

Dudhwa National Park

Some botanical aspects of the proposed new habitat for Rhino

By
P. K. Hajra
& U. Shukla
B S I Dehra Dun

The Dudhwa National Park in the Kheri District of U.P. has recently been proposed as a possible new habitat for the rhinoceros. The Indian rhinoceros which had a much wider distribution in the past is now confined to the Brahmaputra valley in Assam, Jaldapara Sanctuary in West Bengal and Chitawan range in Nepal. In this paper an attempt has been made to compare the rhinoceros habitat of Assam and that of Dudhwa National Park with special reference to the availability of food plants.

The Indian-one-horned rhino (*Rhinoceros unicornis* L.) had a much wider distribution about 500 years ago in the foot-hills of Himalayas and the plains of the Ganges and Brahmaputra. Now its population is inordinately depleted due to human interference and is restricted only to isolated pockets in the Brahmaputra valley (chiefly in Kaziranga National Park, Manas Wild Life Sanctuary and Orang Wild Life Sanctuary), West Bengal (Jaldapara) and Nepal (Chitawan range). However, the rhinos are a significant attraction in most of the zoos. The species is represented by about 1500 animals and is presently under severe threat of poaching, owing to its precious horn. The Assam Government realizes amounts like Rs. 62,000/- per kg. of horns. It has been strongly felt that new sites should be located for introduction of the rhino. The Dudhwa National Park in the Kheri District of Uttar Pradesh has been identified as one such site for introduction of the rhino. The Uttar Pradesh Forest Department has proposed an area of approximately 90 sq km or 8939 ha in the south Sonaripur and south Bellraien ranges consisting of 2765 ha grassland, 5580 ha woodland and 594 ha water-logged areas. The centrally located

Bakat Tal with an area of 60 sq km or 5958 ha, much of which remains flooded throughout the year containing two perennial swamps and an adjacent high ground where rhinos could take shelter during exceptionally high flood has also been suggested as an alternative site.

In this paper, the habitat and vegetation of the Kaziranga National Park and Manas Wild Life Sanctuary, the chief locations of the rhino have been compared with that of the Dudhwa National Park. Primary needs of the rhinos, i.e. swampy habitat and plenty of food are available in the area selected for introduction in the Dudhwa National Park. In fact, this place was in the belt of rhino distribution in the past. Similar and dissimilar features of these areas are discussed.

Area and topography

The Kaziranga National Park lies approximately between $90^{\circ}5'$ — $93^{\circ}40'$ E and $26^{\circ}30'$ — $26^{\circ}45'$ N. The park is situated partly in the Nowgong district and partly in the Sibsagar district of Assam at the foot of the Mikir Hills (Karbi-Anglong) south of National Highway No. 37.

It is bounded in the north and west by the Brahmaputra river, in the south by Mora Diphlu river, Mikir Hills and a number of villages of Nowgong and Sibsagar districts and in the east and west by many villages and cultivated fields of Nowgong and Sibsagar Districts. The important small streams draining into the park from south to north are Borjuri, Dring, Kohora, Dihing, Bhalukjhuri, Deopani, etc. There are many 'Bils' inside the park.

The total area of the Kaziranga National Park is 429.96 sq km. The terrain is a flat land.

Manas Wild Life Sanctuary lies approximately between $26^{\circ}30'$ — 27° N and 91° — 92° E. It is bounded in the north by the international boundary between India and Bhutan, in the south by the thickly populated regions of North Kamrup district of Assam; but in east and west, the different reserved forests are separated by cultivated fields and gardens. Of the total area of 2837 sq km under the Tiger Project in Assam, Manas has about 580 sq km.

The terrain is a flat land gently sloping to the south with a number of rivers draining from north to south. The main rivers are Manas, Mora-Manas (or Beki), Jong-rong, Gyati, Chorphuli, Garuchara and Rahang.

The Dudhwa National Park lies approximately between 28°18'-28°-42' N and 80°28'80°57' E. It is bounded in the north by international boundary of Nepal and remaining sides are contiguous with the Kheri district of Uttar Pradesh. The total area of the Park is about 490 sq km and adjoining area of 123 sq km is also under the administrative control of the Park, thus making it a complete block of 613 sq km. The Park area is a vast alluvial plain, traversed by a number of small rivers and rivulets and tals, the important among these being Mohan which more or less forms an international boundary between Nepal and Suheli which forms southern boundary of the Park and Jauraha, Neora, Nagroles nalas and Kakraha, Nagra, Churela tals. The mean elevation above sea level ranges from 182 m in the extreme north to 150 m in the south-east.

Climate

Kaziranga : There is heavy rainfall from July to October. The mild winter occurs from November to February and the summer is from March to May. The climate is tropical, hot and humid. Maximum temperature often approaches 35°C between March and September and minimum temperature rarely falls below 10°C during December and January.

Manas : The climate is warm and humid, maximum temperature goes up to about 37°C and the mean minimum is about 11°C.

Dudhwa : There are distinctly 3 seasons, winter from mid-October to mid-March, summer from mid-March to mid-June and rainy season from mid-June to mid-October. Average rainfall is + 160 cm. About 90% of the total rainfall is between June and September. During rainy season the Park roads get water-logged and remain so till the end of November.

Vegetation of Kaziranga National Park

Vegetation of Kaziranga National Park (Hajra, 1980) can be broadly classified into Alluvial inundated grasslands, Tropical wet evergreen forestry and Tropical semi-evergreen forests.

Alluvial inundated grasslands: Almost two-third of the Park is covered by grasslands. Amidst grasses there are numerous herbaceous plants and scattered trees of *Bombax ceiba* L., *Dillenia indica* L., *Careya arborea* Roxb., *Emblia officinalis* Gaertn., etc. In the extensive grasslands the dominant grasses are *Saccharum procerum* Roxb., *S. spontaneum* L., *Vetiveria zizanio ides* (L.) Nash, *Themeda villosa* (Poir.) A. Camus, *Apluda mutica* L.,

Arundinella bengalensis (Spreng.) Druce, *Digitaria setigera* Roth, *Hygroryza aristata* (Retz.) Nees, *Narenga porphyrocoma* (Hance) Bor, *Phragmites karka* (Retz.) Trin., *Sclerostachya fuscata* (Roxb.) A. Camus, etc.

Tropical wet evergreen forests : Besides grasslands there are patches of evergreen forests near Kanchanjhuri, Panbari and Tamulipathar blocks. The common trees in these forests are *Aphanamixis polystachya* (Wall.) Parker, *Dillenia indica* L., *Syzygium tetragonum* (Wt.) Kurz, *S. cumini* (L.) Skeels, *Talauma hodgsonii* Hook. f. & Thoms., *Garcinia tinctoria* (DC.) Wight, *Ficus ruzizhii* Bl., *Cinnamomum bejolghota* (Buch.-Ham.) Sweet, etc.

Tropical semi-evergreen forests : This type of forests occurs in the Baguri, Bimali and Haldibari surroundings. Here the common trees and shrubs are *Albizia procera* (Roxb.) Benth., *Dalbergia grandiflora* (Roxb. ex DC.) Walp., *Ligerstroemia speciosa* Pers., *Crateva unilocularis* Buch.-Ham., *Sterculia urens* Roxb., *Grewia serrulata* DC., *Mallotus philippensis* Muell.-Arg., *Bridelia retusa* Spreng., *Aphania rubra* (Roxb.) Radlk., *Leea indica* (Burm.) Merrill, *L. unbraculifera* Clarke etc.

The vegetation of Manas Wild Life Sanctuary (Jain & Hajra 1975) is basically wet alluvial grasslands but there are patches of *Dillenia* swamp forests (High Savannah *Bombax-Albizia* type of Rajkhowa, 1961), Semi-evergreen forests and Riparian fringe forests.

Wet alluvial grasslands form extensive areas. The common grasses are *Apluda mutica* L., *Chrysopogon aciculatus* (Retz.) Trin., *Cynodon dactylon* (L.) Pers., *Cyrtococcum accrescens* (Trin.) Stapf, *Digitaria ciliaris* (Retz.) Koel., *D. longiflora* (Retz.) Pers., *Echinochloa colonum* (L.) Link, *Eleusine indica* (L.) Gaertn., *Eriarthus longisetosus* Anders., *Hemarthra protensa* Steud., *Imperata cylindrica* (L.) P. Beauv., *Neyraudia reynaudiana* (Kunth) Keng, *Saccharum procerum* Roxb., *S. spontaneum* L. etc. In the grasslands several tree species occasionally grow. These are *Dillenia pentagyna* Roxb., *Emblia officinalis* Gaertn., *Bombax ceiba* L. etc. The common shrubs and herbs are *Clerodendron viscosum* Vent., *Grewia sapida* Roxb., *Pygmaeopremna herbacea* (Roxb.) Moldenk, and *Mussaenda roxburghii* Hook. f.

Dillenia Swamp forest : It is a fairly dense forest of medium height with many evergreen and semi-evergreen species and this type occurs in flat areas periodically flooded during the wet season with intervening dry periods. This type of vegetation is met with near Mothanguri and Uchilla Beat of Manas Sanctuary.

The conspicuous species in this area are *Dillenia indica* L., *Bischofia javanica* Bl., *Albizia procera* (Roxb.) Benth., *Lagerstroemia speciosa* Pers., *Terminalia chebula* (Gaertn.) Retz., *Bombax ceiba* L., *Duabanga grandiflora* (Roxb. ex DC.) Walp., etc.

Semi-evergreen forests : In this type of vegetation common trees are *Aphanamixis polystachya* (Wall.) Parker, *Anthocephalus chinensis* (Lour.) A. Rich. ex Walp., *Syzygium cumini* (L.) Skeels, *S. formosum* (Wall.) Masamune, *S. oblatum* (Roxb.) Wail. ex Cowan et Cowan, *Bauhinia purpurea* L., *Mallotus philippensis* Muell.-Arg., *Cinnamomum bejolghota* (Buch.-Ham.) Sweet, *Actinodaphne obovata* (Nees) Bl., *Kydia calycina* Roxb., *Casearia vareca* Roxb., etc.

The undergrowth consists mainly of *Leea aequata* L., *Coffea bengalensis* Wall. ex Roxb., *Phlogacanthus thyrsoflorus* Nees, *Adhatoda zeylanica* Medic., *Piper mullesua* D. Don, etc. This kind of vegetation is met with chiefly along the international boundary of India and Bhutan.

Riparian fringe forests : This type of vegetation is met with along the banks of Manas, Mora Manas, Jongrong, Gyati & Rabang rivers inside the Sanctuary.

A few species of large trees form a narrow fringe along the water courses. These trees are of sub-evergreen type. They stand widely spaced with smaller trees and shrubs in between and often with much coarse grasses mainly *Saccharum* spp. The common trees are *Bischofia javanica* Bl., *Polyalthia simiarum* (Hook. f. & Thoms.) Hook. f. & Thoms., *Aesculus assamica* Griff., *Lagerstroemia speciosa* Pers., *Bridelia retusa* Spreng., *Macaranga denticulata* (Bl.) Muell.-Arg., *Litsaea salicifolia* (Nees) Hook. f., *Trema orientalis* (L.) Bl., etc.

AQUATIC FLORA

There are a number of rivers and 'Bils' inside the Kaziranga National Park and Manas Sanctuary which harbour a variety of aquatic flora. About 5.58 percent of the total area is covered by the 'bils' and rivulets. In the treatment of aquatic plants the classification as suggested by Mirashi (1957) has been followed.

Free-floating hydrophytes

Eichhornia crassipes (Mart.) Solms, *Azolla pinnata* R. Br., *Utricularia flexuosa* Vahl., *Trapa natans* L. var. *bispinosa* (Roxb.) Makino.

Suspended submerged hydrophytes

Ceratophyllum demersum L.

Anchored submerged hydrophytes

Limnophila sessiliflora Bl., *Ottelia alismoides* (L.) Pers., *Vallisneria spiralis* L., *Cryptocoryne retrospiralis* (Roxb.) Kunth.

Anchored hydrophytes with floating shoots

Limnophila sessiliflora Bl.

Emergent amphibious hydrophytes

Polygonum caespitosum Bl., *Typha elephantina* Roxb., *Monochoria hastata* (L.) Solms.

Wet land hydrophytes

Cyperus brevifolius (Rottb.) Hassk. *Lasia spinosa* (L.) Thw., etc.

VEGETATION OF DUDHWA NATIONAL PARK

The vegetation of Dudhwa National Park is of Tropical moist deciduous type. It may be categorically stated that it is one of the best natural Sal forests, apparently a climatic climax in Uttar Pradesh. Champion & Seth (1968) have classified this Sal forest into Moist Bhabar Sal and Moist Plains Sal and further sub-types being Damar Sal forest and Western light alluvium plain Sal. These are found at Dudhwa, Bellraien, Bankati and several other places within the area. However, Sal gives the major coverage either natural or by plantation. Grasslands (phantas) are also seen within the area along with riparian fringe forest, Sal forest, mixed Sal and teak and semievergreen forests. The composition of these various forest types are as follows :

Grasslands (Phantas)

The various types of forests throughout the park are interrupted by wide stretches of mesophyllous grasslands locally called the 'phantas'. The common perennial grasses are *Themeda arundinacea* (Roxb.) Ridley, *Saccharum spontaneum* L., *S. bengalense* Retz., *Narenga porphyrocoma* (Hance) Bor, *Vetiveria zizanioides* (L.) Nash., *Cymbopogon flexuosus* (Nees) Wats., *Desmostachya bipinnata* (L.) Stapf, *Apluda mutica* L., *Dichan-*

thium annulatum (Forssk) Stapf, *D. glabrum* (Roxb.) Jain et Deshpande, *Pseudosorghum fasciculare* (Roxb) A. Camus, etc. *Hygroryza aristata* (Retz.) Nees is the common aquatic grass, and on the margins of ditches *Panicum paludosum* Roxb., *Echinochloa* spp. are frequent.

Trees Shrubs

Occasionally scattered trees or shrubs of *Syzygium cumini* (L.) Skeels, *Lannea coromandelica* (Houtt.) Merr., *Mallotus philippensis* Muell-Arg. with climbers like *Ventilago denticulata* Willd, *Dioscorea belophylla* Voight, *D. bulbifera* L. and *Trichosanthes cucumeriana* L. are also seen.

Riparian fringe forests

This type of forest is found on the bank of Suheli river near Dudhwa and elsewhere. *Acacia catechu* Willd. and *Dalbergia sissoo* Roxb. are found associated with *Trewia nudiflora* L., *Mallotus philippensis* Muell-Arg. and occasionally with *Syzygium cumini* (L.) Skeels and *Barringtonia acutangula* Gaertn.

Sal forests.

Thick Sal forests are met with in Dudhwa, Bankati, Bellraien and several other places and occupy a fairly large area in the National Park. The common associates of *shorea robusta* Gaertn. f. are *Mallotus philippensis* Muell. Arg., *Syzygium cumini* (L.) Skeels, *Ardisia solanacea* (Poir.) Roxb., *Callicarpa macrophylla* Vahl., *Murraya koenigii* (L.) Spreng., *Clerodendrum viscosum* Vent., *Mitragyna parviflora* (Roxb.) Kunth, *Flemingia macrophylla* (Willd.) Prain ex Merr., *Grewia elastica* Royle, *Ziziphus mauritiana* Lamk., *Z. oenoplia* (L.) Mill., *Z. xylocarpa* (Retz.) Willd., *Carissa spinarum* L., *Aegle marmelos* Corr. The common grass in undergrowth is *Desmostachya bipinnata* (L.) Stapf.

Mixed Sal and teak forests

These mixed forests are found in Dudhwa, Bankati and elsewhere. The characteristic species in these forests are *Mitragyna parviflora* (Roxb.) Kunth, *Adina cordifolia* (Roxb.) Hook. f. ex Brandis, *Dalbergia sissoo* Roxb., *Aegle marmelos* (L.) Corr., *Kydia calycina* Roxb., *Embllica officinalis* Gaertn., *Ziziphus mauritiana* Lamk., *Ehretia laevis* Roxb., *Ficus semicordata* Buch-Ham., *Desmodium triangulare* (Retz.) Merr., *D. pulchellum* (L.) Benth.

Semi-evergreen forests

This type of forests occupies a small portion of land in Gauriphanta, Bankati and Bellraien. The forest of these areas have no uniformity in composition of vegetation and with no apparent dominant species. The important constituents in this type are *Cassia fistula* L., *Kydia calycina* Roxb., *Mitragyna parvifolia* Korth., *Adina cordifolia* Benth., *Terminalia bellirica* Roxb., *Mallotus philippensis* Muell-Arg., *Syzygium cumini* (L.) Skeels, *Acacia Catechu* Willd., *Casearia elliptica* Willd., *Tectona grandis* L., *Embllica officinalis* Gaertn., *Phyllanthus reticulatus* Poir., *Holarrhena antidysenterica* (Roth) Wall. ex A. DC., *Millettia auriculata* Baker, *Helicteres isora* L. and *Xeromphis spinosa* (Thunb.) Keay.

Climbers

The stragglers and climbers frequently met with are *Dioscorea belophylla* Voight, *D. bulbifera* L., *Phanera vahlii* (W. & A.) Benth., *Porana paniculata* Roxb., *Ipomoea cairica* (L.) Sweet, *Cryptolepis buchmanii* Roem et Schult., *Ichnocarpus frutescens* (L.) R. Br., *Thunbergia grandiflora* Roxb., *Abrus precatorius* L., etc.

Occasional occurrence of *Naravelia zeylanica* (L.) DC., a climber and *Ola x nana* Wall, a short woody herb at Bellraien is interesting.

Herbs

The herbaceous undergrowth often encountered in these forests has *Ajuga macrophylla* Wall. ex Benth., *Alternanthera sessilis* (L.) DC., *Borreria brachystema* (R. Br. ex Benth.) Valet, *Mazus pumilus* (Burn. f.) Steen., *Hemigraphis hirta* T. Anders., *Uraria picta* Desv. and hedges like *Cyperus rotundus* L.

AQUATIC FLORA

There are a number of rivulets and temporary water pools and permanent tals in the Dudhwa National Park which support a variety of aquatic plants; some are listed below :

Free-floating hydrophytes

Trapa natans L. var. *bispinosa* (Roxb.) Makino, *Utricularia flexuosa* Vahl, *Hygroryza aristata* (Retz.) Nees, *Lemna perpusilla* Torrey, *Spirodela polyrrhiza* (L.) Schleid.

Suspended submerged hydrophytes

Aponogeton crispum Thunb., *Hydrilla verticillata* (L.f.) Royle, *Potamogeton pectinatus* L.

Anchored submerged hydrophytes

Ottelia alismoides (L.) Pers.

Anchored hydrophytes with floating leaves

Nelumbo nucifera Gaertn., *Nymphaea nouchali* Burm. f., *Nymphoides cristata* (Roxb.) Kuntze.

Anchored hydrophytes with floating shoots

Monochoria vaginalis (Burm. f.) Presl, *Sagittaria guayanensis* H.B.K. ssp. *lappula* (D. Don) Bogin.

Amphibious hydrophytes

Echinochloa colonum (L.) Link, *E. stagnina* (Retz.) P. Beauv., *Panicum paludosum* Roxb.

Wet land hydrophytes

These occur in low lying areas of the park and in marshy places near Water pools, tals, rivers, drying up rice fields etc. The common species are : *Ludwigia actovalvis* (Jacq.) Raven, *L. prostrata* Roxb., *Salvia plebeia* R. Br., *Alternanthera sessilis* (L.) D. C., *Phyllanthus nodiflorus* (L.) Greene, *Mazus pumilus* (Burm. f.) Steen., *Amisophacelus axillaris* (L.) Rolla Rao et Kammathy, *Hydrola Zeylanica* Vahl, *Gnaphalium luteo-album* L., *Polygonum plebeium* R. Br., *P. barbatum* L., *Xanthium strumarium* L., *Cyanotis cristata* (L.) D. Don, *Commelina benghalensis* L., *Murdannia nudiflora* (L.) Brenan and sedges, e.g. *Cyperus iria* L., *Scirpus articulatus* L., *Scleria levis* Retz., *Eleocharis palustris* R. Br.

The present population of Rhinos is estimated as

Assam : Kaziranga 960, Manas 90, Orang 60, Sonai Rupai 10, Laokhawa 100.

West Bengal : Jaldapara 19.

Nepal : Chitawan 300.

Food

Rhinos generally prefer grasses like *Saccharum* spp., *Cynodon dactylon* (L.) Pers., *Arundo donax* L., *Polytoca digitata* (L.f.) Druce, *Hygroryza aristata* (Retz.) Nees, *Vetiveria zizanioides* (L.) Nash, *Imperata cylindrica* (L.) P. Beauv., *Themeda* spp., *Chrysopogon aciculatus* (Retz.) Trin., *Setaria Pallide-fusca* (Schumach.) Stapf et C.E. Hubb, *Paspaliidum flavidum* (Retz.) A. Camus, *Narenga porphyrocoma* (Hance) Bor and *Phragmites karka* (Retz.) Trin., sedges like *Cyperus* spp. as well as herbs, shrubs and saplings of species like *Polygonum plebelium* R. Br., *Ageratum conyzoides* L., *Erigeron* sp., *Artemisia nilagirica* (Clarke) Pamp., *Eupatorium odoratum* L., *Solanum* spp., *Colebrookia oppositifolia* J.E. Smith, *Murraya koenigii* (L.) Spreng., *Trewia nudiflora* L., *Litsaea* sp., *Premna* sp., *Ehretia* sp.

They also prefer aquatic plants like *Hydrilla verticillata* (L.f.) Royle, *Vallisneria spiralis* L., *Hygroryza aristata* (Retz.) Nees ex Wt. & Arn., *Potamogeton* sp., etc. During the rainy season they move along the river beds and in cultivated fields and sometimes take *Oryza sativa* L. It is estimated that the rhino population in Kaziranga takes about 77% grasses and 23% herbs and shrubs. Wide range of materials eaten by the rhinos suggests that the animal is not very specific in its choice, though data on food habit of the animal in captivity have not been gathered. However, majority of the above mentioned food plants are available in the Dudhwa National Park.

ACKNOWLEDGEMENT

This survey has been financed by the grant made available by the Department of Environment, Government of India through the Director, Botanical Survey of India, Howrah-3, which is duly acknowledged. Thanks are also due to Dr. U.C. Bhattacharya for his valuable guidance in preparation of this manuscript.

REFERENCES

- CHAMPION, H.G. & S.K. SETH *A revised survey of the forest types of India*
Govt. of India-1968.
- HAJRA, P.K. Vegetation of National Parks and Sanctuaries
of Assam in *Proc. Workshop on Wild Life*
Ecology, 1971, 53-59, 1980.
- JAJN, S.K. & P.K. HAJRA On the botany of Manas Wild Life Sanctuary in
Assam. *Bull. bot. Surv. Ind. a* 17 : 75-86. 1975.
(Pub. 1978).
- MIRASHI, M.V. Studies on the hydrophytes of Umred. *J. India.*
bot. Soc. 39 : 396-407. 1957.
- RAJKHOWA, S. Forest types of Assam with special reference to
evergreen and semi-evergreen forest. *Ind. For.*
87 : 520-541. 1961.

Extracts from the final recommendations of the Rhino
Sub-Committee of the Wildlife Status Evaluation
Committee of the IBWL in the Translocation of
Great Indian Rhinoceros

THE PROPOSAL TO RE-INTRODUCE RHINOCEROS INTO
DUDHWA

Since Dudhwa does not currently have rhinos, the question of suitability of habitat was carefully examined in addition to protection and the general quality of management.

Background Information on Dudhwa National Park

The following floral elements are common to Dudhwa, and Kaziranga and Manas National Parks, both of which are good areas presently maintaining large populations of rhinoceros :

Grasses	10 spp
Herbs and climbers	10 spp
Hydrophytes	6 spp
Shrubs and undershrubs	7 spp
Trees	12 spp

A tentative list of rhino food plants (i.e., plants which rhino eat in other areas) was drawn up for Dudhwa and included some 14 species.

The U. P. Forest Department has proposed an area of approximately 90 km² in the south-west part of the park (South Sonaripur and South Bellarian ranges) : as providing the most suitable rhino habitat. It includes a 15 km long tract of grassland on the southern boundary of the park bordering the Suheli River. Fifty per cent of the area is subject to seasonal floods and an area of 560 hectares is permanently swampy and water-logged. The Committee felt that the area was highly suitable. A disad-

vantage of the area proposed is that it is adjacent to the southern boundary of the park (Suheli River) which lacks a buffer zone and outside of which is an area of dense human occupation and cultivation. There is thus a danger of rhinos wandering across the river and causing damage to cultivation and possibly also to human life (see Recommendations with regard to this point).

Recommendations on Dudhwa

The Committee is of the view that Dudhwa National Park contains suitable habitat for a population of Indian Rhinoceros. In particular, the area of South Sonaripur/South Bellraian provides water for drinking and wallowing, shade and an adequate variety of plants known to be eaten by rhino elsewhere. (However, as a confirmation of this latter point, the Botanical Survey of India was requested to carry out a survey in September 1980, of the incidence and frequency of rhino food plants in Dudhwa, with particular attention to the three areas mentioned.)

(i) As a prerequisite to the introduction of rhinoceros it is essential to fully enforce the provisions of the wild Life Act (1972) determining the management and control of Dudhwa as a National Park. In this regard, the efforts of the Chief wildlife warden and his staff must be strongly reinforced. To this end and in order to increase the suitability of the Park as a rhino introduction site, the Committee recommends that the following measures should be undertaken *prior* to the release of rhinos into Dudhwa.

- a. A portion of the existing Reserve Forest adjacent to the southern Park boundary should be transferred to the control of the Park management and managed as a buffer zone.
- b. The cutting of thatching grass and collection of fuel by local villagers must be stopped within a radius of 3 km of the release site, i. e. an area of 30 km²
- c. No further building within the Park should be undertaken.
- d. The installation of the radio network within the Park should be completed and protection staff re-deployed accordingly.
- e. A Research Assistant (A. C. F. level) should be appointed and undergo training in methods of monitoring the introduced rhinos and research on aspects of their ecology and behaviour,

such as interaction with other species, either at Dehra Dun or Hyderabad. He should ultimately be linked to the larger rhino research project to be based in Assam.

- f. A Range Officer and four Guards selected by the Park Director should be sent to Kaziranga for 2 months to undergo a period of training in rhino management under the Kaziranga wildlife staff, by arrangement with Assam Forest Department.
- g. In order to prevent rhinos from Wandering across the Park boundary from the proposed release area, a rhino-proof barrier should be erected parallel to the right bank of the Suheli river from the point where the Dudhwa/South Sonaripur inter-range border joins the southern Park boundary to a point on the Park boundary south of Salukapur F. R. H. The distance is approximately 11 km. The type of barrier erected initially will be a trench-cum-fence and should be regarded as experimental. Size of the trench will be $2 \times 2 \times 1$ m the outer slope being brick-lined to prevent scouring. 60 m sections of trench will be alternated with 15 m sections of iron fencing so as to avoid water flow in these trenches turning it into a 'nullah'. Regular maintenance of the trench will be necessary.

(ii) In addition to the prerequisites to rhino release listed in (i) above the following long-term measures are recommended to further strengthen the quality of management in Dudhwa :

- a. The remaining half of the village in the north of the Park should be resettled as per sanctions already provided.
- b. The following railway stations within the Park which are very little used by people, should be closed as soon as possible : Sonaripur, Phulwaria, Rehta and Dingania.
- c. The railway line running through the Park should eventually be removed and realigned along the outside northern border of the Park, where it would be of great service to the tribals living in that area.
- d. The main road through the interior of the Park should be closed to the public as soon as the new road in the northern buffer zone has been completed (this was expected to be in mid-1981)
- e. A Perimeter track should be constructed inside the Park boundary, where not already present, to facilitate patrolling of the boundary by vehicle.

- f. Existing tourist accommodation should be moved outside of the park boundary.
- g. It is recommended that the Park authorities monitor flow of water in the Suheli River as well as activities in the catchment areas which are likely to affect water flow. Immediate steps should be taken to rectify and modifications of the catchment area which adversely affect flow.
- h. The cutting of thatching grass and fuel wood in the Park by local villagers should be progressively eliminated within the next 5 years.
- i. Judicious management of water in potential rhino areas is recommended. In particular, an increase in the amount of water held in ponds/tals during the dry season is desirable. However, measures to achieve this, such as raising the level of roads should be undertaken with due aesthetic care and conservation of the existing natural environment in mind.
- j. The following extra transport should be provided in order to increase the patrolling and fire-fighting capabilities of the Park Staff:
 - 1 Jeep (with trailer)
 - 2 Motorcycles
 - 10 Bicycles
 - 2 Elephants
- k. The following additional personnel are also recommended :
 - 1 Driver (for the Jeep)
 - 2 Mahouts
 - 4 Armed Guards
- l. The management plan for the Park, revised so as to incorporate provisions for carrying out these recommendations, should be submitted to the Jt. Secretary for evaluation within 4 months of the finalisation of the recommendations.

- iii. It is recommended that when recommendations (i) (a) to (g) above have been carried out, arrangements should be made for the release of rhinoceros into Dudhwa National Park in accordance with the following :
- a. An initial release should consist of six young adult animals (2 males; 4 females).
 - b. They should be released South Sonaripur Range South-West of Kakraha Tal (the boundary of which area will have been provided with a Rhino proof barrier).
 - c. Prior to release, the animals should be confined in Stockades in the release area for a minimum of 8 weeks. The design of the stockades should follow F. A. O. Field Document on rhino translocation. After initial individual confinement in the stockades animals should be let out into a 1 ha communal paddock under careful supervision thus allowing increasing familiarity with their new surroundings. It is recommended that the period within the paddock be used to experiment with the effectiveness of various types of barrier against Rhinos e. g. electric fence, steel cables under tension (c. f. Addo electric fence), ditches etc. (A barrier established as reliable for Rhinos in these limited experiments could then be 'field tested' by erecting a section of it along the southern Park boundary next to the trench-cum-fence, where it would be subject to stresses in addition to those due to rhino, such as elephant or cattle damage.)
 - d. The translocation should take place during the winter months of December to February, following suitable capture and holding preparations within Assam.
 - e. All animals should be immunised against infectious diseases prior to release in Dudhwa.
 - f. The movements and feeding habits etc. of the introduced rhinos be carefully monitored by the Research Assistant after release. In particular, any attempts to leave the Park area should be noted including interaction with the experimental trench-cum-fence
 - g. Because of the danger of tiger predation, new-born rhinoceros should be protected for a period of at least 6 months after birth, if possible by round-the-clock presence of Guards.

- h. Suitable publicity and, in particular, preparation of the local human population around Dudhwa National Park should be mounted prior to the introduction operation. Preparatory and follow-up publicity should commence under the direction of the Chief wildlife warden, Lucknow.
- i. Further releases in Dudhwa should be planned based on the experience with the initial six animals. A total release of up to 30 about over 5 years, in the South Sonaripur/South Bellprairan ranges is recommended. The area of 90 km² proposed as suitable for rhinos be able to accommodate a maximum 90 animals but clearly rhinos must leave space for future population growth by reproduction. A limiting factor might prove to be the availability of funds for further fencing of the southern boundary, depending on which type barrier eventually proves to be the most suitable.

Rhino Research Project

I. Introduction

The Great Indian rhinoceros (*Rhinoceros unicornis*) formerly occupied a large geographical range across North India including the terai zone, the Indo-gangetic plains and the valley of the Brahmaputra. Today the total species population is approximately 1500 individuals of which 1200 are in India (300 being in Nepal). Of these, some 100 are in Kaziranga, the remainder being dispersed among approximately a dozen smaller populations in Assam and West Bengal (two populations).

Concern has been expressed about the unusually high density of the Kaziranga population (2.5/km) and the threat of poaching. While some of the small populations in Assam are not in protected areas, a number of possible sites for reintroduction have been proposed by Government of Assam. The Government of West Bengal reports poor reproduction in both its small populations and requested introduction of "new blood" from elsewhere. A Government of India Committee recommended (1981) limited introduction of new males into these populations on an experimental basis. It further recommended the experimental translocation of 6 rhinos into Dudhwa National Park, Uttar Pradesh which is a former haunt of the species and, in view of the Committee and international rhino experts, offers suitable habitat in a well managed national park. Both African species of rhino have responded well to reintroduction programmes, indicating suitability of the rhino group to this form of management.

Two recent studies on Great Indian rhinoceros (Laurie, 1978 and Patar, 1977) have provided some basic ecological data on the Chitawan population and winter feeding habits in Kaziranga respectively. However there is an urgent need of long-term studies of the species within India as a basis for more scientific management. Drug capture trials of the species have already been undertaken (Sale & Woodford, 1981).

Against this background it is proposed to set up a Centrally sponsored research aimed at assisting the improved management of the rhino, within the recognised principles of endangered species conservation. The project will be financed by the Department of Environment and affiliated to the Wildlife Institute of India who will appoint a supervisor for the project.

2. Objectives

To provide objective scientific data as a basis for improved management of the endangered Great Indian rhinoceros within India, including :

1. Up-to-date information on the numbers, distribution and conservation status of all existing populations in Assam and West Bengal.
2. A detailed study of the ecology of the Kaziranga population and comparison with other populations, with particular reference to density, distribution in relation to habitat types, and food supply, local movements, natality, mortality, incidence of disease.
3. The intra-specific behaviour of rhinos, especially adult males, should be monitored and comparison of such social behaviour as male-male fights be made between high and low density populations. Any harmful effects of high density on social behaviour should be described and quantified.
4. A study of the reproductive performance of the Jaldapara and Gorumara rhinos in West Bengal in the light of reported lowered fecundity of these populations.
5. The effect of high rhino density on other species of herbivores should also be studied, e. g. competition at water holes, loss of food supply and competition for shade.
6. An evaluation of possible protected areas for reintroduction within the species' former geographical range (i. e. Assam, West Bengal, Bihar and Uttar Pradesh), paying particular attention to ecological suitability and the quality of protection which should be afforded.
7. Monitoring of the ecology and behaviour of any reintroduced groups, in order to evaluate reintroduction as a management tool in relation to the conservation of Indian rhino.

3. Methodology

In addition to general ecological methods the following specific methodologies should be employed :

1. In order to study and monitor numbers and density, an efficient census method must be worked out for the species. The present blockwise visual counting from elephant back practised in Kaziranga should be thoroughly evaluated statistically. If it is felt necessary to try other methods, systematic aerial census, at an appropriate time of day, should be evaluated, using the services of a pilot familiar with wildlife census work (such a pilot is now available at the FAO project at W. I. I.). Census should be replicated annually for all populations.
2. Various habitat types in rhino occupied areas should be defined on the basis of presence of major factors, including terrain, open water, swamps and vegetation type characterised by frequency of dominant plant species and physiognomy. Habitat types should be mapped with rhino density at different seasons by use of map overlays and contingency tables.
3. Food habits should be studied both by direct quantified observation of feeding rhinos and analysis of faecal matter in the laboratory.
4. For studies of individual movements, home range, social behaviour, etc it will be necessary to identify individuals and a card index of readily identifiable characteristics such as horn proportions, wrinkles on upper lip, ear tears and other deformities should be built up and used in the field. photographic profiles should form part of the index card. If it proves difficult to keep track of individuals moving over a large area, radio-tracking may have to be resorted to. However, this sophisticated technique will probably not be necessary with a relatively sedentary species such as the Indian rhino.
5. To study effects of rhino feeding on the vegetation and its possible effects on the food supply of other herbivores, exclosures may be used to examine the vegetation in the absence of rhino grazing/browsing.

4. Duration

The project should be set up for 3 years in the first instance and progress should be reviewed after 2 years when the possible need for an extension should be considered.

5. Reporting

Brief progress reports should be made at 6-monthly intervals to the Department of Environment and copies to the Project Supervisor at W.I.I. A fuller Annual Report, containing a summary of research findings should also be made.

6. Location

The project should be headquartered in Assam, preferably at Kaziranga where a small field laboratory and office accommodation will need to be provided. Arrangements for living accommodation for project staff will also have to be worked out.

Frequent research travel to rhino areas elsewhere in Assam and in West Bengal, as well as to prospective reintroduction sites in other States will be necessary. For such trips temporary F. R. H. accommodation can be arranged.

7. Personnel

Senior Research Officer : This officer will be in charge of the field research programme and in addition to his own area of investigation (e.g. rhino numbers, density, distribution, reproduction, monitoring, conservation strategy) supervise the work of other team members. He should possess a Ph.D in large mammal ecology or behaviour and have experience in carrying out a wildlife research programme of international standard. Tropical experience is desirable and an ability to work well within a team context essential.

Financial support for this post should be sought from international sources such as I. U. C. N., W. W. F., F. A. O., New York Zoological Society etc, and their assistance taken in identifying a suitable candidate for the S. R. O. post.

Research Officers (2) : Each R. O. will be responsible for a specific aspect of the programme such as habitat studies, feeding, behaviour etc. They should possess a Ph.D in an appropriate area of specialisation i. e, vegetation ecology and mammalian behaviour respectively.

These posts will be financed at the level of Government of India Research Associateships.

Research Fellows (4) : Two fellows will be attached to the Senior Research Officer (in different locations) and one to each of the R. O's.

They will carry out the more routine aspects of data gathering under the direction of the officer in charge of that part of the programme. A good M.Sc with emphasis on either animal or plant ecology will be the minimal qualification for these posts. Registration of the allocated research topic within the rhino project for a Ph.D at a reputable university will be encouraged.

These posts will be financed at the level of Government of India Junior Research Fellowships.

Field/Laboratory Assistants (5) : One assistant will be attached to each Research Fellow whom they will assist in the field and laboratory with routine tasks such as measurements, collection of samples, care and maintenance of equipment, washing of glassware etc.

Stenographer/clerk : To maintain office records, files, type correspondence, research results, papers etc and to maintain project accounts.

Drivers (3) : One attached to Senior Research Officer and each Research Officer.

8. *Financial estimates* : (for 3 year project)

i) <i>Non-recurrent items</i>	<i>Rs.</i>	<i>Rs.</i>
Jeeps (3)	@ Rs. 85,000	2,55,000
* Binoculars (5)	@ Rs. 1,000	5,000
* Spotting scopes (2)	@ Rs. 2,100	4,200
* Cameras with telephoto lens (2)	@ Rs. 5,000	10,000
* Walkie-talkie (2) pairs	@ Rs. 2,700	5,400
Scientific calculators (3)	@ Rs. 250	750
Monocular research microscope(1)	@ Rs. 4,000	4,000
Binocular microscope (faecal analysis (1)	@ Rs. 5,000	5,000
Laboratory equipment (glasware, ovens balances etc)		25,000
Mapping equipment		10,000
Field equipment spotlights, plant presses, (plastic bags, wire for enclosures etc)		30,000
Office furnishings and equipment		30,000
Erection of laboratory, darkroom etc—to be provided by Government of Assam)		50,000

		4,34,350

ii) *Recurrent items*

Travel (between study areas)	@ Rs.	10,000 pa	30,000
Fuel & vehicle maintenance	@ Rs.	100,000 pa	3,00,000
Films, chemicals, batteries	@ Rs.	10,000 pa	30,000
Stationery & office supplies	@ Rs.	10,000 pa	30,000
Field contingencies (hire of elephants etc)	@ Rs.	12,000 pa	36,000
Salaries : S.R.O. (external funds)			
R.O's (2)	@ Rs.	1,300 pm	93,600
R.F's (4)	@ Rs.	650 pm	93,600
Assistants (4)	@ Rs.	700 pm	1,00,800
Steno/UDC (1)	@ Rs.	900 pm	32,000
Drivers (3)	@ Rs.	700 pm	75,600

			8,22,000

* These items may be supplied on loan via UNDP/FAO Project at W.I.I. TOTAL 12,56,350

Note : Should aerial census prove necessary supplementary estimates will be made for this and funds sought accordingly

Literature cited

- Anon (1981). Final recommendations of the rhino Sub-committee, of the Wild Life Status Evaluation Committee of the I.B.W.L., on the translocation of Great Indian rhinoceros.
- Laurie, W.A. (1978). The ecology and behaviour of the Greater One-horned rhinoceros. Ph. D thesis, University of Cambridge.
- Patar, K.C. (1977). Food preferences of the one horned Indian rhinoceros, *Rhinoceros unicornis*, in Kaziranga National Park, India. M.Sc thesis, Michigan State University.
- Sale, J.B. & Woodford, M.H. (1981). Preliminary report on drug immobilisation and transport of the Great Indian rhinoceros. IND/74/046/, Field Document No. 7. Food & Agriculture Organisation of the United Nations, Rome.

DUDHWA NATIONAL PARK

Area

613 Sq. Kilometres (Core 490 Sq. Km. and Buffer Zone 123 Sq. Km.)

Location

The Park is situated on Indo-Nepal Border in Lakhimpur Kheri district Uttar Pradesh.

Open Season

November 15 to June 15.

Approach

From Delhi : BY ROAD (430 Km.)—Delhi - Moradabad - Bareilly - Purnanpur-Khutar Crossing-Mailani-Bhira-Pallia-Dudhwa.

BY TRAIN—Delhi-Moradabad-Bareilly-Bhojipura-Mailani-Dudhwa.

From Lucknow : BY ROAD (238 Km.)—Lucknow-Sitapur-Lakhimpur-Sharadanagar-Nighasan-pallia-Dudhwa, OR, Fair Weather only (215 Km): Lucknow - Sitapur - Lakhimpur - Pachapedighat - Nighasan - Pallia-Dudhwa.

BY TRAIN—Lucknow-Sitapur-Lakhimpur-Mailani-Dudhwa.

Wildlife

There are natural Sal Forests in the Park. Grass lands and wetlands including lakes and ponds cover about 20% of the area. The abundance of varieties of animal life and flora in the park is a great attraction to the tourists.

The estimated number of wild animals in the area according to the census of 1982 is as under :—

Sl. No.	Name	Estimated No.	
1.	Tiger	65	
2.	Leopard	10	
3.	Swamp Deer	2600	In addition to these, jungle fowls, partridges and quails of different varieties are found in large number. In winter season a number of migratory birds are also seen. There are also fishes, amphibians and snakes of different types.
4.	Chital	9800	
5.	Hog Deer	2150	
6.	Barking Deer	675	
7.	Sambhar	560	
8.	Wild Elephants	5	
9.	Sloth Bear	65	
10.	Blue Bull	600	
11.	Wild Pigs	3300	
12.	Black Buck	20	
13.	Otter	15	
14.	Crocodile (Mugger)	6	

The main attraction of the park is Swamp Deer, locally known as 'gond' or 'barasingha'. This species is one of the endangered ones. At present there are about 2600 swamp deer in the area which is the largest population of this species at some place.

C O R R I G E N D U M

<u>PAGE</u>	<u>FOR</u>	<u>READ</u>
1, Line 2	international	intentional
5, Line 7	below:	On page 4.
11, Para 3, Line 10	Per 7 m	per Km
13, Caption of top photograph facing	Rhinos	Rhino
15, Footnote, Line 5	reintroduction	reintroduction
15, Footnote, Line 6	place	range
63, heading, Line 3	in	on
63, heading, Line 4	Rhinocers	Rhinoceros