

## Grasslands in Royal Shukla Phanta Wildlife Reserve: Status, Importance and Management

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### Abstract

Royal Shukla Phanta Wildlife Reserve, located in the western Terai, is famous for having a large herd of swamp deer (*Cervus duvauceli duvauceli*). Within its relatively small area, the reserve has diverse types of habitat. A large tract of grassland, the Shukla Phanta, is the main habitat of 1,500 to 2,000 swamp deer, or 'barhasingha'. The park contains many other small to moderate-sized grasslands, some interconnected and others scattered, such as the Barkaula Phanta, Sundari Phanta, Karaiya Phanta, and Haraiya Phanta. (The open grassland in the forest is locally called 'phanta'). One of the main objectives of the reserve is to manage these phantas in a way that will maintain them as a suitable habitat for swamp deer and other wild animals. Several management activities, have been conducted within these phantas including regular burning, ploughing, uprooting, and construction of waterholes. Despite these activities, portions of many phantas, such as the south-eastern part of Sundari Phanta, the northern part of Shukla Phanta, and the south-eastern part of Karaiya Phanta have been invaded by tree species which are spreading fast and thus threatening the existence of the grasslands. Block-wise management activities need to be conducted with a long-term perspective in order to manage these grasslands of international importance within the reserve.

### Introduction

The Royal Shukla Phanta Wildlife Reserve (RSWR) is one of five protected areas located in the Terai. This reserve was gazetted in 1976 when a network of protected areas was established throughout the country. RSWR is famous for having the largest herd of swamp deer (*Cervus duvauceli duvauceli*), locally called 'barhasingha', and is thus of international importance. Many other wild animals, such as tiger, leopard, wild elephant, spotted deer, hog deer, and wild boar, are also found within the reserve. Shukla Phanta, a large area of grasslands located in the southern part of the reserve, is the main habitat of the barhasingha. The reserve also contains many other grasslands, such as the Barkaula Phanta, Sundari Phanta, Karaiya Phanta, and Haraiya Phanta. However, these grasslands are not devoid of trees, rather trees are scattered throughout making them more like a savanna type of vegetation than a pure grassland.

The grasslands within the reserve have been subjected to different kinds of management activities such as regular burning, ploughing, up-rooting, and construction of waterholes. These activities are carried out to prevent invasion of trees, to promote the growth of palatable short grasses, and to provide drinking water for wild animals in the dry season. However, except for burning, all the activities have been limited to a small portion of the Shukla Phanta because of

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the limitations of resources and manpower. As a result, parts of Shukla Phanta and the other grasslands have been invaded recently by many trees, which are growing fast. If management activities do not address the problem seriously, these grasslands will soon be replaced by trees in the course of succession, and will lose their significance as a habitat for the many wild animals, including swamp deer and birds, that prefer grasslands habitat.

The present paper describes the physical features and the history of the reserve, the importance of grasslands as the habitat of swamp deer, present management issues, and management activities that have been carried out in the grasslands. Finally, some recommendations are given for the management of these grasslands in the long-term .

### **Physical Features of Royal Shukla Phanta Wildlife Reserve (RSWR)**

#### **Location**

RSWR is located in Kanchanpur district in the Far Western region of Nepal. The reserve is situated between 28°45'16" and 28°57'23" N and 80°06'04" and 80°21'40" E. The total area of the reserve, including its recent extension to the east, is 305 sq.km, and its altitude varies from 150 to 184 masl. The western boundary of the reserve runs along the western bank of the Mahakali river; the southern boundary runs along the Nepal-India boarder for 15 km and then eastward along the canal through the Beldandi Village Development Committee area (VDC). The reserve extends up to the Syali river in the east and to the Siwaliks in the north-east corner. Mahendranagar Municipality, the headquarters of Kanchanpur district, is situated to the north-west of the reserve.

The headquarters of the reserve is located at Majhgaon, which is to the south of the airport and about 6 km from the Mahendranagar market area. There are nine guard posts, one each located at Malumela, Barnikhera, Champapur, Beldandi, Dhaka, Radhapur, Singhpur, Shukla Phanta, and Piparia. There is one elephant camp located at Piparia near the Mahakali river. Army posts are located at Majhgoan, Mangalsera, Jhilmila, Singhpur, Barkaula, and Piparia.

#### **Climate**

The area has a tropical monsoon climate with four different seasons: winter, spring, summer, and monsoon. The mean monthly minimum temperature varies from 10° to 12° C in winter, gradually rising to 17° C in the spring and 26° C in the summer. The maximum temperature varies from 22° C to 36° C, reaching as high as 42° C in the pre-monsoon period. December and January are fairly cold and misty with occasional frost. This part of the country receives less rain than eastern Nepal, even so the average annual rainfall ranges from 1,300 mm to 2,300 mm, 80% of which falls during the monsoon, i.e., during the months of July to September. The relative humidity remains fairly high throughout the year except in the dry months of the pre-monsoon period.

#### **Soil**

There are five different types of soil in the SPWR. The soils in the riverine forests of khair (*Acacia catechu*) and sissou (*Dalbergia sissou*) along the Mahakali River are loamy-sand with small gravel and stones; in the mixed forests they are

sandy-loam; in the sal (*Shorea robusta*) forests, they are loam to sandy-loam with a high organic content; in the grasslands in lowland areas, they are clay-loam and sticky, and in the Siwaliks the soils consist mainly of sandstone, conglomerates, quartzite, shales, and micaceous sandstone.

### History of the Reserve

The far-western Terai of Nepal, which includes the present RSWR, was covered by dense forest with grassland openings until the early 1960s and was inhabited by the aboriginal Tharus (Balson 1976). The forests and grasslands of this region were noted for an abundance of big game and the rulers of Nepal used to visit this area to hunt during the relatively cool and dry winter months. This area remained a famous hunting site for many years and in 1965/66 an area of 131 sq.km, including the Shukla Phanta, was declared a Royal Hunting Reserve by a decree of the late king Mahendra Bir Bikram Shah Dev. Fairweather tracks were then cleared to facilitate the hunt and several villages were removed from the reserve area.

In 1976, the Royal Shukla Phanta Hunting Reserve was gazetted as the Royal Shukla Phanta Wildlife Reserve with minor changes in the boundary, giving an area of 150 sq.km. A special unit of the army was assigned to protect the reserve, replacing the forest guards formerly responsible. Thereafter several villages, including Singhpur, were removed from the reserve area. Later, an additional area of 155 sq.km was added to the reserve in 1984, making a total area of 305 sq.km. The extension area lay to the east of the previously gazetted reserve. Several villages, including Jhala, Bichhwa, Bhatapuri, Tarapur, Paraw, and Hirapur, were included within the extension area. The people from the villages of Arjuni and Hirapur have already been resettled, and those from the other villages are in the process of being resettled. The extension area has four guard posts, one each at Barnikhera, Beldandi, Dhaka, and Champapur. There are no army posts in the extension area yet.

### Vegetation

Two thirds of the previously gazetted reserve area is covered by forests and one third by grasslands, in contrast more than 90% of the extension area is forested and the remainder includes agricultural lands and settlements. There is hardly any natural grassland within the extension area.

### Forest Types

There are different types of forest within the reserve. The riverine vegetation comprises khair-sissoo (*Acacia catechu-Dalbergia sissoo*) forests present on the Mahakali floodplains, and pure stands of sissoo on the banks and gravel bars of the Mahakali river. Sissoo trees are also found scattered in grasslands. Khair trees are components of the mixed riverine forests found at various sites along the river.

Mixed deciduous forests occupy about 20 sq.km of the lowlands. The major tree species in this type of forest are guthail (*Trewia nudiflora*), jamun (*Syzygium cuminii*), simal (*Bombax ceiba*), sindure (*Mallotus philippnesis*), *Celtis australis*, *Ficus* spp., *Cedrela toona*, and *Murraya koenigii*. Ground cover is poor in this type of forest, consisting only of leaf litter where the canopy is dense and

dominated by *Ageratum conyzoides* and ferns in other places, especially moist areas. Grasses are very infrequent in this type of forest.

Approximately 80 sq.km of the originally gazetted reserve, and most of the extension area, is occupied by different stages of sal forest (*Shorea robusta*). In many places this species forms pure stands, while in others it is associated with *Lagestroemia parviflora*, *Embllica officinalis*, *Terminalia belerica*, and *Terminalia chebula*. Ground vegetation is very poor in the mature forest where there is a closed canopy, while grasses like *Narenga porphyrocoma*, *Themeda arundinacea*, *Saccharum bengalense*, *Saccharum munja*, *Eulalipsis pinata*, *Desmostachya bipinata*, *Thysanolaena maxima*, *Apluda mutica*, and *Eulalia* spp. are present in the immature forests which have a relatively open canopy.

### **Grasslands**

The RSWR is famous for large tracts of grasslands, among which Shukla Phanta is the largest. Shukla Phanta covers an area of 54 sq.km south-west of the Bauni river and south of the forest. Other grasslands include the Sundari Phanta, Barkaula Phanta, Karaiya Phanta, Singhpur Phanta, Haraiya Phanta, and Mangalsera Phanta. The Haraiya Phanta lies on the floodplain of the Chaudhar river; the Mangalsera Phanta is a relatively small opening in the sal forest near the Mangalsera post; Sundari Phanta and Barkaula Phanta are in lowland areas to the north-west of Shukla Phanta; Karaiya Phanta lies in the south and is bounded by a strip of forest along the Nepal-India boarder; and Singhpur Phanta is in the lowland area to south of the Singhpur post at the former site of Singhpur village.

Some of the grasslands, especially those on the slightly elevated lands with sandy-loam soils, are relatively dry. Central Shukla Phanta, west Seta Khera, and parts of Karaiya Phanta have this type of grassland. *Saccharum bengalense*, *Saccharum spontaneum*, *Imperata cylindrica*, *Narenga porphyrocoma*, and *Desmostachya bipinata* are the dominant grasses. Other grasslands lie at lower elevations and are seasonally flooded. This type of grassland is present in the north-eastern part of Shukla Phanta, most of Sundari and Barkaula Phantas, and almost the whole of the Singhpur and Mangalsera Phantas. The dominant species in these grasslands are *Saccharum spontaneum*, *Vetiveria zizanoides*, *Narenga porphyrocoma*, and *Imperata cylindrica*.

The grasslands in the Barkaula Phanta, Sundari Phanta, Karaiya Phanta, Haraiya Phanta, and southern part of Shukla Phanta contain a number of scattered trees, and thus form a savanna type of vegetation rather than pure grassland. The dominant trees in the savanna are *Dalbergia sissoo*, *Acacia catechu*, *Butea monosperma*, *Bombax ceiba*, *Cedrela toona*, and *Sterculia villosa*. The relative abundance of these trees varies in the different phantas.

### **Grasslands: Status and Significance**

The grasslands in the RSWR have both national and international importance. Grasslands in this reserve are the habitat of swamp deer (*Cervus duvauceli duvauceli*), which is one of the world's endangered large mammals. The population of swamp deer in Shukla Phanta is estimated to be 1,500 to 2,000, probably the world's largest herd .

Swamp deer used to be present in other parts of the central and western Terai but are now mostly confined to the SPWR with a very few in Royal Bardia National Park. This loss of range is attributed mainly to habitat loss and other pressures exerted by the ever-increasing human population in this region since the eradication of malaria in the late fifties.

In the reserve, swamp deer prefer the dry grasslands present in the central part of Shukla Phanta and the north-western part of Karaiya Phanta in all seasons except the very hot months in the pre-monsoon period, when they prefer seasonally wet grasslands. This preference results from the presence of preferred grass species such as *Imperata cylindrica*, *Narenga porphyrocoma*, *Saccharum bengalense*, and *Saccharum spontaneum*. These grasslands are also the preferred habitat of hog deer and spotted deer. However, while swamp deer and hog deer avoid forest as a habitat, spotted-deer are found abundantly in forest areas as well.

In addition to swamp deer, five other mammalian species that are found in the grasslands of Shukla Phanta, including hispid hare (*Caprolagus hispidus*), are listed by the IUCN (1993) as threatened species. The grasslands of Shukla Phanta are also an important habitat for a number of bird species. A total of 345 species of birds has been recorded in the reserve (Chaudhary 1997; Baral 1997). Most of them are found in grasslands and savannas. Among the several species of birds that primarily depend on grasslands, Bengal floricans (*Houbaropsis bengalensis*), swamp francolin (*Francolinus gularis*), white-throated bushchat (*Saxicola insignis*), bristled grassbird (*Chetornis striatus*), lesser florican (*Sypheotides indica*), grey-crowned prinia (*Prinia cinereocapilla*), Jerdon's bushchat (*Saxicola jerdoni*), and Finn's weaver (*Ploceus megarhynchus*), are either regionally or globally endangered. Many other bird species that are threatened at national level are found in the grasslands of Shukla Phanta. They include the black bittern (*Dupetor flavicollis*), yellow bittern (*Ixobrychus sinensis*), tawny eagle (*Aquila rapax*), small buttonquail (*Turnix sylvatica*), yellow-legged buttonquail (*Turnix tanki*), grass owl (*Tyto capensis*), striated grassbird (*Megallurus palustris*), rufous-rumped grassbird (*Graminicola bengalensis*), jungle prinia (*Prinia sylvatica*), and rufous-bellied babbler (*Dumetia hyperythra*).

The grasslands in the Shukla Phanta are also rich in plant diversity. Only one detailed report exists of the floral composition of the grasslands, the study by Schaff (1978). He reported 54 species of grasses and sedges but did not include dicots in his list. More recently a total of 125 species was recorded (unpublished data) in a preliminary survey of species in different grasslands, including Shukla Phanta, Singhpur Phanta, Barkaula Phanta, and Haraiya Phanta.

The grasslands have been very important sources of thatch grass for the local people. Harvesting of grass from the reserve is legally permitted to local people for seven days once a year. A total of 36,000 people entered the RSWR to cut grass in 1998. The availability of grass from the reserve is considered an incentive for local people to develop a positive attitude towards the reserve.

### Grassland Management Issues

Despite several management interventions, some management issues still exist in the grasslands of RSWR.

Inaccessibility in the monsoon period—Although there is a network of roads in Shukla Phanta, the area becomes difficult to reach by vehicle in the rainy season and for one month after. This is because of the bad state of the roads near the Bauni River between Singhpur and Shukla Phanta, near Barkaula post, and near the Headquarters in Madhgaon. As a result, patrolling and other management activities are difficult to carry out during the rainy season.

Invasion by trees—Despite the grazing by swamp deer and other wild animals and regular burning, some areas of grasslands, such as the northern part of Shukla Phanta, Karaiya Phanta, Sundari Phanta, and Barkaula Phanta, have been heavily invaded by trees like *Dalbergia sissoo*, *Bombax ceiba*, *Acacia catechu*, and *Butea monosperma*. If management interventions are not carried out in time, these trees will colonise the area and the grasslands will be lost.

Scarcity of water—During the hot season, marshes in the grassland area dry up. Swamp deer and other wild animals move further south in search of water to places where the deer's life is in danger.

Livestock grazing—Since the villages along the Chaudhar river in the extension area are still present, livestock graze in grasslands like the Haraiya Phanta and the eastern part of Singhpur Phanta. Thus wild animals have to compete with domestic animals. The grassland quality has deteriorated in this area as a result of over-grazing.

Uncontrolled burning—Every year grasses are burned in the dry season. The uncontrolled burning of grasses is thought to be one of the factors contributing to the deterioration of grass quality.

### Management Activities

The reserve authorities carry out different kinds of activities for the management of the grasslands within RSWR, such as construction and clearing of access roads, regular burning, ploughing, and construction of water holes, in close cooperation with the army. For the last few years, a UNDP funded project, the Park People Programme, has also helped the reserve administration to conduct management activities in order to improve the condition of the grasslands as the habitat of swamp deer and other wild animals. The different management activities are as follow.

Construction and Clearing of roads—A network of roads has been constructed within and around Shukla Phanta since the declaration of the area as a wildlife reserve. One road runs parallel to the Nepal-India boarder in the south, passes through Karaiya Phanta and Seta Khera, and continues to Jhilmila in the south-east. Another road passes through Barkaula Phanta on the way to Shukla Phanta from the north-west side of the reserve. Mangalsera Phanta is situated at the side of the road leading from Majhgaon to Malumela post. Haraiya Phanta has no road passing through it. Work is in progress to construct a road from Singhpur through Haraiya Phanta by clearing the vegetation.

All the access roads are cleared manually after the monsoon every year. Clearing is done to facilitate the movement of both official vehicles on patrol and visitors' vehicles. Clearing is also done with the idea that the roads can act as fire breaks in the dry season.

**Burning**—Since swamp deer are primarily grazers, they find young grass highly palatable. Burning is one of the management tools used to promote the growth of tender shorts. In Shukla Phanta, regular burning of grasslands causes *Imperata cylindrica* to produce tender foliage, which is highly preferred by grazing animals. All the burning activities in the grasslands are done from mid-November to mid-February. It is after this that swamp deer in herds of hundreds are seen grazing in the grasslands.

**Ploughing**—Non-palatable tall grasses were seen to be growing in all the grasslands including Shukla Phanta. Ploughing is used to break up swards of tall grasses and promote the growth of short grasses. Ploughing has been included as a grassland management activity for the last four years. Altogether 110 ha of grasslands have been ploughed by tractor since 1996. Five ha were ploughed twice, the others only once. Table 9 shows the details of ploughing since 1996. Ploughing could not be done at a particular time of the year because of reasons like shortage of staff and lack of timely availability of the budget. There has also been no research programme to discover the most suitable time for ploughing.

Year	Month	Location	Area (ha)	Programme
1996 (2054)	Sept	North-east of the viewing tower	10	PPP
1996 (2054)	Sept	West of the viewing tower	5	PPP
1997 (2055)	Apr	North-east of the viewing tower	30	PPP
1997 (2055)	Apr	Central part of Shukla Phanta	40	PPP
1997 (2055)	Apr	East of viewing tower	15	HMG
1997 (2055)	Jan	West of viewing tower	10	HMG
1998 (2056)	Jan*	East of viewing tower	5	HMG

\* In previously ploughed area

**Uprooting**—The grasslands in Shukla Phanta, Barkaula Phanta, Sundari Phanta, and Karaiya Phanta have been invaded by several tree species, such as *Dalbergia sissoo*, *Bombax ceiba*, and *Butea monosperma*. Once these trees become established in the grasslands they produce seeds which germinate. As a result, succession proceeds towards complete colonisation by the species at a later stage. For example, there were no sissoo trees in Shukla Phanta to the north of the viewing tower before 1982 when one of the reserve staff planted a tree. Later, many sissoo trees were found growing in the area (personal communication). It is better to prevent these species from becoming established, but if they do become established the only option is to them when uprooted young, or fell if they are mature. Simal (*Bombax ceiba*) saplings were uprooted in a five ha area in 1998.

**Construction and Repairing of Water Holes**—During the hot season, the marshes situated along the periphery of Shukla Phanta dry up. Even the Rani Tal, which is seven kilometres from Shukla Phanta and occasionally used by swamp deer for drinking water, has dried up every summer for the last three years. A continuous supply of water needs to be maintained in the vicinity of the habitat of the swamp deer in order to keep the herds healthy. Two ponds were dug near the viewing tower in Shukla Phanta and a third one renovated with the help of the Park People Programme in 1996. These ponds were filled with the help of boring and pumping sets. Renovation of these ponds was repeated in 1997.

### Research Activities

Very little research has been carried out on the grassland ecology of Shukla Phanta. Schaff researched the population size, structure, and habitat relations of the swamp deer (*Cervus duvauceli duvauceli*) in 1978. In the same year, Bhatt and Shrestha (1978) published a book entitled 'The Environment of Shukla Phanta', in which they gave a brief history of the area, vegetation types, and animal diversity. Their book was based on a very brief visit of the area and did not include any detailed study. Later, Peet *et al.* (1997) classified the grasslands of Shukla Phanta based on species composition as part of a larger study of the ecology of Terai grasslands. There has been no systematic research on the impact of management activities.

As a result of the realisation of the national and international importance of the area, many researchers have recently started studying the grasslands of RSWR.

Mr. Hem Sagar Baral selected the grasslands in Shukla Phanta as one of his study sites to study grassland birds for his Ph.D. He is collecting data on birds along several transects passing through the grassland.

Mr. Jay Prakash Sah is doing his Ph.D based on fieldwork within the reserve. Although his work is mostly related to the wetlands, he is also working in grasslands like the seasonally flooded grasslands in Mangalsera Phanta. He has also surveyed the volume of grass being harvested during the grass-cutting season, socioeconomic conditions, and the attitude of the people who come to the reserve to harvest grass.

Mr. Mahendra Shrestha has started research on the habitat of tigers in the western Terai, including Shukla Phanta Wildlife Reserve.

Recently, two students, Bindu Sharma and Shrijna Poudel, from the Central Department of Botany, Tribhuvan University, have started research into the impact of ploughing on grasslands under the supervision of Mr. J. P. Sah.

A Peace Corps volunteer, Timothy M. Croissant from the USA, has been doing research on the population of swamp deer and birds in the Shukla Phanta area.

### Research Needs

Research is still needed into the following.

- The carrying capacity of phantas

- The water quality and status of wetlands in and around the grasslands
- Prey and predator relationships in grasslands
- Flooding patterns and their effect on grasslands
- The effect of burning on grassland quality and wild animals
- The ecology of swamp deer

### Management Recommendations

The following recommendations are made for management.

- Roads should be properly maintained so that the movement of vehicles is smooth throughout the year. The roads near Barkaula post, the Bauni river, and the Headquarters should be repaired by filling with gravel.
- To ensure a regular supply of water in the Shukla Phanta area, the existing ponds should be renovated and filled. Three pumping sets should be bought and kept in running condition.
- Saplings of simal (*Bombax ceiba*), sissoo (*Dalbergia sissoo*), and other trees growing near the viewing tower, north of the access road, near the Barkaula post, and in Sundari Phanta, should be uprooted in a timely fashion so that further colonisation by these trees is checked.
- Growing trees of sissoo (*Dalbergia sissoo*), simal (*Bombax ceiba*), and palans (*Butea monosperma*) should be killed by girdling so that further colonisation is checked, but at the same time the dead intact trees can still provide a habitat for several bird species.
- Uncontrolled and illegal burning by people during the grass-harvesting season should be checked by employing temporary guards and making people aware of the damage caused by such burning. Similarly, fire fighting equipment should be made available to control uncontrolled and untimely burning.
- The villages along the Chaudhar River should be removed as soon as possible. This will help check livestock grazing in Haraiya Phanta, and add additional grassland habitat suitable for swamp deer and even rhinos.
- The location of the army post near the viewing tower in Shukla Phanta, which is a sensitive area in terms of the habitat of swamp deer, needs to be assessed and appropriate measures taken.
- Regular monitoring programmes should be conducted to monitor the impact of management activities so that necessary changes can be made.

### Conclusion

Grasslands are an important habitat for wildlife. Management interventions will improve the status of grasses. Burning grassland in blocks can help to maintain bird life and reptile species. The focus should also be on wetland management, which will help maintain the wildlife diversity in the grasslands.

### References

- Balson, E.E. (1976) *General Report on the Royal Shukla Wildlife Reserve*. Project Report No. NEP 72/002. Kathmandu: DNPWC/FAO.

- Baral, H.S. (1997) 'Shukla Phanta: A Grassland Reserve of International Importance'. *Danphe (Newsletter of Bird Conservation Nepal)*, 6 (3): 6-8.
- Bhatt, D.D. and Shrestha, T.K. (1978) *Environment of Shukla Phanta*. Kathmandu: Tribhuvan University, Curriculum Development Center.
- Chaudhary, R.D. (1997) *Shahi Shukla Phanta Banyajantu Araksha: Yek Chinari*. (A bulletin in Nepali). Kathmandu: Shahi Shukla Phanta Banyajantu Araksha.
- IUCN (1993) *Nature Reserves of the Himalaya and Mountains of Central Asia*. Gland: IUCN/World Conservation Monitoring Centre.
- Peet, N.B.; Watkinson A.R.; Bell, D.J.; and Brown, K. (1997) 'The Management of Tall Grassland for the Conservation of Biodiversity and Sustainable Utilization', scientific and management report for University of East Anglia, Norwich, UK, and Department of National Parks and Wildlife Reserve, Kathmandu, Nepal
- Schaff, C.D. (1978) *Population Size and Structure and Habitat Relations of the Barasingha (Cervus duvauceli duvauceli) in Shukla Phanta Wildlife Reserve, Nepal*, Ph.D Dissertation. East Lansing: Michigan State University.