

Vegetation dynamics and management of Rhinoceros habitat in *Duars* of West Bengal: An ecological review

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Abstract

Jaldapara Wildlife Sanctuary and Gorumara National Park in Northern West Bengal, located in the *Duar* areas, represent biodiversity hotspots amidst sea of human habitation. The natural vegetation of *Duars* is characterized by a mosaic of hygrophilous (tall) grasslands, woodlands, tropical moist deciduous and tropical semi-evergreen forests which remain in a state of flux due to recurring flood and succession. The Great Indian rhinoceros (*Rhinoceros unicornis*), a native herbivore of north Indian flood plains has evolved to exploit all the seral stages to meet its year round food and cover requirements. Management of habitat for this species within these protected areas would require understanding of successional trends and mimicking the natural processes. This review deals with the habitat characteristics in these areas, current habitat management practices and their ecological implications.

(Keywords : *duars/successional trends / rhinoceros unicornis / hygrophilous grasslands / habitat management*)

The flood plains of Ganges and Brahmaputra adjoining sub-Himalayan tracts are among the most dynamic ecosystems in Asia. These landscapes have evolved under a 'natural disturbance' regime *i.e.*, annual fluvial deposition since Miocene times, 20 million years before present¹. The vegetation in the area is in a state of flux reflecting mosaics of successional stages. The pioneer phase of succession is formed by the tall wet (hygrophilous) grasslands which are well adapted for seasonal inundation, siltation, fire and grazing by large ungulates. In terms of productivity the grasslands of this region rank highest among the terrestrial ecosystems of the world^{2,3,4}. Man, since the dawn of civilization, has been exploiting these areas heavily for settlements, agriculture and livestock

grazing and conservation efforts have been rather negligible till recently⁵.

The Great Indian (one-horned) Rhinoceros (*Rhinoceros unicornis*), one of the endemic large herbivores of these flood plains, is adapted to a mosaic of tall grasslands and riverine forests where water and some green growth remains available throughout the year^{6,7}. The species has faced major setback from habitat alteration and heavy poaching for its valuable horn. As a result, it is confined to only certain protected areas (PAs) of Assam, West Bengal and Nepal besides a small reintroduced population in Dudhwa National Park, Uttar Pradesh⁸. Long term conservation of this species warrants much more intensive management backed by detailed ecological information on the species and remnant habitat patches. This review deals with the vegetation dynamics and ecological basis for habitat management in the *Duars* of West Bengal with special reference to rhinoceros based on a rapid assessment in the field⁹ and discussions with the wildlife management authorities in the state.

Habitat Requirements of Rhinoceros

The rhinoceros is adapted to feed on abundant fibrous food supplemented by a wide variety of other plants⁶. In Chitawan National Park (Nepal) rhino fed on parts of 183 species of plants from 57 families. Grasses, nearly 50 species, constituted 70-89% of the diet according to season. Other components of diet include fruits, leaves and branches of shrubs, trees, submerged and

floating aquatic plants and agricultural crops¹⁰. Rhinos are reported to spend more time feeding during winter than in summer. Another study in Nepal¹¹ confirms the diverse diet of rhinoceros and reveals that grasses form >60 % summer diet while browse (forbs and shrubs) are more important during winter. Highly preferred food plants in Nepal included grasses such as *Saccharum spontaneum*, *S. bengalense*, *Arundo donax*, *Phragmites karka*, and browse species *Mallotus philippensis*, *Calamus tenuis*, *Coffea benghalensis*, *Murraya paniculata* and *Dalbergia sissoo*. In Jaldapara Wildlife Sanctuary (JWS), West Bengal it has been found¹² that 75.6% of rhinoceros diet consisted of grasses (16 species) and remaining items were herbs, shrubs, young foliage of various tree species such as *Acacia catechu*, *Dalbergia sissoo*, *Macaranga denticulata*, *Trema orientalis*, *Syzygium cumini*, *Ficus hispida*, *F. semicordata*, *Litsea monopetala*, fallen flowers of *Bombax ceiba* and *Oroxylum indicum*. Among grasses *Saccharum narenga*, *S. arundinaceum* and *S. longisetosum* var. *hookeri* were preferred forming 16.5, 17.3 and 18.2 % of the diet respectively. Thus, three categories of food items are considered important for the year round food for rhinoceros: (a) tall grasses, (b) browse species such as shrubs, tree saplings, fallen flowers and fruits, and (c) aquatic and semi-aquatic herbs. Woodlands and riverine forests are also crucial to meet cover requirements of rhinos during summer months.

The review of literature on the food habit of rhinoceros reveals that the rhinos are efficient in exploiting the large areas of riverine forests with plenty of browse and grasses^{7,13}. Rapid transformation of riverine areas into bare sand banks due to periodic flood and subsequent colonization by grasses, forbs, shrubs and eventually trees ensures the supply of the diverse food items. The areas dominated by one or only few species of grasses are thus likely to be poorer habitats as compared to diverse landscapes with abundant water and aquatic vegetation. These parameters are important for the evaluation and management of rhino habitat.

The Duar Ecosystem of West Bengal as Rhino Habitat

West Bengal, India's most densely populated states, is left with two small populations of rhinoceros numbering less than hundred. These populations are confined to two PAs viz., JWS and Gorumara National Park (GNP) located in the northern flood plains of the state, generally known as *Duars*. The *Duars* are essentially recent slightly elevated alluvial plains (200 -500 m above mean sea level) between Teesta and Sankosh rivers. These formations merge with a narrow *Bhabar* tract in the north and the central plains (*Terai*) in the south and cover an area of ca 5100 km². Several rivers and rivulets flowing from north to south intersect the *Duars* and deposit enormous silt and sand on either banks every monsoon. The annual average rainfall is about 350 - 400 cm. The rivers are notorious for changing their courses frequently and causing severe soil erosion but at the same time creating new flood plain habitats. For example, river Torsa which flows through JWS has occupied different positions over a width of 20 km by shifting its course time and again in the last 150 years giving rise to a network of dry stream beds, gullies and alluvial plains.

The historical accounts indicate that rhinoceros were much more widely distributed throughout the central plains and *Duars*¹⁴. It got confined to *Duars* by late 19th century especially along courses of Teesta, Mahanada, and Sankosh rivers. Since the upper parts of *Duars* become dry during winter and early summer due to porous soil, the rhinoceros which are obligate to perennial water courses and reed swamps might have used upper parts only during monsoon period. Now most of the lower arable plains have been taken over by the agriculture and upper undulating areas by tea plantations leading to fragmentation of forests and wildlife habitats in this area (Fig. 1). The forest vegetation of *Duars* is broadly divisible into Tropical Moist Deciduous (TMD) and Northern Tropical Semi-evergreen Forests as per classification by Champion & Seth¹⁵. Various sub-groups within TMD are

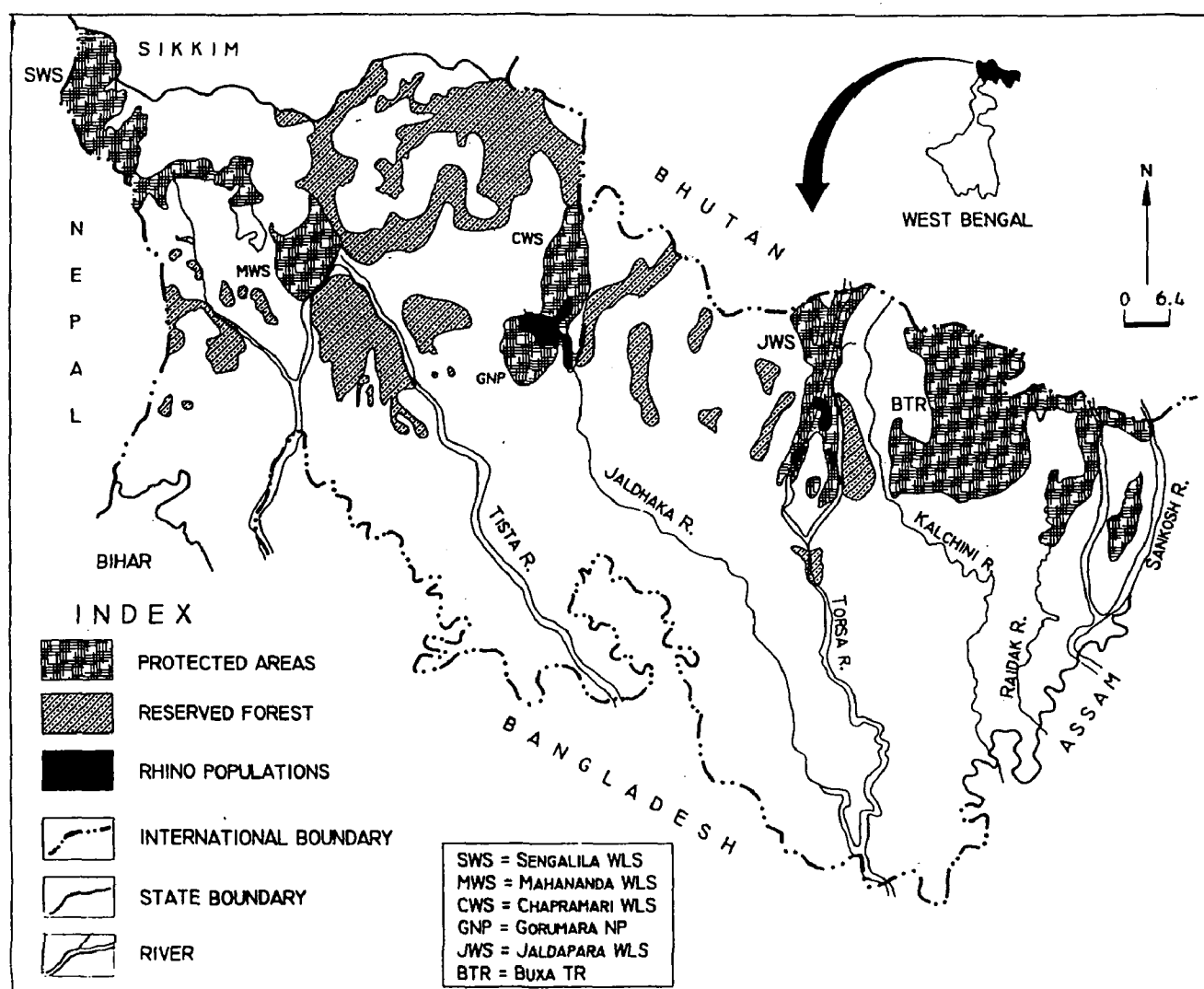


Fig. 1—Forests of Northern West Bengal showing PAs, RFs and present populations of Rhinoceros

Eastern Bhabar Sal, Eastern Terai Sal, Sal savannah and Lower alluvial savannah as seral stages. The sal (*Shorea robusta*) is commonly associated with the members of Lauraceae, Meliaceae, Annonaceae, *Terminalia* spp., *Lagerstroemia parviflora*, *Dillenia pentagyna*, *Sterculia villosa*, and *Schima wallichii* among others¹⁶. Low alluvial savannah woodlands are represented by tall grasses such as *Saccharum spontaneum*, *S. arundinaceum*, *Phragmites karka*, *Arundo donax*, *Narenga porphyrocoma*, and *Themeda villosa* dotted with associations of Khair - Sissoo (*Acacia catechu* - *Dalbergia sissoo*) and Semul - Siris (*Bombax ceiba* - *Albizia procera*)

woodlands. The forests of this tract have been heavily worked in the past for the supply of slippers to the Bengal Duars Railway and supply of fuel wood to the Tea Estates. The first working plan of Jalpaiguri Division for the period 1895-1905 prepared by Haines prescribed removal of over matured trees along with improvement felling in Khair and Sissoo forests and 'Coppice with Standard System'. Subsequent plans prescribed agri-silviculture method commonly known as *Taungya* which was followed in subsequent plans. A number of forest villages were set up to ensure the supply of labourers for raising plantations of commercial species such as teak (*Tectona*

grandis), champ (*Michelia champaca*) and gamari (*Gmelina arborea*). It is estimated that a total of ca 570 km² area in Duars falls under one or other type of plantation¹⁷. This altered the original habitat conditions drastically. Although, Chapramari, Jaldapara and Gorumara areas were declared as Game Sanctuaries in the years 1940, 1941 and 1949 respectively, human dependence on these areas for various resources continues to increase. At present nearly 350 km² area of Duars falls under the PA category. But increasing populations of elephants, gaurs and domestic livestock in and around these PAs, resultant habitat degradation, and conflict with the local people pose a big challenge to the wildlife managers. Although rhinoceros has been given a special status in the state but the PAs in their present form do not cover the sizeable ecological units required by this species. There is limited scope for the large scale flood plain dynamics and creation of new habitats which are crucial for long term conservation of rhinoceros and associated herbivores such as hispid hare (*Caprolagus hispidus*) and hog deer (*Axix porcinus*). Habitat degradation due to encroachment and disturbance by man and domestic livestock, invasion of exotic weeds such as *Ageratum conyzoides*, *Eupatorium odoratum*, *Mikania scandens* and *Eichhornia crassipes*, illegal removal of timber, and overcrowding and straying of wild ungulates have been major problems¹⁸. Other management constraints are as follows:

- i. Although natural disturbance i.e. annual flood is crucial for the maintenance of habitat diversity in Duars, it cannot be used as a tool for habitat management in a small PA. The flood is considered a problem if viewed on a short term basis in a small area.
- ii. The soil moisture and nutrient gradients to which various plant communities are adapted, have been created by flood so far. Maintaining these gradients by artificial means is beyond human abilities.
- iii. Biomass production and landscape diversity in a natural area cannot be

increased beyond certain limit. The rhinoceros is adapted to use the interspersed vegetation with uneven distribution of food plants during different seasons. It is very difficult to ensure the year round forage for the natural population of rhinoceros in a small area.

- iv. In a complex of multifarious conservation objectives where man-wildlife conflict has already crossed the critical point, the hands of PA managers are too tight to take any drastic decision for a species specific management.

Current Habitat Management Practices

JWS is heavily infested by an exotic climber *Mikania scandens*. The rhinoceros concentration areas vary greatly in the frequency of flood and moisture regime. The oxbow lakes with more stable reed swamp vegetation are rather limited in extent. These grasslands are shared by large ungulates such as gaur, elephant, and domestic cattle. In addition, annual harvest of thatch grass (*Imperata cylindrica*) by the local people and grazing by livestock and camp elephants limit the year round food availability for rhinoceros. Therefore, the park management is forced to take measures for increased grass production in these areas. Natural regeneration of tall grasses such as *Saccharum arundinaceum*, *S. bengalense* and *Themeda villosa* appears to have failed due to changed soil moisture and heavy grazing. Such problems are apparently more in elevated areas free from frequent flood. The park management had constructed four concrete water recharging structures in one of the rhino concentration areas for maintaining the water level in the streams during 1995 - 1996 which have given encouraging results¹⁹.

In order to improve the habitat of rhinoceros and its associate species in JWS the following major management activities have been proposed by the Wildlife Wing of West Bengal Forest Department²⁰ : (i) Overwood removal in areas colonised by woody species such as Khair - Sisoo, *Lagerstroemia parviflora*, followed by weed

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elimination and enrichment planting with indigenous fodder grasses, (ii) Plantation of indigenous tall as well as short (on experimental basis) fodder grasses (iii) Eradication of weeds and climbers from important wildlife habitats, (iv) Judicious use of fire for production of nutritive fodder in natural grasslands and fodder plantation area, (v) Reforestation of degraded forests, and (vi) Construction of water harvesting / recharging structures.

Vegetation Dynamics and Management Implications

A generalized diagram of successional stages in the Duars and adjoining flood plains is given in Fig. 2. Depending upon the substrate and moisture level two distinct paths can be traced. The distinct hydro-geomorphic processes give rise to a number of fluvial landforms such as oxbow lakes, sloughs and back swamp areas. Consequently, these plains comprise a mosaic of habitats leading through dynamic successional paths. Obviously, an uniform grassland habitat cannot be created in these areas unlike *Chauris* of Bhabar tracts and grasslands of Central India. In order to increase the area under tall grassland and to increase the forage production a total of 664 ha area was brought under fodder plantation in JWS (Pandit, P.K., *personal communication*). Site assessment and interviews with the field staff revealed that tall perennial grasses e.g., *S. arundinaceum* and *S. bengalense* can be established only in alluvial soil close to rivers and almost 90% plantations in other areas have failed. A clear inference to be drawn from this experiment is that the grass plantation in most of the rhinoceros areas may not be sustainable in the long run and new areas particularly well established mesic woodlands should not be brought under grass plantation. The implications are as follows:

- (i) Fodder plantation areas cannot be excluded from immediate grazing by more voracious feeders like gaur and elephant. Heavy use of plantation areas by these animals makes room for less palatable exotic weeds such as *Ageratum conyzoides*, *Eupatorium odoratum* and *Mikania scandens* which suppress regeneration of native species.
- (ii) Soil working without proper supervision and subsequent digging by wild pigs favours growth of opportunistic herbs rather than grasses. Similarly, low lying mesic areas dominated by ferns such as *Christella dentata*, *Ampelopteris proliferata*, and *Diplazium esculentum* cannot be converted into grasslands as most of the grasses have totally different ecological requirements.
- (iii) Grasses become coarse and less palatable during dry season hence herbivores shift their diet. This is nature's way of relieving the grasses from continuous herbivory. Attempts to attract rhinos and other herbivores in artificially created grasslands throughout the year may further degrade the habitat.
- (iv) The likely reasons for poor regeneration of *Saccharum* and *Themeda* in these areas are change in moisture regime and heavy grazing pressure. Uprooting *Saccharum arundinaceum* and *S. bengalense* from the drier parts to plant in new areas will eventually disturb both the areas.
- (v) Removal of woody vegetation from well established natural forests and plantation of fewer fodder grasses will lead to reduction in diversity of food plants required by rhinoceros. Fire can be used as effective tool for grassland management^{21, 22} albeit not all the grasses in the flood plains are adapted to fire.

Given the limited areas under wet grasslands and tremendous pressure of wild herbivores as well as domestic livestock, JWS in its present condition cannot be considered as ideal habitat for rhinoceros. The northern parts which have been recently included in JWS have potential to support other herbivores but not the rhino. Therefore, in order to maintain the rhino habitat in

lower parts of JWS, pressure of camp elephants will have to be shifted to the north. Livestock pressure needs to be diverted to areas away from the sanctuary. The core zone of Gorumara NP, on the other hand, appears to be more natural and productive for its present population of rhinos. However, with increasing number of elephants (both wild and camp) and gaur it is feared that this park may also face the similar consequences. Only mixed deciduous woodlands should be burnt during winter season followed by immediate cutting of certain unwanted shrubs/pole size crop. Manipulation of grasslands might work in some areas where the successional trajectory is correct or the stage of intervention is appropriate (Fig. 2).

For example, fire cannot be used as a tool for maintaining grasslands both in the low lying (wet) as well as upland (dry) grasslands. Attempts to control low lying grasslands by fire would be costly and impractical. Annual burning followed by sapling removal can be practiced only in stable, drier places which are progressing towards mixed woodland stage. Present practice of brushwood cutting before burning is likely to increase the labour cost and duration of disturbance. Removal of overwood in well established woodlands (late seral stages) and mixed forests need to be strictly prohibited. Low lying swamp vegetation should be maintained by carefully recharging the streams.

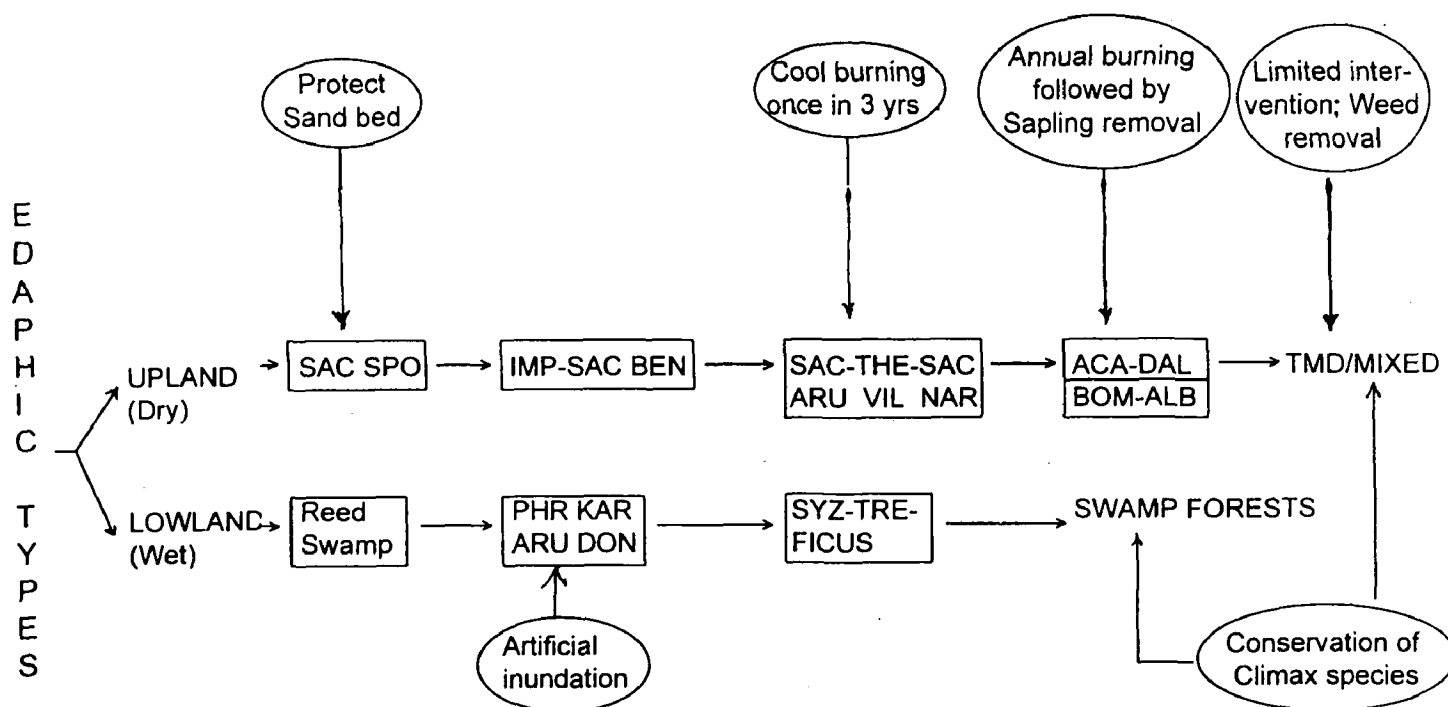


Fig. 2– Successional stages in flood plains of N-West Bengal and suggested management strategies

(SAC SPO = *Saccharum spontaneum*, IMP = *Imperata cylindrica*, SAC BEN = *Sac. bengalense*, SAC ARU = *Sac. arundinaceum*, The VIL = *Themeda villosa*, SAC NAR = *Sac narenga*, ACA = *Acacia catechu*, DAL = *Dalbergia sissoo*, BOM = *Bombax ceiba*, ALB = *Albizia odoratissima*, PHR KAR = *Phargmites karka*, ARUN DON = *Arundo donax*, SYZ = *Syzygium cumini*, TR = *Trewia nudiflora*)

A careful monitoring of flood dynamics will be helpful in predicting loss and creation of new flood plain habitat. Similarly, patches of low lying semi-evergreen and swamp forests should be protected in order to conserve the climax species of flora and fauna. Construction of water recharging structures, proposed in the present management plan, would be useful in this regard. It is likely that most favoured grasses including *Coix lachryma-jobi* have been selectively removed by the herbivores. The browse availability in and around rhino concentration areas of JWS and GNP is rather low⁹. This could be due to heavy browsing pressure by wild as well as domestic ungulates. Old concept of climber cutting for promoting regeneration of tree species in a natural forest still prevails among the forest staff. It must be clarified that most of the climbers in this tract form staple food for elephants during dry season. However, rhinoceros may not be able to exploit the climbers as efficiently.

Conclusions

Plantation of fodder grasses by modifying forested habitats, especially low lying swamp forests and semi-evergreen forests may not be sustainable in Duars. However, continuous efforts will be required to check the weed invasion and resultant decrease in grass production in the rhino concentration areas so that the rhinos continue to use these areas in all the seasons. Rhino concentration areas are likely to be degraded further if weed infestation and over crowding of other large herbivores such as gaur, domestic elephants and livestock are not checked. Long term monitoring of vegetation / habitats and water courses using large scale aerial photography, and satellite data backed by ground information would go a long way in predicting future trends in the rhino habitat and dynamics of *Duar* ecosystem.

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