Grasslands and Large Mammal Conservation in the Lowland *Terai*: A Preliminary Synthesis Based on Field Research Conducted in Royal Bardia National Park, Nepal

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Abstract

In the lowland *Terai* of Nepal, two types of grassland are found, viz. riparian tall-grass floodplains, and wooded grasslands and phantas. The floodplain grasslands, which consist of tall, perennial grasses, are established and maintained by fluvial action and flooding; the wooded grasslands and phantas consist of shorter perennial grass and originated following human intervention (forest clearing, burning, grazing of domestic stock , and cultivation). Both of these types of grassland have traditionally been utilised by local villagers for different purposes. In addition, both types of grassland are periodically burnt, either intentionally by protected area managers or by local people. Field studies in the protected areas of Koshi Tappu, Chitwan, Bardia, and Sukla Phanta have documented the crucial role that both types of grassland play in the conservation of several wild mammalian herbivores, and thus in the conservation of their carnivore predators. In these grasslands, various management interventions such as burning, grass harvesting, ploughing, and uprooting of tree saplings are carried out by reserve authorities. Recent research suggests that rotational cutting and patch burning spread over a longer time during the dry season should be practised. Similarly, smaller wooded grasslands and phantas should be created within the surrounding sal forests in Royal Bardia National Park. Finally, it is suggested that long-term research should be conducted on the ecological effects of cutting and burning in the tall-grass floodplain and the effects on the productivity and mineral balance of the wooded grasslands and phantas. Research into grazing lawns and grazing pressure, and on proposed experimental clear felling in mature sal (*Shorea robusta*) and asna (*Terminalia tomentosa*) forest to create wooded grasslands and phantas is emphasised.

Background

The grasslands in the lowland *Terai* basically consist of two types: a) riparian tall-grass floodplains, and b) wooded grasslands and phantas. These types are quite different in origin, species composition, and ecological dynamics, and functionally in the larger-scale ecosystems in which they occur.

The floodplain grasslands consist of tall, perennial grasses (*Saccharum, Narenga, Themeda, Phragmitis spp.*). They are natural in the sense that they become established and are maintained as a result of fluvial action and flooding during the monsoon; but they are successional and would develop into forest if periodic flooding ceased and the soil substrate become stabilised. In contrast, the wooded grasslands and phantas consist of shorter perennial grasses (mainly

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Imperata cylindrica and *Vetiveria zizanoides*); they originated following human intervention (forest clearing, burning, grazing of domestic stock, and cultivation); and they occur on more or less stabilised soils where monsoonal rains have little impact on the substrate. Both types share the characteristic of a high water table, which facilitates extensive grass growth and gives graminoids a competitive advantage over shrubs and trees under conditions of more or less uninterrupted insolation.

Traditionally, both types of grassland have been utilised by local villagers for different purposes. The tall grasses in the floodplain are cut and harvested mainly for canes, whereas the wooded grasslands and phantas were previously grazed by domestic stock and grasses cut and harvested for a variety of local uses. Grazing of domestic livestock is now prohibited inside the protected areas, but harvesting is permitted both in the floodplain and in the phantas during a short period in the early (cool) part of the dry season. At the same time of year and shortly thereafter, large parts of both types of grassland are burnt each year intentionally by Park staff as part of a habitat management programme. Fires are also set by others as a result of carelessness and for no defined purpose.

Grasslands and Phantas as Habitats for Larger Mammals

Field studies in the protected areas of Koshi Tappu, Chitwan, Bardia, and Sukla Phanta have documented the crucial role that both types of grassland play in the conservation of several wild mammalian herbivores, and thus in the conservation of their carnivore predators. The floodplain grasslands are particularly important habitats for the two megaherbivores rhinoceros (*Rhinoceros unicornis*) and wild elephant (*Elephas maximus*) (Laurie 1978; Dinerstein and Price 1991; Jnawali 1995; Fjellstad and Steinheim 1996), other mammals such as wild water buffalo (*Bubalus bubalis*) (Heinen 1993), hog deer (*Axis porcinus*) (Dhungel and O'Gara 1991), and barasingha (*Cervus duauceli*) (Schaaf 1978; Pokharel 1997; Moe 1994), whereas the wooded grasslands and phantas are critical habitats for chital (*Axis axis*) (Mishra 1982; Moe and Wegge 1996) and seasonally for barasingha (Pokharel 1997). Nilgai (*Boselaphus tragocamelus*) are also dependent on the short grasslands, although to a lesser extent than the other two ungulates (Khatri 1993). The successional pattern of floodplain grasslands (in the absence of flooding disturbance) is through intermediate stages of riparian sissoo (*Dalbergia sissoo*) and khair (*Acacia catechu*) forest to a more or less stable semi-evergreen riverine forest (Dinerstein 1979). These intermediate stages are also prime habitats for chital and to a lesser extent for barking deer (*Muntiacus muntjak*).

Recent census data from the western part of Royal Bardia National Park (RBNP) show 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, with more than 200 animals per square kilometre. In the surrounding sal forest and other non-related grassland habitats that cover the largest portion of RBNP, the density is only a fraction of this (Andersen and Næss 1993, Wegge *et al.* unpublished). One of the main reasons for the extraordinarily high density and also diversity of ungulates in the grassland-related habitats of RBNP is probably the fine-grained pattern of habitat dispersion in which the landscape consists of a mosaic of different

habitat patches: animals do not need to move far to obtain seasonal high quality food and shelter (Moe and Wegge 1996).

The very high biomass of ungulates in the floodplain-phanta habitat complex constitutes the food base for a dense predator fauna. Recent investigations have disclosed a higher density of tiger in this mixed habitat complex of RBNP than in Royal Chitwan National Park and most other tiger reserves elsewhere (Pokharel *et al.* unpublished), and circumstantial evidence indicates that this local tiger population has a different social structure, probably as a result of the high prey base (Wegge and Storaas unpublished). A newly initiated study on leopards has confirmed that the Park also contains a viable population of this species, which in part is attributable to the presence of a prey base that is sufficiently diverse and dense for the two carnivores to coexist (Wegge and Odden, unpublished).

Management Considerations

In the south-western part of RBNP, the mosaic of grasslands—both the natural riparian floodplains and the man-made wooded grasslands and phantas—surrounded with and interspersed with seral forested plant communities, provideS optimum habitats for an exceptionally dense and diverse assemblage of wild herbivores, and consequently for their main predators—the tiger (*Panthera tigris*) and the leopard (*Panthera pardus*). Several of the species in this area belong to the categories 'endangered' or 'threatened' internationally. From a conservation standpoint, this ca 100 sq.km of the Park should be considered a biodiversity 'hot spot', requiring special attention by management.

The two types of grassland together play a vital role in shaping the large mammal communities, but they are quite different ecologically and need different management interventions. Before suggesting options, some general comments are necessary. The strategy of 'no intervention - let nature take its course' would lead to the following scenario.

1. The natural tall grasslands of the floodplain would remain more or less intact; some new grasslands would slowly change through sissoo and khair forests into climax-like riverine forest, while at the same time forested river banks and islands would be disrupted by flooding and revert to grasslands. The local population of hog deer—a main prey for tigers—would remain more or less unaffected as would the seasonal habitat for barasingha and the two megaherbivores.

2. The shorter grass wooded grasslands and phantas dominated by *Imperata cylindrica* would change through shrub encroachment and succession into forest, mainly of the sal complex. Understorey vegetation would become shrub and seedling dominated—the grasses, except the less palatable *Desmostachya bipinnata*, would more or less disappear. This change would have a significant negative effect on barasingha and chital, and on the small population of nilgai. Because chital is by far the most important prey of tigers (Støen and Wegge 1996), a decline in the chital population would affect the local tiger population. At present the 'hot spot' area of the Park acts as a 'source' from which tigers disperse to peripheral habitats both inside and

outside the Park. Thus a a decline in the local tiger population would reduce the capacity of the area to produce dispersers and maintain connectivity with other reproducing tiger units within the region.

3. The reduction of prey biomass through loss of wooded grasslands and phantas as a result of natural succession would also intensify the food competition between tigers and leopards. A likely result is that leopards would be further displaced to the periphery of the Park and increase their predation on small livestock. Depredation of domestic stock by tigers and tiger encounters with humans might also increase as a result of the reduced prey base inside the Park, at least temporarily.

4. The local populations of rhinoceros and wild elephants are currently increasing in RBNP, particularly in the hot spot in the western part. None of these species are dependent on the wooded grasslands and the open phantas. Instead, they feed on the tall grasses in the floodplain and on a variety of browse from shrubs and trees. A continued increase, especially of elephants, would modify the forests in the direction of more open-spaced forests with a higher proportion of grass in the understorey. This would to some extent counteract the negative effects of loss of the short grassland phantas, and thereby slow down the rate of habitat deterioration for chital and nilgai. It is less clear what the effect would be on barking deer and wild boar (*Sus scrofa*), but a reduction in the shrub understorey would probably affect barking deer negatively, and thus also reduce the natural prey base for leopards.

The Park authorities are already practicing a moderate 'human-intervention' management policy. Until recently, this consisted of permitting some 35 - 40,000 villagers to enter the Park during a short period in the early dry season to cut and harvest grasses, both in the phantas and in the floodplain (Sharma and Shaw 1993; Pokharel 1993; Sætre 1993; Brown 1997), and of burning large parts of the grasslands shortly thereafter. Recently, a programme of 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.

As is clear from the above, and from recent research (Moe and Wegge 1997; Peet *et al.* 1997), the cutting and burning of the grasslands have a positive effect for the larger herbivores, and hence on the predator fauna. Recently, however, the number of permits for grasscutting has increased, with a concurrent increase in the amount harvested.The density of chital also seems to be increasing following a temporary die-back in the early 1980s, leading to a higher grazing pressure and creation of preferred 'grazing lawns', that are now patchily distributed on the phantas (Karki 1997). With little grass left after harvesting and more conversion to grazing lawns, the fuel load is reduced. This may explain why the rate of invasion by shrubs on phantas has increased, as the post-harvest burns have not been intense enough to kill back the encroaching vegetation, particularly the fire-resistant *Callicapra macrophylla* (personal observation). Thus 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 to maintain the high diversity and density of wild ungulate biomass as a food base for the predator community.

Management Guidelines

Wooded Grasslands and Phantas

Management guidelines for these short grassland types (both cutting and burning) have been suggested by Moe (1994) and Peet *et al.* (1997). Both suggest a rotational cutting and burning regime as is largely practised at present. Moe (1994) further suggests that patch burning be spread over a longer time during the dry season so that animals (mainly chital and barasingha) may have access to newly burnt grassland over a longer period of time. Because the early part of the dry season may be the most critical period in terms of nutrition for chital and barasingha, cutting and burning of grass should take place as early as possible, preferably before mid-January. Burning during the first half of February should be avoided as this is the main calving season for chital. In addition to cutting and burning of grasses, encroaching shrubs and younger trees should be removed every 2-3 years, and the present intervention of opening the wooded grasslands by cutting down trees should be continued. However, widely spaced trees with shading foliage like *Ehretia laevis* and *Mallotus phillippensis* should be retained to provide rest areas.

Peet *et al.* (1997) recommend that the road be closed to traffic during the dry season because traffic might prevent the chital and barasingha from utilising the phantas optimally. Our observations do not support this: the animals are habituated to motorised transport, and their main foraging period is in the evening and early night, depending on the moon cycle, when there is little or no traffic anyway (Wegge unpublished).

Floodplain Grassland

Less research has been done on the ecological effects of cutting and burning of tall grasses in the floodplain. River action may maintain an equilibrium between the relative coverage of grass-dominated communities and later tree-covered successional stages by creating new grassland. Thus, a 'no intervention' policy may not result in any loss of these natural grasslands. Cutting and burning in these areas may have adverse effects, however, by reducing the cover for cryptic species like hog deer, thus making them more vulnerable to tiger predation. Ongoing research tends to support the notion that hog deer abandon tallgrass areas when more than 80 percent of the area is cut, but if smaller patches are left uncut in a mosaic pattern, the deer will remain in their original habitat (Wegge and Storaas unpublished). Until more research has been undertaken, it is reasonable to assume that cuttting and burning will have the same positive effects on deer nutrition and arresting the invasion of shrubs as in the *Imperata*-dominated wooded grasslands and phantas.

Since the harvesting of grasses in the floodplain provides tangible benefits to the local villagers, the negative effects of disturbance are thought to be negligible, and the effects on habitat quality may be positive, the present practice of cutting

and burning should continue. However, the increased cutting pressure observed in recent years, where large stretches of uninterrupted tall grasslands are cut down almost to the soil line, should not continue. Instead, cutting should be monitored in such a way that about 1/3 of the grasslands consist of uncut patches. During the subsequent controlled burning operations, some of these patches should also be spared to provide cover after the rest of the grasslands have been burnt.

Creation of New Grasslands

It should be emphasised again that the high diversity and density of wild herbivore species in the 'hot spot' portion of RBNP is a result of the spatial arrangement of the many different habitats there; the presence of interspersed grasslands and the early successional stages from tallgrass floodplain play a vital role. The high ungulate biomass provides for a very dense tiger population, but this is confined to the very small area of the 'hot spot'. Preliminary data indicate that the tiger density is much lower, outside the grassland-forest complex presumably as a result of the much lower biomass of prey. In order to increase the food base for tigers—a species with priority conservation status in Nepal—Park authorities should consider creating smaller wooded grasslands and phantas within the surrounding sal forests. Clearfelling smaller blocks in sal (*Shorea robusta*) and asna (*Terminalia tomentosa*) dominated forests will increase the habitat quality for wild herbivores and thus expand the prey base for tigers and leopards. Depending on the soil conditions and use of fire, creating gaps in the tree overstorey through clearfelling of small blocks or selection cutting may also increase the shrub layer and stimulate regeneration of woody saplings. This is expected to improve the habitat quality for sambar (*Cervus unicolor*), which is considered a main prey species of tiger throughout most of the tiger's geographical range (Karanth and Sunquist 1995).

Such an intervention may at first glance appear rather drastic and not readily acceptable within national parks. However, in order to conserve viable subpopulations of tiger and provide dispersal habitat between existing protected areas, it is necessary to provide sufficient natural prey not only in smaller hot spots within the PAs but also in other parts of the PAs and in remaining forests outside the protected areas.

Research Priorities

Many studies have already been conducted and the current management practices appear ecologically sound, thus we see the following four themes as the priority.

1. Further studies on the ecological effects of cutting and burning of grass in the tallgrass floodplain
2. Studies on the long-term effects of cutting and burning on the productivity and mineral balance of the wooded grasslands and phantas
3. Further studies on grazing lawns and grazing pressure—how they are created and maintained—a follow-up of the recent study conducted by Karki (1997)
4. Experimental clearfelling in mature sal and asna forest to create wooded grasslands and phantas in order to increase and expand the habitat quality for deer, thereby improving the habitat for tiger

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