natural community by annual flooding and the associated high moisture regime with the synergistic influence of fire. Prior to 1978, a large number of domestic livestock used to graze the area and grass was cut and taken away for thatching. There is an unsubstantiated belief, notwithstanding the effect of fire and flood, that grazing and cutting used to maintain a layer of palatable grasses. Prescribed fires have been carried out in these grasslands for a long time. During floods, silt is deposited on the bed of these tall grasses. When they are burned the silt acts as an insulator and burning is incomplete. In order to improve the habitat quality, different grassland management practices are now being undertaken.

The main study area was a part of the DNP called Sathiana. This area used to be the main stronghold of swamp deer (Schaller 1967). During the summer of 1981 more than 2000 swamp deer were counted here (Sawarkar 1988). During the past few years, there has been a severe decline in the swamp deer population. The largest population of swamp deer seen in Sathiana in 1991 was 150 (Qureshi *et al.* 1991). The current estimate is 200 swamp deer in this area. Different grassland management programmes are now being undertaken in DNP to manage the monospecies dominant areas of the tall grassland habitats. An experimental study has been started to assess the effect of different management practices on the grassland vegetation and its use by wild ungulates.

Methods

For the purpose of the assessment two grassland communities were differentiated: short grasslands of *Imperata cylindrica-Veteveria zizanoidis*, with an average grass height of less than 1.5 m; and tall grasslands characterised by *Sclerostachya fusca-Saccharum spontaneum,* with an average grass height of more than two metres and a maximum of up to seven metres. Split plots of 100 x 200 m were used to study the different burning practices with six replicates of each split design, three each in the short grassland and tall grassland communities. Each experimental plot was split into four equal blocks (100 x 50 m) or treatments: (i) grass cut and burned; (ii) grass cut, removed, and burned; (iii) grassland harrowed and burned; and (iv) grass burned as standing. These treatments were randomly assigned in the split plots. The treatments were performed in January/February.

Habitat Use by Wild Ungulates

Prior to treatment and burning, the initial plant species composition, phenology, grass height, and phytomass were recorded, and pellet counts taken for swamp deer (*Cervus duvauceli duvauceli)* and hog deer (*Axis porcinus)*. For vegetation assessment (species composition, height, and biomass), ten random sample plots (1 x 1 m) were laid in each treatment plot. For the assessment of phenology and grazing occurrence, ten 2 x 2 m quadrats in 2 rows of 5 quadrats were placed systematically in each treatment plot. Three placements were made of a 0.5 x 0.5 m frame with a 5 x 5 interior grid in each 2 x 2 m quadrat, to estimate the grazing intensity. Two belt transacts (100 x 2 m) were marked at 17 m intervals from the left side in each split plot for the assessment of ungulate use through pellet counts. Total pellet groups of the two herbivorous animals were counted in two belt transacts and later collected and removed. All the above measurements were repeated three times at intervals of three months after the different treatments had been carried out. In all, four sets of measurements were made of each parameter (one prior to the experimental treatment, and three after). The above ground phytomass was determined by clipping vegetation species-wise in 1 x 1 m plots and calculating the dry weight.

Analysis

Dunnet's t-test (two–tailed test) was performed to compare the control values with treatment values. The analysis was done using SPSS version 8.0 software (Norusis 1994) and biostatistical analysis.

Results and Discussion

The area was regularly grazed by wild ungulates during all seasons. *Imperata cylindrica* sprouted from the ground after harrow and burn treatment, after the other three treatments sprouting was from the remnant tussocks. Except in the harrowed and burned sections, the grasses began to flower in February and grass senescence started in March. In the harrowed and burned sections, *Veteveria zizanoidis* sprouted in February and was grazed intensively by herbivores during February and March, presumably because of the palatability and nutritive content. Flowering of grass started during March, but unlike in the other sections there was no senescence. *Saccharum spontaneum* sprouted in March (and in the monsoon), so that when *Imperata cylindrica* and *Veteveria zizanoides* were flowering the ungulates fed on sprouts of *Saccharum* *spontaneum*. The *Imperata cylindrica-Veteverian zizanoides* communities supported grazing throughout the year in both harrowed and burned sections and sections subjected to burning alone. Hog deer grazed more heavily on harrowed and burned sections and sections subjected to burning alone, but preferred patches subjected to burning alone since this left more cover to hide in.

In the tall grassland communities, *Imperata cylindrica* sprouted from the ground in harrowed and burned sections during January, and there was intensive feeding on it during January and February. *Sclerostachya fusca* sprouted in February in all sections except the harrowed and burned and was moderately grazed. *Schlerostachya fusca* sprouted during March in harrowed and burned areas as did *Cyprus* species. Grazing seemed to be heaviest in relative terms in harrowed and burned sections. *Viccatia coenifollia* appeared as a dominant species in harrowed and burned areas during April. *Saccharum spontaneum* also sprouted in April.

In the tall grassland communities, the harrow and burn treatment areas were used relatively more by swamp deer because during the early dry season the tall grasses were replaced by short grasses which provided the preferred combination of food and cover as well as open areas for resting. Between January and April, 126 swamp deer were observed resting in the openings created by the harrow and burn treatments. The open areas presumably provide a good escape distance for the ungulates, and were combined with a mosaic of fodder areas and hiding cover. As the grass height increased the visibility decreaseds.

The above ground biomass before the start of treatment (January) and at three intervals of three months after the treatments is shown in Figures 7 and 8.

In the short grassland communities (Figure 7), the above ground biomass in the harrowed and burned areas was markedly lower than in the other areas three months after treatment, presumably as a result of the late response of species, the fact that grass had to sprout from under the ground rather than from tussocks, and that the intensity of grazing was higher. The difference was less marked in July. After the monsoon, in October, the above ground biomass was more or less the same in all treatment areas. Dunnet's two-tailed t-test showed a significant difference in above ground biomass between harrowed and burned and only burned treatments ($t = -105.75$; $n = 30$; $P < 0.001$); and between cut. removed, and burned, and only burned treatments ($t = -62.61$; $n = 30$; $P < 0.02$). There were no interaction effects between treatments and seasons on above ground biomass, i.e., the effects of the treatment and seasons were independent.

In the tall grassland communities (Figure 8) the above ground biomass three months after treatment was markedly higher after burn only treatment than after any of the other treatments, and was slightly lower in the harrowed and burned areas than in the cut, removed, and burned, and cut and burned areas. By July, the above griound biomass had increased somewhat in all treatment sections, but the differences remained similar to those in April. In October, after the

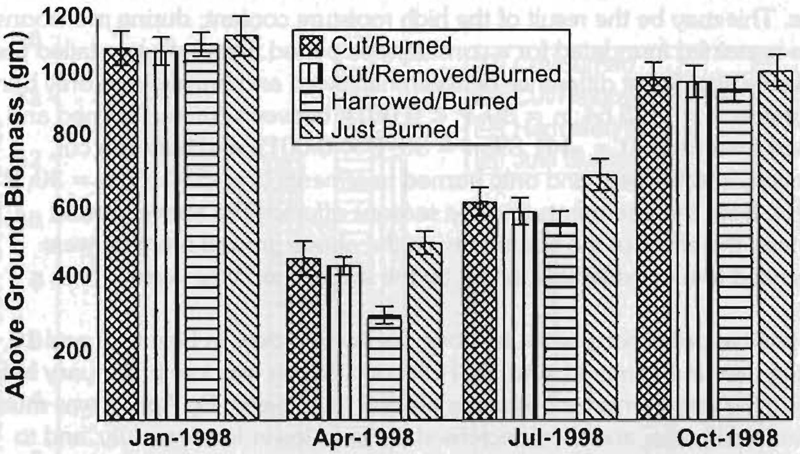

Figure 7. Above ground biomass in short grassland communities (g/m^2)

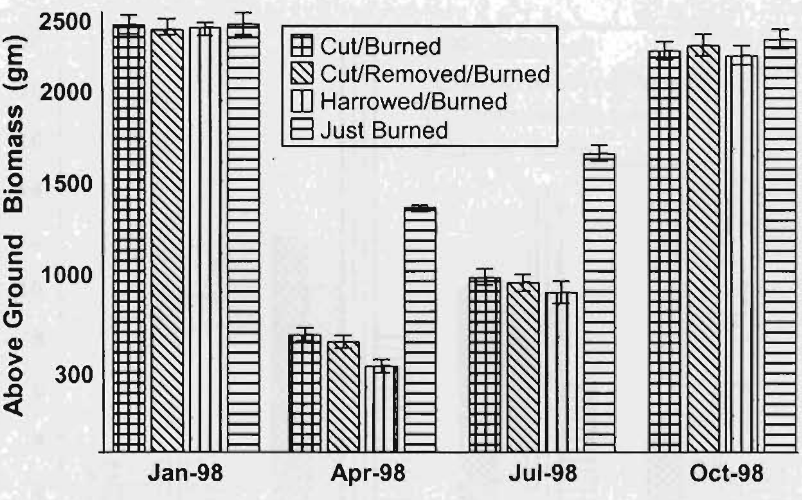

Figure 8. Above ground biomass in tall grassland communities (g/m^2)

monsoon, the above ground biomass was more or less the same in all treatment areas. This may be the result of the high moisture content; during monsoons the areas remained inundated for a considerable period. Dunnet's two tailed t-test showed a significant difference between harrowed and burned and only burned treatments ($t = -525.64$; $n = 30$; $P < 0.001$); between cut and burned and only burned treatments ($t = -441.89$; $n = 30$; $P < 0.001$); and between cut, removed, and burned, and only burned treatments ($t = -520.69$; $n = 30$; $P < 0.001$). Both the treatments and the seasons affected the above ground biomass; the effect of the treatments on the above ground biomass were influenced to a considerable extent by the season and vice versa.

The relative pellet occurrence is shown for swamp deer in Figures 9 and 10, and for hog deer in Figures 11 and 12. Pellet occurrence was low in January before starting the treatments for both animals and in all areas. By April it was much higher in all areas, and then decreased again to lower levels in July, and to levels closer to the original levels by October. These changes reflect the changes in grass height. Before starting the treatments the grass height was quite high; after the treatments the grasses were short and in the early months palatability was high; as time passed the grass height increased and the palatability decreased and this was accompanied by a decline in the relative pellet occurrence. The above ground biomass of different species has still to be analysed.

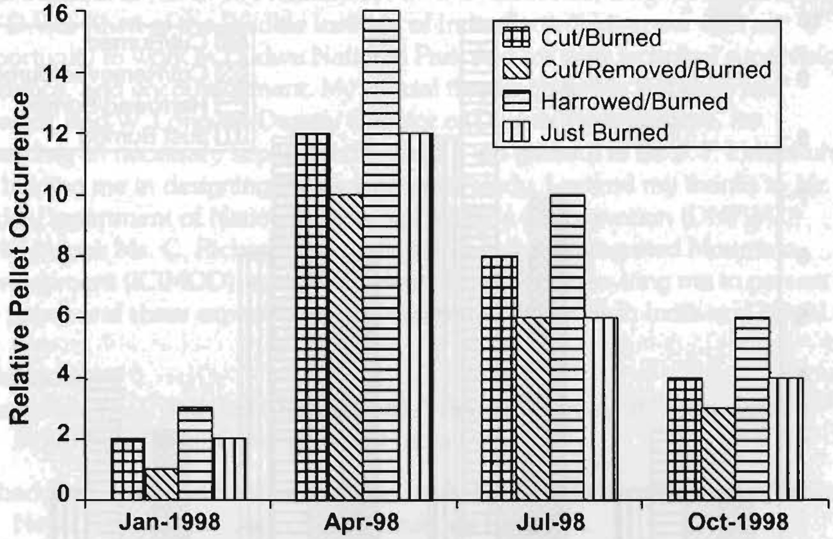

Figure 9. Relative pellet occurrence of swamp deer in short grassland communities

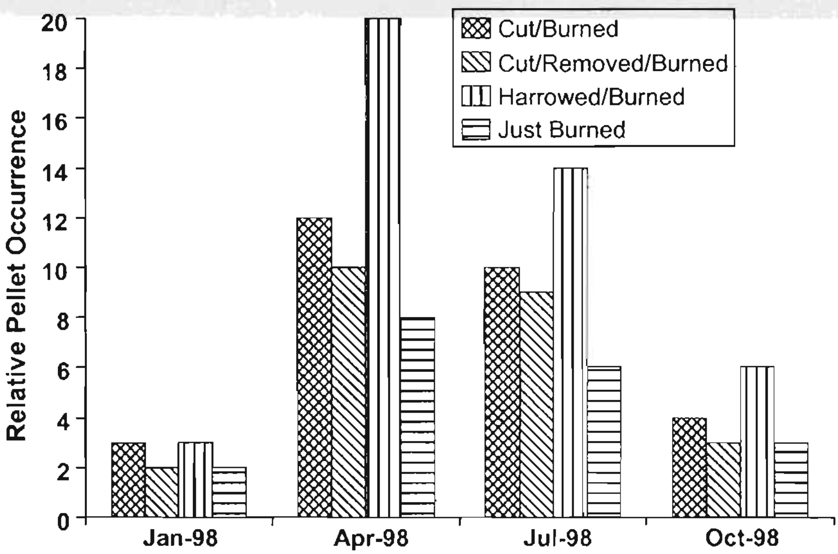

Figure 10. Relative pellet occurrence of swamp deer in tall grassland communities

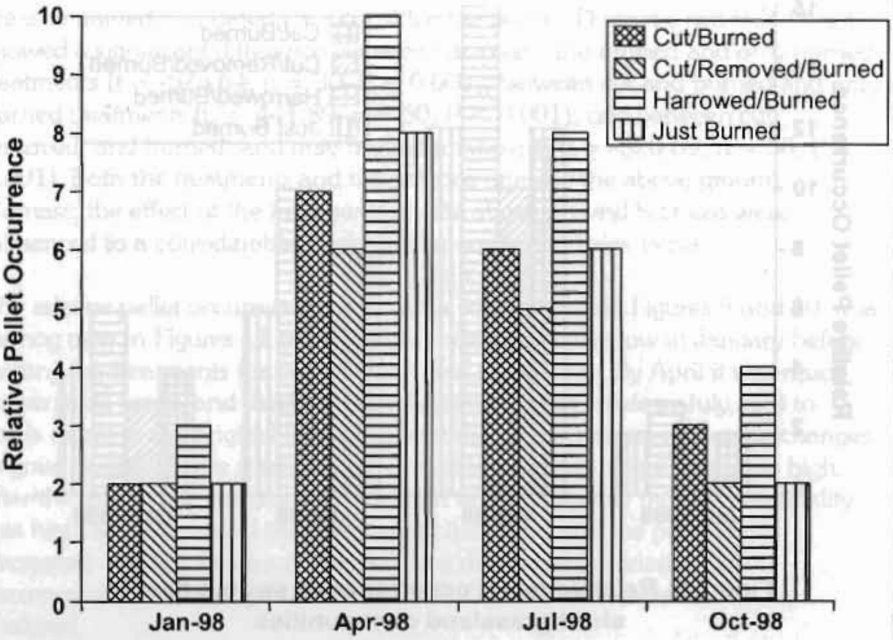

Figure 11. Relative pellet occurrence of hog deer in short grassland communities

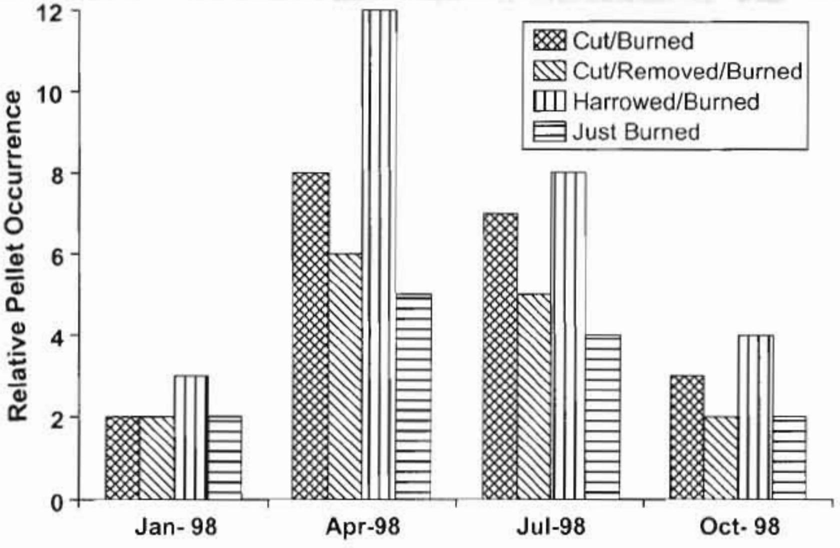

Figure 12. Relative pellet occurrence of hog deer in tall grassland communities

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