Impact of Grassland Management on Avian Fauna

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Abstract

Tall moist lowland grasslands are by far the most threatened habitat in Nepal and probably in the entire Indian subcontinent. More than one third of globally threatened bird species in Nepal live in lowland grasslands. Tall moist grasslands were surveyed at different times of the year for three consecutive years in three protected areas of lowland Nepal. A total of 219 species of birds were found to be using lowland grasslands at different times of year. The effects of management regimes such as fire, floods, and grazing were studied. The grassland management in lowland protected areas differed in space, time, and habitat grain. The effects of grassland management on avian fauna were studied. Better understanding of grassland dynamics is recommended to facilitate effective grassland management.

Introduction

The tall grasslands in Nepal are found in the fertile Gangetic plain in the southern part of the country. In former times, the grassland habitat was more or less continuous from west to east Nepal, occurring mainly along the floodplains of rivers. Since 1954, the Government of Nepal has been actively engaged in the eradication of malaria in lowland Nepal with funding from USAID. The government encouraged people to cultivate the low-lying fertile plains in order to remove increasing pressure in the mid hills of Nepal and increase the agricultural productivity of the country. During the 1950s, hill people migrated in large numbers to lowland Nepal in the quest for agricultural land (Bhatt 1977). It was during this period that most grasslands and marshlands disappeared from the country as a result of cultivation. Previous to this period, movement of people was restricted to the winter months as malaria was prevalent in the summer. Grasslands soon vanished from many areas and today there are no tall moist grasslands of any size in Nepal outside the protected areas.

In many parts of the world, grassland research has now been given top priority (Collar 1996; Goriup 1996) and several studies have been conducted (Glover 1969; Goriup 1992; Leslie 1996). Grasslands in Europe have been highlighted as an important feeding and breeding habitat for birds (Goriup 1992). The grasslands in the Indian subcontinent are more significant on a global scale than those in Europe (Collar 1996). In India, a significant amount of information has already been collected on bird species (Narayan and Rosalind 1990; Javed and Rahmani 1991; Iqbal *et al.* 1994), grassland bird communities (Rahmani 1986, 1992; Majumdar and Bramhachari 1986), and grass cover types (Dabadghao and Shankaranarayan 1973).

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In Nepal, many of the large mammals found in grasslands (Schaff 1978; Laurie 1979; Mishra 1982; Dhungel and O'Gara 1985; Moe and Wegge 1997; Peet 1998) and the structure of these grasslands (Lehmkuhl 1994; Peet 1998) have been well studied. Comparatively little is known, however, about the avian fauna and the impact of management effects on avian fauna has been little studied in the context of the lowland grasslands. More is known about the socioeconomic issues related to grasslands and protected areas especially in Chitwan (Mishra 1984; Heinen 1993b; Sharma and Shaw 1993; Banskota *et al.* 1998).

At present there are five protected areas in the *Terai* region of Nepal, the name given to the plain that lies along the southern border of the country between 75 and 300 masl. One of the areas, the Parsa Wildlife Reserve, is a continuation of the Royal Chitwan National Park. All of the *Terai* protected areas lie within the same ecological zone. Together they comprise a total of 272,900 ha of land, of which roughly 50,000 ha is estimated to be grassland in various forms (Table 2). The Parsa Wildlife Reserve has very little grassland.

Study Area

Two of the protected areas, Royal Chitwan National Park and Royal Shukla Phanta Wildlife Reserve, were chosen for the study. Observations were also made in the easternmost reserve, Koshi Tappu, in 1996 and 1997, and Royal Bardia National Park was visited briefly in March 1998.

The Royal Shukla Phanta Wildlife Reserve (hereafter called Shukla Phanta) lies in the extreme south-west of the *Terai* (between 28°49' and 28°57' N and 80°07' and 80°15' E) and is the smallest of the protected areas. It covers 15,500 ha and ranges in altitude from 90 m to 270 m (IUCN 1993). Approximately 55% of the reserve—the southwest where soils are of recent alluvium—is covered by mixed deciduous forest, grassland, and marsh. The remainder is moist deciduous forest and savanna, supported by the better-drained soils on higher terrain in the northeast (IUCN 1993). The reserve possesses the largest grassland phantas in Nepal. There is a plan to extend the reserve at the eastern side. When this plan is realised and protection is afforded, more phantas will be created. After this extension, the total area of Shukla Phanta will be 30,500 ha (Tirtha Man Maskey, personal communication). The climate of Shukla Phanta is hot and dry. The grassland soil here is drier than in Chitwan. In April and May, warm and dry westerly winds blow across the phantas during the late afternoon generally settling before sunset.

A total of 30 species of mammals and 350 species of birds (Bird Conservation Nepal 1998) have been definitely recorded in the reserve. The grasslands at Shukla Phanta support a high population of *Houbaropsis bengalensis* (Inskipp and Inskipp 1983), *Francolinus gularis* (Baral 1998a), *Chaetornis striatus* (Baral 1997), and *Saxicola insignis* (Baral 1998c), all taxa that are considered to be threatened globally (Collar *et al.* 1994). Recently, two grassland birds found in Shukla Phanta were presented as new species to Nepal (Baral 1998b). One of these, *Ploceus megarhynchus*, is a globally threatened species (Collar *et al.* 1994) and previously described as endemic to India (Ali and Ripley 1987). Shukla Phanta also supports a large population of *Cervus duvauceli duvauceli*, a globally threatened ungulate species (Groomebridge 1993).

The Royal Chitwan National Park (hereafter called Chitwan) lies in the central *Terai* of Nepal (between 27°15' and 27°35'N and 83°45' and 84°58'E) between the Siwalik Hills in the south and the Mahabharat Hills to the north. Chitwan is an inner Doon valley situated between these two southernmost ranges of hills. All the other protected areas in lowland Nepal lie beyond the final range of hills. The total area of Chitwan is 93 200 ha. It is bordered by Parsa Wildlife Reserve (49,900 ha) to the east and is located in the drainage basin of three major rivers, the Narayani, Rapti, and Reu. Chitwan has numerous small patches of grasslands lying alongside the rivers. These riverside grasslands vary in width from a few metres to 1,500 m. Approximately 70% of the park is covered by sal forest (Laurie 1979), the remainder being grassland and riverine forest.

Chitwan is an important site for grassland birds, particularly for *Houbaropsis bengalensis* (Inskipp and Inskipp 1983), *Sypheotides indica* (Inskipp and Inskipp 1991), *Moupinia altirostris* (Baral and Eames 1991), *Turdoides longirostris* (H. S. Baral unpublished data), *Chaetornis striatus* (Baral 1997), and *Prinia cinereocapilla* (H. S. Baral unpublished data). Chitwan is the only place in Nepal where *Turdoides longirostris* has been recorded. Chitwan also supports a quarter of the world's population of *Rhinoceros unicornis*, a globally threatened mammal (Groomebridge 1993).

The Koshi Tappu Wildlife Reserve (hereafter called Koshi Tappu) occupies 17,500 ha of the Sapta Koshi River floodplain at the most northeasterly extension of the Gangetic Plain (between 26° 35' and 26° 40' N and 86° 56' and 87° 04' E). It ranges in altitude from 75 to 81 m (IUCN 1993). The reserve is located between two flood control embankments and is subject to annual flooding (Heinen 1993a). Approximately 70% of the reserve's land area is grassland (Heinen 1993b). During high flood years a large amount of grassland is destroyed to be replaced by new alluvial deposits.

The reserve contains Nepal's last population of *Bubalus bubalis*, and is further protected as a Ramsar Site, for its importance to migrating wildfowl (IUCN 1993). *Bubalus bubalis* is a globally threatened species (Groomebridge 1993). Beside being an important site for migrating waterfowl, Koshi Tappu is important for grassland birds like *Houbaropsis bengalensis* (Inskipp and Inskipp 1983), *Saxicola insignis* (Inskipp and Inskipp 1991), *Francolinus gularis* (Baral 1998a), and *Chaetornis striatus* (H. S. Baral unpublished data). The reserve faces problems like illegal grazing, collection of fodder, felling of trees, and hunting from the surrounding villages (Giri 1997; Petersson 1998).

Methods

Methods were made consistent and kept the same throughout the study period. In this paper, I have tried to summarise my observations on the dynamics of grassland vegetation in all the protected lowlands of Nepal since the mid-80s. This paper, presents some preliminary results of the study on the impacts of grassland management on avian fauna. A detailed report of this work will be published once the data analysis is complete.

Transect Counts

Linear transects were laid out in different grassland types in the three study sites. The length of the transects varied from 100 m to 1,300 m. Each transect was

divided into sections of 100 m to standardise observations. Habitat data were recorded for each 100 m section. For all observed birds, the exact distance along the transect and the distance to the right or left were estimated to calculate the density of birds (Bibby *et al.* 1992).

A data sheet was filled out for each visit in which all bird observations were recorded. The species, number, sex, location, behaviour, and overall height of the vegetation used by the birds were noted on the bird data sheet. Only positive identification to species level was used in the final analysis.

Environment Data

A data sheet on the habitat was prepared for each transect. If notable changes had taken place between two visits (either natural or human induced), a new habitat sheet was made. From the beginning, the importance was recognised of recording enough habitat variables to enable easy interpretation of the bird distribution in relation to the habitat (Laurie 1979). These variables were grass species composition, soil moisture, phenophase of grasses, average vegetation height, percentage of bare ground, presence of vegetation other than grasses and their percentage, type and average height of grasses, grazing pressure, data on whether the area had been burned or cut, disturbance by people, and proximity to water and forest. Data were collected in the morning or late afternoon.

Data Analysis

The data were stored in a relational database using the Paradox Database Program. The results presented in this paper are the results of simple queries performed in Paradox.

When the data have been fuly analysed a consolidated report will be prepared (University of Amsterdam, Netherlands) outlining some suggestions for optimal grassland management for birds. Analysis of Variance (ANOVA) and TWINSPAN programmes will be run to discover the bird communities associated with different grassland types using the MINITAB programme. Canonical Correspondence Analysis (CCA) and Detrended Correspondence Analysis (DCA) will be run to confirm these associations using the CANOCO programme (Jongman *et al.* 1995). The density and abundance of birds will be estimated using the DISTANCE programme (Bibby *et al.* 1992).

Results and Discussion

Some important information on grassland birds' ecology was collected during this study. More rigorous data analysis is expected to shed light on bird density, habitat association, and community structure in grasslands. Some preliminary findings on the grassland management and its effect on avifaunal life are presented. Fire, flood, cutting, grazing, and disturbance were recognized as the major ecological factors that effect avifaunal life in the grasslands. A total of 219 species of birds were identified as using lowland grasslands in various ways (H. S. Baral unpublished data). Of these 219, 10 species that depend exclusively on lowland grasslands are threatened globally (Table 4) (Collar *et al.* 1994, BirdLife International unpublished data). Species of global concern such as *Leptoptilos javanicus* and *Pseudibis palpebrosa* (Collar *et al.* 1994) were also observed

frequently in the short grasslands. Nine species found in the lowland grasslands are considered to be threatened at the national level (Baral *et al.* 1996). The present study identified *Cettia pallidipes* as another nationally threatened bird that also has a restricted world distribution.

Table 4. **Threatened birds of the lowland grasslands in Nepal**

English Name	Scientific Name
a. Threatened globally or in Asia	
Lesser Florican	*Sypheotides indica*
Bengal Florican	*Eupodotis bengalensis*
Swamp Francolin	*Francolinus gularis*
Sarus Crane	*Grus antigone*
Jerdon's Babbler	*Chrysomma altirostre*
Slender-billed Babbler	*Turdoides longirostris*
White-throated Bushchat	*Saxicola insignis*
Grey-crowned Prinia	*Prinia cinereocapilla*
Bristled Grassbird	*Chaetornis striatus*
Yellow Weaver	*Ploceus megarhynchus*
b. Threatened in Nepal	
Great Bittern	*Botaurus stellaris*
Black Bittern	*Dupetor flavicollis*
Yellow Bittern	*Ixobrychus sinensis*
Blue-breasted Quail	*Coturnix chinensis*
Small Buttonquail	*Turnix sylvatica*
Yellow-legged Buttonquail	*Turnix tanki*
Eastern Grass Owl	*Tyto longimembris*
Rufous-rumped Grassbird	*Graminicola bengalensis*
Striated Grassbird	*Megalurus palustris*
Pale-footed Bush-Warbler	*Cettia pallidipes*

Source: BirdLife International and Bird Conservation Nepal unpublished data; Collar *et al.* 1994; Baral *et al.* 1996.

Chitwan and Koshi Tappu contained the largest number of globally threatened species, 18 and 17 respectively, followed by Shukla Phanta (14), Bardia (11), and Parsa (2) (Table 5). For its size, Shukla Phanta may be the most significant grassland reserve in the world as it contains internationally significant populations of many globally threatened taxa. Shukla Phanta has internationally significant populations of six globally threatened species, Chitwan of five species, Koshi Tappu of four, Bardia of three, and Parsa of one. At the national level, Chitwan and Shukla Phanta seem to be the most outstanding grassland reserves in Nepal, harbouring 10 and 9 nationally threatened species each. This simple analysis shows the importance of Shukla Phanta, Chitwan, and Koshi Tappu as the main grassland reserves in Nepal. As in other parts of the world (McCrea 1981), Nepal also needs to declare some protected areas as 'grassland reserves' to highlight the grassland and the fauna associated with it.

Table 5. **Protected areas with grasslands and threatened species**

Parks/Reserves	Total Area (sq.km)	Grassland Area (sq.km)	Threatened Birds		
			Global	Important Populations*	National
Royal Shukla Phanta WR	155	76	14	6	9
Royal Chitwan NP	932	185	18	5	10
Royal Bardia NP	968	190	11	3	3
Koshi Tappu WR	175	60	17	4	6
Parsa WR	499	<20	2	1	1?
Total	**2,729**	**<531**			

* Internationally significant populations of globally threatened species
Source: Department of National Parks and Wildlife Conservation, BirdLife International, and Bird Conservation Nepal unpublished data

Grassland Fires

In many regions of the world the practice of burning grassland dates back many thousands of years. Fire has been recognised as an integral part of the grassland ecology in many parts of the world (Mentis and Bigalke 1981; Braithwaite 1987; Braithwaite and Estbergs 1987; Bell and Oliver 1992). Fire and floods have been described as the two main factors affecting the vegetation in Chitwan (Gurung 1983), and this is true for almost all the protected areas of lowland Nepal. Work on grassland management for mammals (Bell 1987; Moe and Wegge 1997; Peet 1998) and birds began only very recently in Nepal (Inskipp and Inskipp 1983; Weaver 1991; Baral 1998a,c).

When it is said that a particular grassland has been burned, it does not mean that everything present was turned into ashes. The extent of burning depends on such things as intensity of the fire, the grass species, soil condition, and phenophase of the grasses. Very intense fire can easily burn many grass species, leaving at most some lower parts of the grass stems of more resistant species. Usually fire is more intense in the early afternoon than in the morning and evening. Short grasses like *Imperata* are burnt wholly and almost nothing is left. In many grass species that have a thick stem like *Narenga porphyrocoma*, *Saccharum benghalensis*, and *Phragmites karka*, only the leaves and upper parts of the stem are burned even by intense grassland fire. The accumulation of moisture and the compact nature of the grass stem prevents the stem from burning. Generally, grasses growing in dry soils burn better than those in wetter soils. Old, dry, and dying grasses are burned better than young, developing, or mature green grasses. Some incompletely burnt grassland has to undergo repeated and irregular episodes of fire before it is completely burnt. Such repeated fires, which are prevalent in grasslands at the edge of and in forests, could prove fatal to some birds such as *Prinia cinereocapilla* and *Cettia pallidipes*. Both species are little known and threatened.

The Ecological Role of Grassland Fire

Gurung (1983) wrote: "Drongos follow the fires, often dangerously close, manoeuvering with amazing agility to catch the insects that fly off to escape the flames; hen harriers and other raptors hunt for rodents and lizards over the

newly-open, burned-out ground". His vivid observations while he worked during the late 70s and early 80s as a naturalist in Chitwan are the best remarks on the ecological role of the grassland fires that affect lowland grassland birds in Nepal.

Until the study is complete it is difficult to gauge the effect of fire because real effects can only be recognised from a long-term study. Generally, the immediate effect of fire appeared to be an increase in bird diversity and abundance. Fire seemed to encourage the growth of new grass shoots and thus provide an abundant food supply for many species such as drongos, *Artamus fuscus*, swallows, owls, bee-eaters, rollers, *Halcyon smyrnensis*, stonechats, and *Lanius schach*. *Houbaropsis bengalensis* were observed feeding on the new shoots of grass a couple of days after fire had swept through an area. Drongos, swallows, bee-eaters, and rollers were seen following the fire-front in grassland fires.

Burnt grasslands were mainly avoided by the species that needed dense and tall grasslands, such as *Prinia flaviventris*, *Timalia pileata*, *Saxicola jerdoni*, *Graminicola bengalensis*, *Megalurus palustris*, and *Chaetornis striatus*. There were many species, however, such as *Saxicola* species, *Luscinia* species, *Turdus ruficollis*, *Dicrurus macrocercus*, *Sturnus vulgaris*, and *Acridotheres spp.* that showed a marked preference for burnt grassland over unburnt areas. Generally, most of the birds that lived exclusively in tall grassland habitats showed a marked preference for unburnt grasslands. Species such as *Acrocephalus dumetorum* and *Prinia subflava* were absent from partially burnt grasslands (Table 6).

It is a proven fact that in some cases diversity will be highest at intermediate levels of disturbance; whereas large and frequent disturbance will tend to decrease diversity (Begon and Mortimer 1986). Partially burnt grasslands away from forests (>100 m) showed a slightly increased bird diversity and nearly double abundance (Table 7). Unburnt and totally burnt grasslands showed less diverse bird communities and lower abundance. Fire, if managed properly, may actually help the birds by maintaining the grasslands so that they are suitable for the species. Fire could be taken as a strong tool for conservation and management of grasslands. Various researchers have considered the importance of fire in the management of grasslands (Dinerstein 1979a, 1979b; Rodgers 1986; Roy 1986).

Along transect 25, which was partially burned, bird abundance was 125 before and 235 after the fire. The diversity before fire was 25 and after fire 28. After fire several bird species seemed to be exploiting the newly burned but resource rich ephemeral habitat. The most numerous among them were *Dicrurus macrocercus*, *Merops orientalis*, *Turdus ruficollis*, and *Acridotheres fuscus*.

A total of 1,690 birds, were registered prior to cutting and burning of grass (before 6 February 1998 in Chitwan) and 3,129 after cutting of grass. This was a near two-fold increase in bird abundance; but there was no significant change in bird diversity except in a few transects (Table 7). The increase in abundance could be attributed partially to the creation of more open habitat that perhaps also increased detectability for the observer. Grassland transects away from

Table 6. **Birds seen during five visits before and after transect 25 was partially burned in Chitwan**

Scientific Name	Abundance	
	Before fire	After fire
*Acridotheres fuscus***		3
*Acrocephalus dumetorum**	1	
Amandava amandava	18	42
*Centropus sinensis**	4	
Cettia brunnifrons	3	3
Cettia flavolivacea	7	6
*Cettia pallidipes***		2
*Chrysomma sinense***		3
*Dicrurus macrocercus***		1
*Ficedula parva**	2	
*Gallus gallus***		3
Graminicola bengalensis	4	7
Lanius schach	5	5
Luscinia pectoralis	7	9
Melophus lathami	3	5
*Merops orientalis***		1
*Oriolus xanthornus**	2	
*Orthotomus sutorius**	4	
Pavo cristatus	1	8
Prinia flaviventris	3	7
Prinia hodgsonii	6	29
Prinia socialis	3	15
*Prinia subflava**	1	
Psittacula cyanocephala	1	2
*Psittacula eupatria**	4	
*Psittacula krameri***		2
Pycnonotus cafer	5	9
*Pycnonotus jocusus***		1
Rhipidura albicollis	1	1
Saxicola torquata	1	4
Tephrodornis pondicerianus	7	1
Timalia pileata	28	58
Turdoides longirostris	4	5
*Turdoides striatus***		2
*Turdus ruficollis***		1

* *Species only recorded before fire*
** *Species only recorded after fire*

forests showed trends similar to transect number 25. The grassland transects in and close to forest areas showed a general decline of bird abundance immediately after the fire.

Table 7. **An overview of bird diversity before and within a month after transects were burned in the Chitwan grasslands**

	Before Fire		After Fire	
Transect No.	**Diversity**	**Abundance**	**Diversity**	**Abundance**
4	18	115	25	85
5	27	134	37	303
6	6	40	9	45
7	12	44	19	119
8	23	99	33	230
10	*38*	*317*	*24*	*202*
12	*32*	*144*	*22*	*114*
16	6	10	18	98
21	42	261	51	384
25	25	125	28	235
26	25	139	25	176
27	*17*	*41*	*12*	*27*
28	12	64	16	73

Italicised figures show grassland transects close to or within forests, these had a lower bird diversity after fire.

The Role of Floods

Flooding occurs in all types of flowing waters during the monsoon in Nepal. The major rivers such as the Koshi in the east; Reu, Rapti, and Narayani in the central Zone; Babai, and Karnali in the west; and Mahakali in the far west contribute 90% to the formation of the existing major tall grasslands in lowland Nepal. The effects of flooding have been studied less than the effects of fire. Flooding, however, is an important natural factor that may have contributed more grassland areas than fire. The impact of flooding on grasslands and their associated fauna are no less than the effects of fire. Irrespective of grass composition, flooding affects all low-lying ground, very often sweeping over large grassland areas at one time.

Flood swept grassland areas were generally devoid of highly sedentary grassland specialist birds like *Timalia pileata*, *Graminicola bengalensis*, and *Chrysomma sinense*. As the flood receded from the grasslands, birds colonised the flood swept areas immediately from 'adjoining grasslands' as soon as the habitat was restored. The 'adjoining grasslands' were presumably on higher ground than the flood level. This seemed to be a common phenomenon in lowland flood affected grasslands. However, large areas of grasslands in Koshi Tappu were found devoid of species that were fairly common in Chitwan and Shukla Phanta in similar grassland types. A possible reason might be that there were no suitable 'adjoining grasslands' to provide refuge for these grassland specialists when most of the area in Koshi Tappu was flooded.

The grassland bird communities in Koshi Tappu, were highly influenced by annual flooding and excessive grazing by domestic livestock. Unfortunately, this study could not look into the details of the flood dynamics, although this is an important element in grassland management.

Grazing

Open fields of short grasslands were the result of intensive grazing, mainly from domestic livestock. Overgrazing in grasslands destroyed the habitat of many grassland specialists that required tall grasses, for example, *Timalia pileata, Graminicola bengalensis,* and *Saxicola leucura*. When grazing was stopped, the grasses resumed their original height. Low and moderate levels of grazing might be beneficial for bird communities. Similar effects have been observed in studies conducted in other parts of the world (Campbell-Kissock *et al.* 1984; Dale 1984).

Intensive grazing seemed to benefit some of the more common grassland birds, for example, *Anthus* spp., *Mirafra* spp., *Alauda gulgula, Motacilla* spp., *Acridotheres ginginianus, Turdus ruficollis, Acridotheres* spp., and *Sturnus* spp. However, most of the threatened grassland birds suffered from intensive grazing.

Grassland management is widely discussed and is a hot issue in many parts of the world. Grasslands could be managed both for wildlife and for the prosperity of villagers living nearby. A thorough study is important to discover the best way to manage grasslands for both wildlife, including birds, and people (Blankespoor 1980; Stuth 1996).

Cutting of Grass

Cutting alone resulted in a negative response from many species and only a few birds seemed to occupy cut plots when there was a choice of a burnt plot nearby. We noted *Francolinus gularis* frequently in such habitats. Once cut, many grassland areas became devoid of cover and unsuitable for feeding. Of all the regimes, cutting alone showed the worst effects on species. The long-term effects of cutting alone are not yet known, however.

Ploughing

Cutting and ploughing generally resulted in decreased avian diversity. Birds like *Anthus rufulus, Pavo cristatus, Alauda gulgula,* and *Streptopelia* spp. seemed to prefer ploughed areas for feeding. However, although ploughing created open areas suitable for many birds as feeding grounds, the absence of perches and suitable cover led them to avoid such areas. Experimental manipulation of ploughed grasslands in Shukla Phanta was attempted. In the winter of 1997 and 1998, ploughed grasslands that were devoid of tall perches were provided with perches. *Saxicola* spp. and *Merops* spp. seemed to use these artificial perches frequently. Similar studies have been conducted in grasslands of the north-eastern United States (Vickery and Hunter 1995).

Current Practices of Grassland Management

Grassland management was initiated in Shukla Phanta and Chitwan in 1996. As part of the management, many grassland areas that were listed as strongholds for *Houbaropsis bengalensis* (Inskipp and Inskipp 1983) were ploughed during 1996-98. There were two main reasons for the practice. The first was to prevent short *Imperata* grasslands from being encroached by taller, hardy, and coarse grass species; and the second to increase sightings of deer and other mammals for visitors.

Though started with good intentions, the results of this practice showed negative results in Chitwan. The natural succession of short grasses by the taller and hardier species was actually speeded up, in particular near Dumaria Guard Post. Within two to three years, most *Imperata* grasses had given way to other hardier and taller grass species. Chitwan is more humid than Shukla Phanta, thus the type of grass management practised had particularly negative effects where moist-loving invasive grass species such as *Narenga porphyrocoma* and *Saccharum bengalensis* were found in abundance.

The effect of management in Shukla Phanta was probably moderate and no obvious negative effects were noted during the study period. Long-term observations are needed.

It is vital that we first understand the nature and life cycle of the grasses that are found in lowland grasslands before management regimes are proposed. The results of studies from other regions and parts of the world should be reviewed when we manage grassland habitat for wildlife.

Conclusions

The present grassland areas are not sufficient to maintain the populations of several globally and nationally threatened taxa. Although in recent years attention in Nepal has been drawn towards active grassland management, some of the existing grasslands are still being rapidly succeeded by woody vegetation and this poses a threat for the future survival of many grassland bird species. Thus management interventions are necessary to conserve the grassland habitats in a manner suitable for the many grassland birds. Research in other parts of the world has shown that in carefully managed areas declining species can respond positively (Swengel 1996).

Recommendations for Conservation and Research

If protected areas in lowland Nepal are proposed for extension, considerable thought should be given to the inclusion of as much grassland area as possible. Highly grazed open areas, if given proper protection, are colonised naturally by either *Saccharum spontaneum* or *Imperata cylindrica* grasses. The colonisation is rapid and the results can be seen within a year.

Shukla Phanta and Chitwan should be declared as grassland reserves of international importance on the basis of the avian and mammalian taxa they contain. HMGN should take the initiative and then seek international support.

The open ground on the eastern side of Shukla Phanta Wildlife Reserve near Radhapur and Jhilmila could be converted to a grassland area of outstanding importance for both birds and mammals. This open area starts at Jhilmila, extends almost five km to the north, and has an average breadth of 500 m. This area is already inside the reserve and under proper protection it could be a safe haven for many grassland birds and mammals. It is quite likely that birds such as *Houbaropsis bengalensis*, *Sypheotides indica*, *Francolinus gularis*, *Chaetornis striatus*, and *Saxicola insignis* will find a suitable home in these grasslands. If the reserve finds it difficult to manage this, a community grassland approach could be tried. This latter approach is a replica of the community forestry concept that

is widely accepted all over Nepal. Reserve wardens and wildlife technicians should guide village communities to ensure the best utilisation of grasslands for both people and wildlife. This aproach can be developed as a future conservation project in Nepal with support and guidance from organisations like BirdLife International. BirdLife International should collaborate with the government of Nepal and Bird Conservation Nepal in these kinds of projects.

Burning should be monitored regularly. It should not coincide with the breeding time of birds. Repeated fire in grasslands could be harmful for birds and other taxa. Instead of cutting large areas of grasslands at one time, an experiment with small patch clearing should be carried out. This might prove beneficial to certain birds. Patch ploughing should be experimented with rather than ploughing large areas of grasslands. A tentative suggestion for managing *Imperata cylindrica* grasslands is described stepwise below. This experiment should be carried out in areas where there are no known threatened bird inhabitants and limited to a small area. It can be stopped immediately if negative results or no significant positive changes are noted.

- Burn the plot between January and February
- Remove unburned reeds and woody vegetation manually
- Plough in such a way that the plough penetrates at least six inches (15 cm) into the earth
- Compact the ground with the help of the type of machine used in road works
- Leave the area for natural regeneration

Grassland management should be focused on providing more habitats for globally and nationally threatened birds. The current practice of grassland management in Nepal is mainly aimed at increasing the population of large mammals. This practice, which overlooks the threats to other smaller taxa, should be changed. With improved grassland management it may be possible to maintain a healthy population of all taxa within the ecosystem concerned. The DNPWC should consult researchers who have worked in the grasslands of Nepal and their suggestions should be taken into account in the management of grasslands.

Grassland research on such things as flora, succession, and fauna should be started as soon as possible. The socioeconomic side should be taken into account while conducting management studies of grasslands.

A grassland conservation forum should be formed under the aegis of DNPWC. This forum, consisting of technicians, researchers and planners, should be a formal group that acts as a watchdog for grasslands and their associated fauna.

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