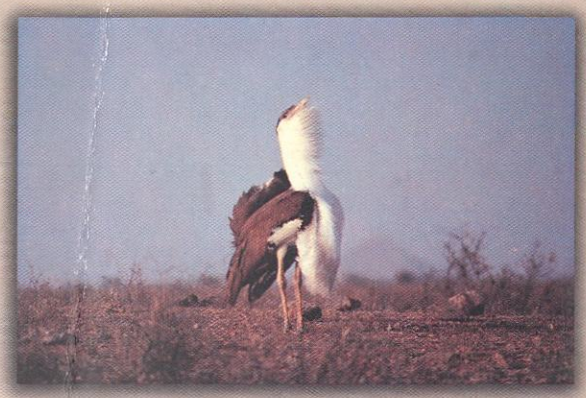
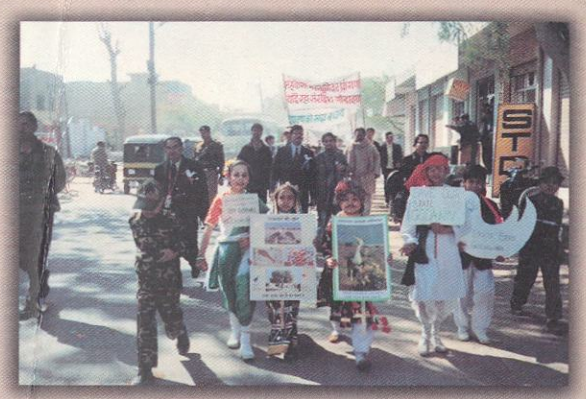
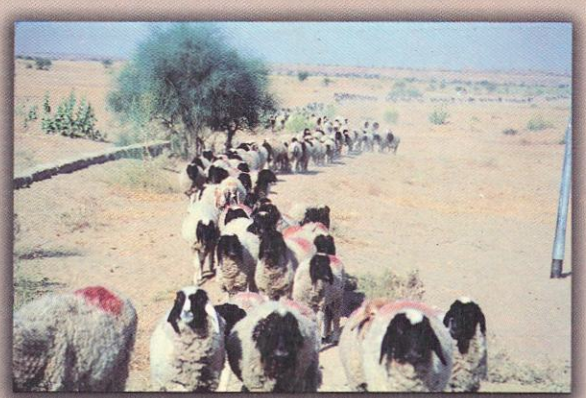
DEVELOPMENT OF DESERT NATIONAL PARK AS BIOSPHERE RESERVE







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Wildlife Institute of India

BNHS INDIA CONSERVING NATURE SINCE 1883

Development of Desert National Park as Biosphere Reserve. Final Report

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DEVELOPMENT OF DESERT NATIONAL PARK AS BIOSPHERE RESERVE

FINAL REPORT

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भारतीय वन्यजीव संस्थान
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BNHS Mission

Conservation of nature, primarily biological diversity, through actions based on research, education and public awareness

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SUMMARY

The Biosphere Reserve Programme aims to conserve biological diversity, including the genetic diversity of cultivated crops, and domesticated and wild animals. It also aims to study the natural ecosystems and comparative studies on man-modified ecosystems. In order to conserve overall biological diversity of Earth, it would be desirable to constitute at least one or two biosphere reserves in each of the biogeographic provinces. More than 100 nations have already set apart 482 such reserves, since the UNESCO's Man and the Biosphere (MAB) programme was initiated in 1974.

The hot desert in north-western region is a unique and the only habitat of its type in the Indian subcontinent. The Ministry of Environment and Forests constituted a working group in 1988 to draw a project document on the Thar Desert Biosphere Reserve (Anon. 1988). The objective of the Biosphere Reserve (BR) was oriented in such a way that BRs were units wherein the biological, socio-economic and cultural elements are integrated together. The main emphasis of this concept is the need for conserving ecosystem capable of being restored to natural condition.

In this study we identified 16 unprotected areas in Bikaner, Jodhpur, Jaisalmer, Barmer, Nagur, Jalor and Sanchor districts with fairly large areas ranging from 5-7,091 km^2. Each area supports mammals as well as several species of plants. These areas represent excellent animal-plant communities and traditional landuse practices, which together support a large number of microorganisms, small grasses and perennial herbs, which constitute the Thar ecosystem.

The main emphasis of developing a Biosphere Reserve was given to Desert National Park (DNP). Vegetation as well as boundary mapping of DNP was done to visualize the landuse/cover in and around it. All the villages in and around the Park were surveyed and mapped on GIS domain.

This region includes the largest known populations of endangered species such as the Great Indian Bustard *Ardeotis nigriceps*, and the Chinkara *Gazella bennettii* and many lesser-known groups of plants and animals. The total area of propsed biosphere reserve is around 4,648 km^2 of which 76.36 km^2 will be as core zone, excluding four new areas, which are marked on the map, and 1,486 km^2 transition zone. The existing area of the DNP is 3,162 km^2 which needs to be further extended upto 5 km from the park boundary. This extra (1,486 km^2) area will be use as a transition zone.

In order to protect and enhance the biodiversity and cultural diversity of the Thar Desert, we also propose the concept of Greater Thar Desert (Marusthali) Biosphere Reserve, which should include the DNP, Tal Chhaper, Diyatra and other biodiversity rich areas. We recommend that in the Greater Thar Desert (Marusthali) Biosphere Reserve, Community Conservation Areas (e.g. Guda-Vishnonian, Dhawa-Doli, Khichan etc.) and Conservation Reserves (e.g. Jakharda) should also be included.

CHAPTER 1

INTRODUCTION

The Biosphere Reserve Programme is an extended strategy for the conservation of representative ecosystems on a landscape level. It could either be in the form of a national park or a nature reserve, and the surrounding areas that impact a protected area. This Programme emphasizes the need for the conservation of the whole environment, including man and his traditional activities.

The concept of establishing Biosphere Reserves (BRs) is the major aim of the UNESCO'S Man and Biosphere (MAB) programme initiated in 1974. By now a network of about 482 Biosphere Reserves has been developed in more than 100 countries (UNESCO-MAB). The Indian Biosphere Reserve Programme, initiated in 1979, intends to preserve representative biotic communities in 10 potential biogeographical regions of country. The Thar Desert has been included as one of the 10 biomes (Rodgers *et. al* 2000).

The hot desert in the north-western region is a unique and the only habitat of its type in the Indian subcontinent. The Ministry of Environment and Forests constituted a working group in 1988 to draw a project document on the Thar Desert Biosphere Reserve (Anon. 1988). The objective of Biosphere Reserves was to integrate biological, socio-economic and cultural elements. The main emphasis of this concept was the need for conserving ecosystems capable of being restored to natural conditions. Being the most populated desert in the world, undisturbed large areas are not available in the Indian Thar Desert. Therefore, the Working Group recommended upgrading the status of the Desert National Park (DNP) as the Thar Desert Biosphere Reserve (Anon. 1988).

Despite strong recommendations of this Working Group, not much action has taken place to upgrade the DNP into a Biosphere Reserve. Moreover, even the exact south-west boundary of this important Park has not been properly defined. Also not much has been done to inventorize and compile data on biodiversity, landuse, human and livestock

The Thar Desert harbours unique flora and fauna

populations and future development needs. Realizing the importance of the biogeography of the area, a research project entitled "Development of Desert National Park as a Biosphere Reserve" based on compilation of resource inventory was undertaken during 2004-2005 by the BNHS and WII, with support from MoEF, Government of India.

In the present publication, the results of these surveys, together with information available from earlier surveys are compiled and presented in the form of a report. As general introduction, a brief description of the location, area, topography, climate, geology, soil, vegetation, and fauna has been given in this report.

The chapters follow the pattern given by the Man and Biosphere Committee of the MoEF for writing such reports (MoEF 1999).

CHARACTERISTICS OF A BIOSPHERE RESERVE

1. Biosphere Reserves (BRs) are protected areas of lands and/or coastal environments wherein people are an integral component of the system.
2. The network of BRs includes significant examples of biomes throughout the world.
3. Each BR includes one or more of the following categories.
   i) BRs are representative examples of natural biomes.
   ii) BRs conserve unique communities of biodiversity or areas with unusual natural features of exceptional interest. It is recognized that these representative areas might also contain unique features of landscapes, ecosystems and genetic variation.
   iii) BRs have examples of harmonious landscapes from traditional patterns of landuse.
   iv) BRs have examples of modified or degraded ecosystems capable of being restored to natural condition.
   v) BRs generally have non-manipulative core areas, in combination with areas in which baseline data, experimental and manipulative research, education and training is carried out. Where the core areas are not contiguous, they can be associated in a cluster.
4. BRs provide opportunity for monitoring, research, education and training on natural and managed ecosystems.
5. A BR must have adequate long-term legal protection.
6. In some cases, BRs coincide with or incorporate, existing or proposed protected areas, such as national parks and sanctuaries.
7. Each BR exemplifies voluntary cooperation to conserve and use resources for the well-being of people at local, national, regional and global levels.
8. It is a system where planners, scientists, managers and local people participate in evolving integrated programmes to manage land and water to meet human needs besides conserving natural process and ecological resources through sustainable resource use that does not reduce the future use potential of the resource. Maintenance of long-term health of representative ecosystems is the ultimate goal of BRs, which will ensure survival of the future human generations.

Sand dunes seems lifeless but supports many species of reptiles and insects

Functions of Biosphere Reserve

Conservation

- To ensure the conservation of landscapes, ecosystems, species and genetic variation.
- To encourage the traditional resource use system
- To understand the patterns and process of functioning of ecosystems.

- To monitor the natural and human-caused changes on spatial and temporal scales.

Development

- To promote, at the local level, economic development that is culturally, socially and ecologically sustainable.
- To develop the strategies leading to improvement and management of natural resources.

Logistics

- To provide support for research, monitoring, education and information exchange related to local, national and global issues of conservation and development.
- Sharing of knowledge generated by research through site-specific training and education.
- Development of community spirit in the management of natural resources.

Structure of Biosphere Reserve

In order to undertake activities relating to biodiversity conservation and development of sustainable management aspect, BRs are demarcated into three inter-related zones (MoEF 1999). (i) Natural or core zone (ii) Manipulation or buffer zone (iii) Transition or restoration zone. In general, core zone and buffer zone are recognized for most of the BRs in India. Ideally all the components of a BR must belong to the same biome (MoEF, 1999).

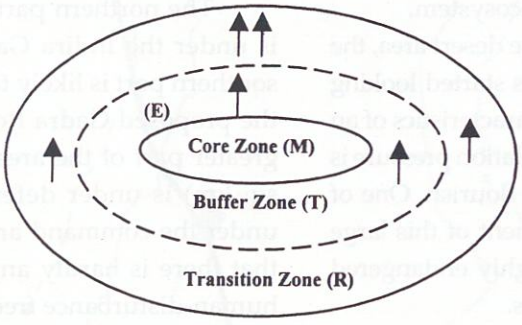


Fig. 1.1: Zonation of a Biosphere Reserve

Concept of Greater Thar Desert (Marusthali) Biosphere Reserve

In order to protect and enhance the biodiversity and cultural diversity of the Thar Desert, we propose the concept of Greater Thar Desert (Marusthali) Biosphere Reserve, which should include the DNP, Tal Chhaper, Diyatra and other biodiversity rich areas. We recommend that in the Greater Thar Desert (Marusthali) Biosphere Reserve, Community Conservation Areas (e.g. Guda-Vishnonian, Dhawa-Doli, Khichan etc.) and Conservation Reserves (e.g. Jakharda) should also be included.

The national park and wildlife sanctuaries within the Greater Thar Desert (Marusthali) Biosphere Reserve could receive MoEF and GOI support through the Central Scheme (Assistance to National Park and Sanctuaries) and the Biosphere Reserve area from the GOI's Biosphere Reserve Programme. However, it is essential for the Rajasthan Government to urgently finalise the Greater Thar Desert (Marusthali) Bisophere Reserve proposal.

With the creation of the Greater Thar Desert (Marusthali) Biosphere Reserve, a new management structure will become essential. It is suggested that the MoEF/GOI and the Rajasthan Government to consider creating the Greater Thar Desert (Marusthali) Biosphere Reserve Management Authority which may be called as Marusthali Area Management Authority (MAMA) with a Chief Conservator of Forest level officer as the Chief Executive Officer (CEO) and officials from Forest, Animal Husbandry, Agriculture, Revenue, Mines and other stake holder agencies being appointed in this Authority. Such management models are already in existence for other biosphere reserves in the country. For example, the Gulf of Mannar Biosphere Reserve in Tamil Nadu is being managed by the Gulf of Mannar Biosphere Reserve Trust. Another example is the Chilika Development Authority - a Ramsar Site in Orissa.

1.1 WHY THE PROPOSED SITE WAS CHOSEN

The Thar Desert of India and Pakistan is one of the smallest deserts in the world. However, as far as diversity, both cultural and natural, is concerned it is very rich. Several floral and faunal species have adapted themselves to survive in the harsh conditions of the Desert, and Man, through his long association with the desert, has evolved several cultural aspects, not seen in other parts of India.

The Thar is the most populated deserts in the world (Rahmani 1997a). During the last three or four decades, it has seen tremendous growth in human and animal populations, and intensive development activities, not ecologically oriented (Appendices: 6 and 7). The Thar is undergoing rapid transformation, which will have long-term and sometimes non-reversal impact on the fragile ecology of this unique ecosystem.

In order to protect representative desert area, the Government of India in the late 1970s started looking for an area that would have all the characteristics of an Indian desert and where human population pressure is minimum and wildlife is allowed to flourish. One of the main purposes for the establishment of this large protected area was to protect the highly endangered Great Indian Bustard *Ardeotis nigriceps*.

As the Thar desert is thickly populated (Appendix: 6), finding a suitable and large area was not easy. Moreover, there are many geo-political and defence considerations before an area was declared a park (Rahmani 1989). The major considerations were:

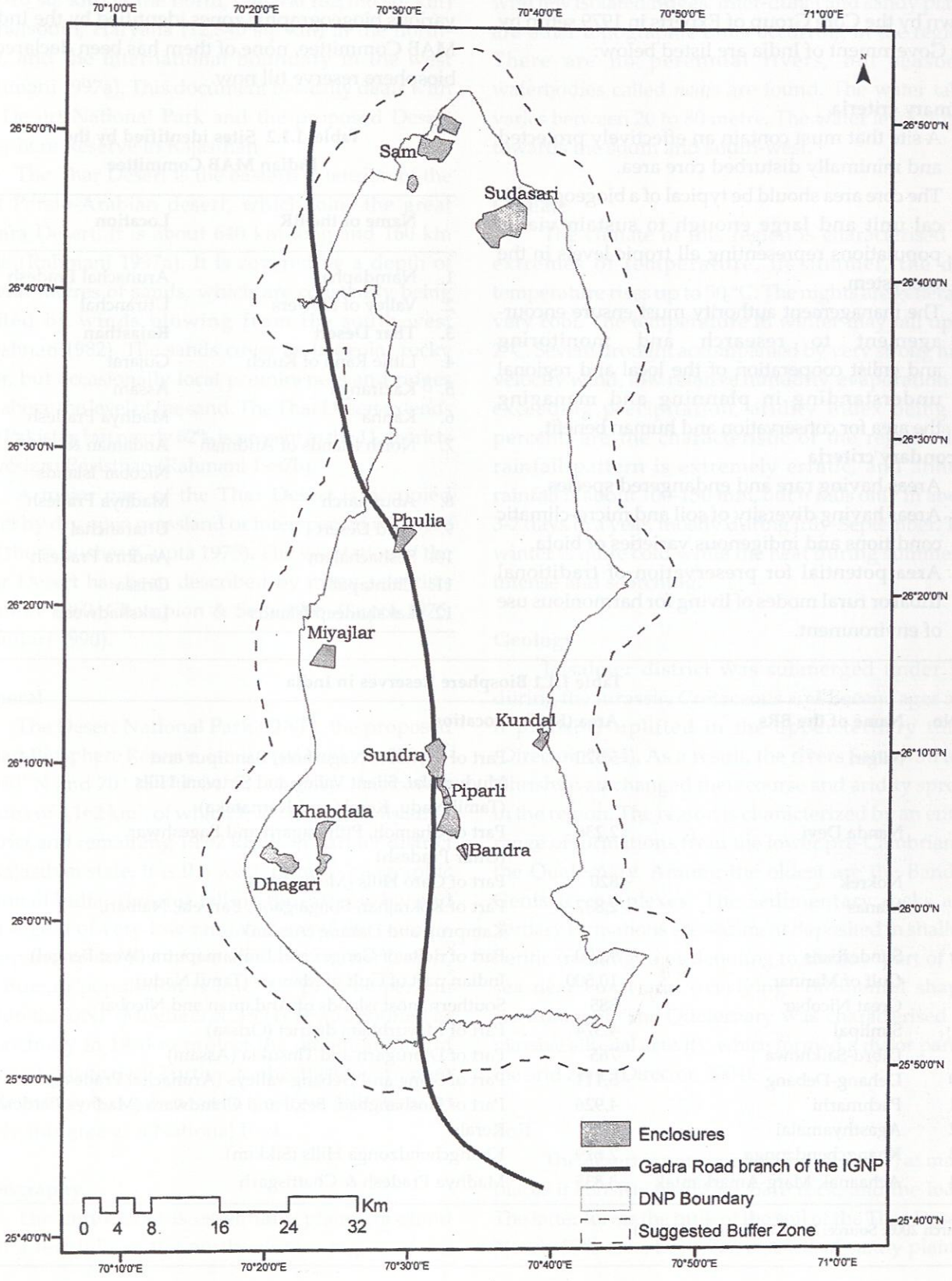
a) The area should be away from the command area of the Indira Gandhi Nahar Project (IGNP).
b) It should be away from the international boundary.
c) It should not fall in the military exercise zone.
d) Human population should be very low so minimum number of people are affected.
e) It should have all the features of the Thar desert, and
f) It should have potentials to build up wildlife populations.

After many years of deliberations, a large area of about 3,162 sq. km in Jaisalmer and Barmer districts was selected in 1980 to be developed as the Desert Wildlife Sanctuary. It was demarcated and notified in 1980. There was a plan to upgrade this sanctuary into a national park, hence its popular name Desert National Park (DNP). Even after 25 years of its establishment this has not happened, because according to the rules of the Wildlife (Protection) Act, 1972, a park should not have any private human habitation, but DNP has more than 70 villages and many settlements (*dhanis*). As these villages have been there for hundreds of years and are a part of the desert ecosystem, the present view is that they should not be disturbed and allowed to remain. Instead DNP should be developed as a Biosphere Reserve where man and desert can co-exist and flourish together.

The northern part of the Desert National Park is under the Indira Gandhi Canal (IGNP) and the southern part is likely to fall in the command area of the proposed Gadra Road Tributary of the IGNP. A greater part of the area in Jaisalmer district (34,000 sq. km) is under defence establishment and now under the command area of the IGNP. The result is that there is hardly any area left for establishing a human-disturbance free conservation unit. About 30 km north of the DNP boundary is Jaisalmer city, while in the south of the Park boundary is the Gadra Road. East of the Park boundary is Gadra-Harsani Satto road and in the west is the international boundary with Pakistan. The area of DNP (3,162 sq. km) was notified as a Desert Wildlife Sanctuary in 1980. Therefore, DNP is the only area, which still has landscape, vegetation, traditional landuse and very low human population, and is large enough to be an effective conservation unit.

The Government of India's Man & Biosphere Reserve Committee in its 9th meeting held 7th August, 2001 had strongly reiterated that the DNP should become a Biosphere Reserve. There are 14 BRs (Table 1.1.1) in India but none of them are located in the Thar Desert of Rajasthan. Therefore, it becomes imperative to develop the Desert National Park as a Biosphere Reserve.

Fig. 1.1.1: Planned route of the Gadra Road branch of the IGNP
(Based on available information)



Why the proposed site was chosen

The criteria for selection of sites for BRs as recommended by UNESCO MAB Programme and laid down by the Core Group of Experts in 1979 setup by the Government of India are listed below:

Primary criteria

- A site that must contain an effectively protected and minimally disturbed core area.
- The core area should be typical of a biogeographical unit and large enough to sustain viable populations representing all tropic levels in the ecosystem.
- The management authority must ensure encouragement to research and monitoring and enlist cooperation of the local and regional understanding in planning and managing the area for conservation and human benefit.

Secondary criteria

- Areas having rare and endangered species.
- Areas having diversity of soil and micro-climatic conditions and indigenous varieties of biota.
- Area potential for preservation of traditional tribal or rural modes of living for harmonious use of environment.

The Desert National Park (DNP) fulfils all the above mentioned criteria for being declared as a Biosphere Reserve (BP). However, of the 12 potential sites in various biogeographic zones identified by the Indian MAB Committee, none of them has been declared as biosphere reserve till now.

Table: 1.1.2 Sites identified by the Indian MAB Committee

	Name of the BR	Location
1.	Namdapha	Arunachal Pradesh
2.	Valley of Flowers	Uttranchal
3.	**Thar Desert**	**Rajasthan**
4.	Little Rann of Kutch	Gujarat
5.	Kaziranga	Assam
6.	Kanha	Madhya Pradesh
7.	North islands of Andman	Andaman & Nicobar Islands
8.	Abujmarch	Madhya Pradesh
9.	Cold Desert	Uttaranchal
10.	Seshachalam	Andhra Pradesh
11.	Chintapalli	Orissa
12.	Lakshadeep Islands	Lakshadweep

Table 1.1.1 Biosphere Reserves in India

S. No	Name of the BRs	Area (Km^2)	Location
1	Nilgiri	5,520	Part of Wynaad, Nagarhole, Bandipur and Mudumalai, Silent Valley and Siruvani Hills (Tamil Nadu, Kerala and Karnataka)
2	Nanda Devi	2,236	Part of Chamoli, Pithoragarh and Bageshwar (Uttar Pradesh)
3	Nokrek	820	Part of Garo Hills (Meghalaya)
4	Manas	2,837	Part of Kokrajhar, Bongaigaon, Barpeta, Nalbari, Kamprup and Darang (Assam)
5	Sunderbans	9,630	Part of delta of Ganges and Brahamaputra (West Bengal)
6	Gulf of Mannar	10,500	Indian part of Gulf of Mannar (Tamil Nadu)
7	Great Nicobar	885	Southern most islands of Andaman and Nicobar
8	Simlipal	4,374	Part of Mayurbhanj district (Orissa)
9	Dibru-Saikhowa	765	Part of Dibrugarh and Tinsukia (Assam)
10	Dehang-Debang	5,111	Part of Siang and Debang valleys (Arunachal Pradesh)
11	Pachmarhi	4,926	Part of Hoshangbad, Betul and Chindwara (Madhya Pardesh)
12	Agasthyamalai	1,701	Kerala
13	Khangchendzonga	2,619	Khangchendzonga Hills (Sikkim)
14	Achaanak Marg-Amarkantak	3,835	Madhya Pradesh & Chattisgarh

(March 2005: Source: India 2006 Annual book)

1.2 AN OVERVIEW OF THE PROPOSED SITE

The Thar Desert occupies nearly 9% of India's geographical area and covers 208,751 sq. km in Rajasthan alone. The Thar desert is bound by Punjab (14,510 sq. km) in the north, Gujarat (62,180 sq. km) in the south, Haryana (12,840 sq. km) in the north-east, and the international boundary in the west (Rahmani 1997a). This document basically deals with the Desert National Park and the proposed Desert Biosphere Reserve in Rajasthan.

The Thar Desert is the eastern extension of the vast Persio-Arabian desert, which joins the great Sahara Desert. It is about 640 km long and 160 km wide (Rahmani 1997a). It is covered by a depth of several metres of sands, which are constantly being shifted by winds blowing from the south-west (Krishnan 1982). The sands cover an irregular rocky floor, but occasionally local prominences and ridges rise above the level of the sand. The Thar Desert extends into Pakistan but nearly 62% is present in the 11 districts of western Rajasthan (Rahmani 1997b).

A major part of the Thar Desert is occupied either by dry open grassland or interspersed with tree and thorn bushes (Gupta 1975). The vegetation of the Thar Desert has been described by many scientists (Mathur 1960, Champion & Seth 1968, Gupta 1975, Bhandari 1990).

General

The Desert National Park (DNP), the proposed Desert Biosphere Reserve, is situated between 25° 51'-26° 52' N and 70° 18'-70° 34' E, (Map A). This covers an area of 3,162 km^2, of which 1,900 km^2 is in Jaisalmer district and remaining 1,262 km^2 is in Barmer district of Rajasthan state. It is the western most geographic region of India. The area falls in the extreme hot and arid region of very low rainfall zone of the country. Compared to the rest of the areas of the Thar Desert, the human population is low, 4-5 persons per km within the DNP (Moghe *et al.* 1994). It was notified as a Sanctuary in 1980 to protect the unique flora and fauna of this region. Further to this the Government of Rajasthan has taken some positive initiatives to notify this area as a National Park.

Topography

The entire area is essentially plain grassland with a few hills in the north-western region of the DNP. The entire zone is dominated by sand hills and dunes. These dunes at places rise up to 316 m elevation. At places, topography is gravelly and stony with few isolated ridges. Inter-dunal and sandy plains are other topographic units occurring in the region. There are no perennial rivers, but seasonal waterbodies called *nadis* are found. The water table varies between 20 to 80 metre. The water level slopes towards the south and south-west.

Climate

The climate of this region is characterised by extremes of temperature. In summer, the day temperature rises up to 50 °C. The nights are generally very cool. The temperature in winter may fall up to 2°C. Severe drought accompanied by very strong high velocity wind, low relative humidity, evaporation far exceeding precipitation, aridity index being 80 percent, are the characteristic of the region. The rainfall pattern is extremely erratic, and annual rainfall is about 100-150 mm, but it falls only in about 3-7 days in a year, mostly during July-September. The winter is quite cold while the heat during summer is intense and scorching.

Geology

Jaisalmer district was submerged under sea during the Jurassic, Cretaceous and Eocene ages and it probably uplifted in the upper tertiary times (Director, 2004). As a result, the rivers Saraswati and Dhrishtavati changed their course and aridity spread in the region. The region is characterized by an entire range of formations from the lower pre-Cambrian to the Quaternary. Among the oldest are the Banded Genissic complexes. The sedimentary rocks and Tertiary formations are sediment deposited in shallow neritic (relating to or denoting to shallow part of the sea near coast and overlying continental shape) environment. The Quaternary was characterised by massive alluvial activity, which formed a major part of the arid zone (Director, 2004).

Soil

The desert is not necessarily "all sand", at many places it consists of gravel, bare rock, and the loam. The latter forms the bulk of the soil of the Thar Desert. Nearly 57% area, however, consists of sandy plains.

The soil of Rajasthan are complex and highly variable, reflecting a variety of differing parent materials, physiographic land features, range of distribution of rainfall and its effects. However, broadly the soils can be put into five major groups, based on the basic fabric of soil i.e. soil texture which governs its many properties. They are, (1) sandy soil, (2) sandy loam, (3) loam, (4) clay loam, (5) shallow rocky and hilly soils (Moghe *et al.* 1994).

Vegetation

Ecologically, the vegetation of the major part of arid region falls under the category of thorn forest type (Champion & Seth 1968). However, the natural vegetation cover has got greatly transformed due to intense biotic influence. Much of the area of Thar Desert has come under cultivation, even if this cultivation is possible only during monsoon. Even in the remaining areas, the density of natural cover is much less than that permitted by the soil-climate condition, thanks to intensive biotic pressures. The flora of the Thar Desert has been well described by Bhandari (1990). Khejri *Prosopis cineraria* is commonly found and religiously protected by the locals. A lot of shrubs and grasses are also found growing in fallow as well as croplands and of course in grazing lands.

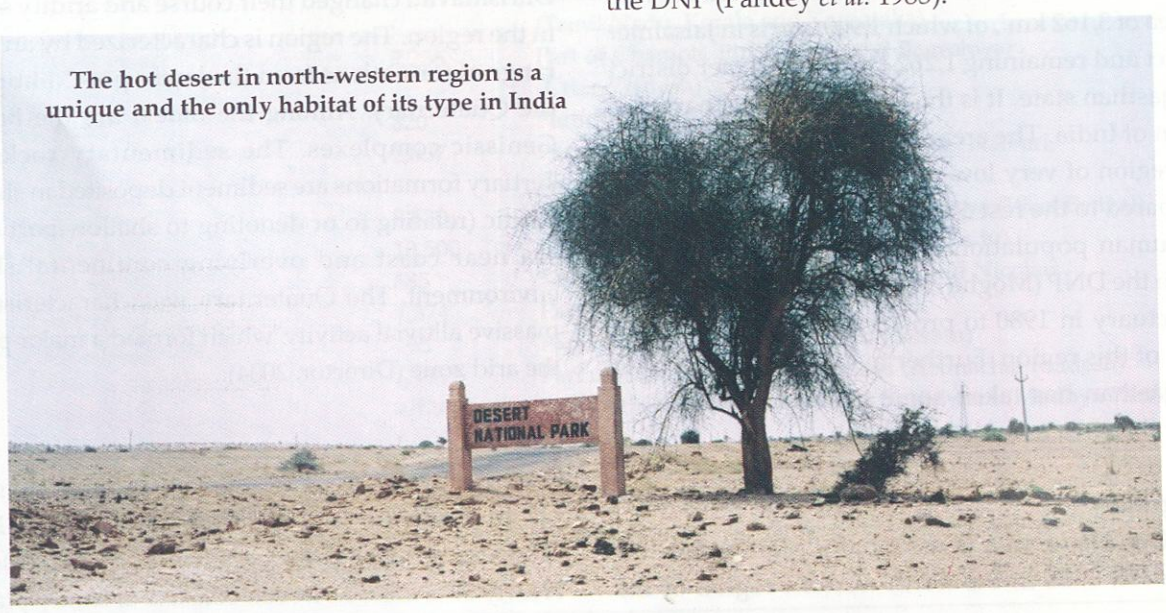
The forests are almost negligible in the desert, comprising about (1.8%) of the total desert area (Baqri & Kankane 2001). The stabilized dunes and sandy plains are generally covered with *Capparis decidua*, *Calotropis procera*, *Acacia senegal*, *Prosopis cineraria*, *Aerva javanica*, *Aristida* spp. *Zizyphus nummularia*, *Crotalaria burhia*, *Leptedenia* spp., *Tephrosia* spp. Two creepers *Citrullus* and *Cucumis*, are commonly found in sandy plains. In the rocky areas, the following species of trees and shrubs are predominant: *Acacia senegal*, *Calotropis procera*, *Euphorbia cauducifolia* and *Capparis decidua*.

On both the sides of the Indira Gandhi Canal, *Acacia nilotica*, *Prosopis cineraria*, *Zizyphus* spp. and *Dalbergia sisso* have been planted.

The following plant species are of economic importance in the Thar: *Anogeissus pendula*, *Acacia catechu*, *A. senegal*, *A. nilotica*, *Prosopis cineraria*, *P. juliflora*, *Capparis decidua*, *Zizyphus nummularia*, *Salvadora persica*, *S. oleoides*, *Ephedra foliata*, *Calotropis procera*, *Calligonum polygonoides* and *Haloxylon salicornicum* (Bhandari 1990; Moghe *et al.* 1994).

The grassland of the Thar Desert come under *Lasiurus-Cenchrus-Dichanthium* type, i.e., L. *sindicus*, C. *biflorus* and D. *annulatum*. Among these, *Lasiurus sindicus* is considered to be very important (Bhandari 1990; Moghe *et al.* 1994).

The vegetation of Desert National Park is quite sparse with limited number of species. It can be described mainly into the following types based on landforms and habitat (Maps B & C) *viz*, open grassland, thorny bushes, plantation and dunes. So far, 168 species of plants (Appendix 1) belonging to 46 families have been specifically reported only from the DNP (Pandey *et al.* 1985).



The hot desert in north-western region is a unique and the only habitat of its type in India

1.3 BIO-GEOGRAPHY, FLORA AND FAUNA

The Thar Desert occupies nearly 9% of India's geographical area and covers 2,08,751 sq. km in Rajasthan alone. To the north, it extends into Punjab in the Ferozpur, Sangrur and Bhatinda districts (14,510 sq. km), and in the northeast, it joins the desert areas of Haryana (12,840 sq. km) in parts of the Mahendragarh and Hissar districts. The Aravalli mountains, starting from Champaner in North Gujarat and extending up to Delhi form the eastern boundary of the Thar. In the west are the Thar-Parkar, Cholistan and Thal deserts of Pakistan. In the south, it extends into Gujarat, mainly in the Kutchch, Mehsana and Banaskantha districts, and to some extent in the Saurasthra region. The total desert area in Gujarat is about 62,180 sq. km or 20% of the Thar Desert (Rahmani 1997a).

Depending upon the rainfall and edaphic factors, the Thar Desert can be divided into four regions: (i) the Luni basin comprising Pali, Jalore, the south-eastern part of Barmer, eastern part of Jodhpur, western part of Ajmer, Sirohi, and the southern part of Nagaur district; (ii) the northern drainage zone, comprising Sikar, Jhunjhunu and northern Naguar; (iii) the agriculturally rich district of Shri Ganganagar adjoining Punjab and Haryana; and (iv) the true desert or *Marusthali* consisting of entire Jaisalmer, northern Barmer, western parts of Jodhpur, Bikaner and Churu districts.

The Thar Desert is one of the smallest deserts in the world, but it exhibits a wide variety of habitats and biodiversity. It is the most thickly populated deserts in the world with an average density of 83 persons per sq. km, whereas, in other deserts, the average is only seven persons per sq. km (Baqri and Kankane 2001). It is considered an important desert in terms of its location where Palaearctic, Oriental and Saharan elements of biodiversity are found.

Flora

The vegetation of the major part of arid region falls under the category of thorn forest type (Champion and Seth 1968). However, the natural vegetation cover has been transformed due to extended and intense biotic pressure. A large proportion of the Thar Desert is under monsoonal cultivation due to which natural vegetation is removed from the crop areas. Even where cultivation is not done, the density of natural cover is low due to soil and climate conditions.

***Prosopis cineraria*-the state tree of Rajasthan**

The vegetation has since been grouped here as mixed xeromorphic wooded desert. The dominant tree species are *Prosopis cineraria* and *Salvadora oleoides*. The common associates of these trees are *Calotropis procera, Mimosa hamata, Acacia* spp., *Haloxylon salicornicum, Crotalaria burhia, Lasiurus sindicus, Cenchrus biflorus, Cyperus rotundus, Indigofera cordifolia, Aerva persica*. On the dunes the vegetation mostly consists of *Calligonum polygonoides, Panicum turgidum, Lasiurus sindicus,* and *Cenchrus biflorus* (Bhandari 1990).

Overgrazing is a major problem of DNP

Fauna

Mammals

Among the large mammals, Chinkara *Gazella bennetti* is the most common. Desert Fox *Vulpes vulpes pusilla* and, in some areas, the Indian Fox *Vulpes bengalensis* are the major natural predators. The Desert Cat *Felis silvestris* is also found but is difficult to sight.

Desert Hare *Lepus nigricollis dayanus*, a subspecies of the Black-naped Hare, and the Long-eared Hedgehog *Hemiechinus auritus* are among smaller denizens of the desert. About 60 species of mammals (Appendix 2), 8 species of amphibians and 51 species of reptiles are reported from the Thar Desert (Tyagi & Baqri 2005).

The mammalian fauna was studied by a number of scientists (e.g. Prakash 1956 a,b; 1992, 1994; Alfred & Agarwal 1996). Hedgehogs and shrew were studied by Krishna & Prakash (1955a, 1955b) and Rana & Prakash (1979), Chiroptera by Prakash (1963) and Sinha (1980), and reproduction biology of the Indian desert hare was studied by Prakash & Taneja (1969). Mohnot and Srivastava (1996) and Mohnot's students have extensively studied primates, mainly Hanuman Langur, in and around Jodhpur. Small carnivores were studied by Kankane (1996). Rahmani (1990), Rahmani and Sankaran (1991) and Dookia (2002) have studied Chinkara or the Indian Gazelle.

Birds

The Desert National Park is perhaps one of the most important sites for the long-term survival of the globally threatened Great Indian Bustard. In the 1980s, there could have been between 200 to 400 Great Indian Bustards in and around this sprawling Park, but now the number has gone down to less than 100. However, the bustard still breeds in many parts of the Park, especially in Sudasari, Sam and Miyajlar enclosures. Even now, if poaching and habitat degradation are stopped, increase in the number of bustards is possible.

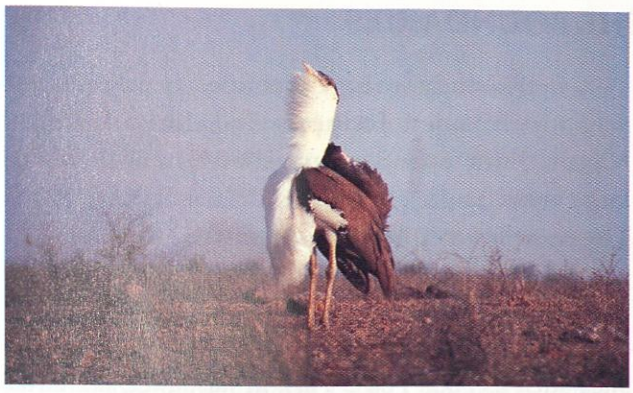
A rare and elusive species, Desert Fox *Vulpes vulpes pusilla*

Other birds of conservation interest are the two *Gyps* species of vultures – the Oriental White-backed *Gyps bengalensis* and Long-billed *Gyps indicus*. Both these vultures have drastically declined during the last decade mainly due to poisoning by the veterinary drug, diclofenac (Oakas *et al.* 2004). Nevertheless, small breeding populations of the Oriental White-backed Vulture are still seen in some parts of the Park. Other species of vulture that is still common is the Egyptian Vulture *Neophron percnopterus*. During winter, Eurasian Griffon *Gyps fulvus* and Cinererous Vulture *Aegypius monachus* are also found. The Red-headed or King Vulture *Sarcogyps calvus* is widespread, but generally seen solitary or in twos or threes. Two nests were found in February near Sudasari inside the Park (Rahmani, 1996a, 1997a).

The Park is also important for the vulnerable Stoliczka's Bushchat *Saxicola macrorhyncha*. It has been seen in Sudasari, Sam and Nibha areas of the Park (Rahmani, 1997c).

There are stray records of Green Munia *Amandava formosa* (Rahmani, 1996c). Among the Near Threatened species, the most notable is the MacQueen's or Houbara Bustard *Chlamydotis macqueeni* (= *undulata*). Although population estimates for the Park are difficult to make, overall in the Thar Desert, Rahmani (1998) estimated a crude density of 0.31 Houbara/km² based on actual sightings and 1.05 Houbara/km² based on sightings and Houbara tracks. Houbara are regularly found in small groups of 3-5 birds in winter in Sudasari and Sam enclosures.

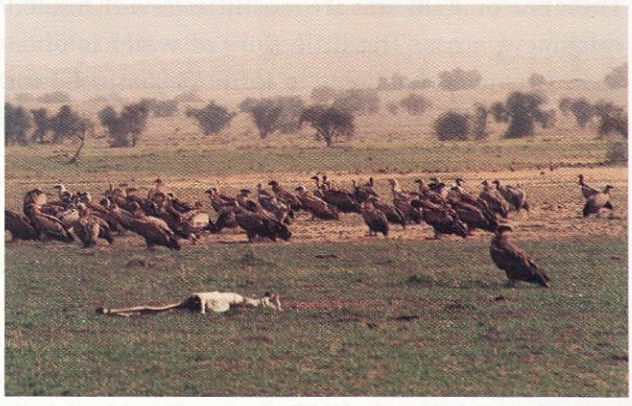
This Park represents the typical flora and fauna of the Indian Thar Desert. The Thar Desert is a part of the much larger Saharo-Sindian Desert. BirdLife International (undated) has identified it as Biome-13 and has listed 11 bird species representing this biome. Including the Great Indian Bustard and Stoliczka's Buchchat, six more species of this Biome have been found in the DNP. The Greater Hoopoe Lark *Alaemon alaudipes* probably breeds here, as its display was seen just outside the Park in July (Rahmani, 1997a). Another interesting bird found breeding was the Cream-coloured Courser *Cursorius cursor* (Rahmani and Manakadan, 1989). So far, more than 100 bird species (Appendix 3) have been reported from the DNP (Rahmani, 1997a).



The endangered GIB is a fast disappearing species in the Thar Desert

The Cream-coloured or Desert Courser: Thar Desert is the eastern-most limit of this widely distributed species of the Middle East and North Africa

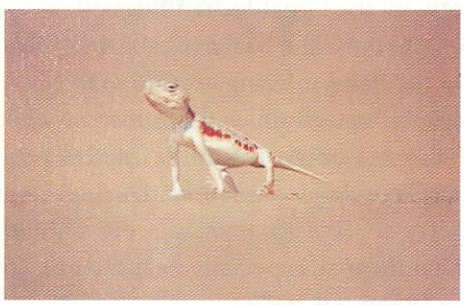
The Red-headed vulture: A rare sighting in DNP



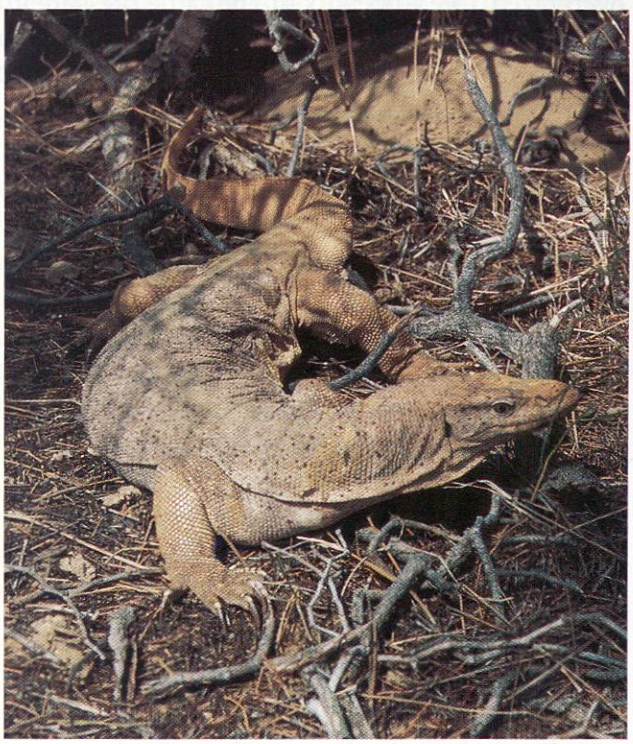
Gyps species can still be found in the Thar Desert but not in their former numbers

Reptiles

The Thar Desert is rich in herpetofauna. Out of 456 species of reptiles from India, 51 species are known from the Thar (Baqri & Kankane 2001). The following species are abundantly found: Lizards *Stenodactylus orientalis, Cyrotodactylus kachhensis,* C. *watsoni, Hemidactylus brooki, Agama agilis, Ophisops jerdoni, Uromastix hardwickii, Varanus bengalensis.* Snakes; *Eryx johni,* E. *conicus, Echis carinatus, Sphalerosophis diadema, Naja naja, Psammophis leithi.* Krishna and Dave (1960) and Krishna (1975) have provided a complete account of reptiles of the Thar Desert.



A dune dweller *Bufoniceps* sp.



The Desert Monitor Lizard can still be found in remote part of the Thar Desert

1.4 THE LAND AND THE BOUNDARIES

The entire area of the Desert National Park is barren and dreary with a few hills and many sand dunes. The Park forms mostly a vast sandy and undulating terrain. It slopes towards the south and the northwest. From Khuri to Sam, the topography is gravel, rocky with the few isolated ridges. Interdune and sandy plains are other topographic feature. The interdunal depressions originate mostly by wind force. There is no perennial river in the Park. Some stream are found during good monsoon years, but they soon die out due to excessive evaporation. These seasonal streams are mostly *nadis* with limited catchment areas. The little flow of water is often locked by the inhabitants to form *Khadins* used for cultivation or for drinking (Anon. 1988). *Khadin* is an old water harvesting method by contour bunding around crop fields in the valley bottom. During good monsoon years, water is left standing for a few weeks or months, thus recharging the ground water as well as moistening the soil. Winter crop is grown in such crop fields (Rahmani, 1997a).

The area of the Park does not support enough natural vegetation to fulfill the needs of livestock present in the area due to which the land is overgrazed. (see Appendix 4) The cattle pressure in certain parts of the Desert National Park is high, especially near Sam village and in the northern part of the DNP (see Map F).

In addition to the Park area, there are four satellite areas that have been fenced long back by Forest Department to provide protection to the wildlife of the region. These satellite areas are located outside the DNP (Table: 1.4.1).

The satellite areas, Rasla, and Ramdevra enclosures are extremely important for the conservation of the Great Indian Bustard and should be taken over in the over-all development of Biosphere Reserve. More satellite enclosures should be developed, away from the command areas of the IGNP.

Table 1.4.1: Satellite area outside the DNP

Satellite enclosures	Area
Ramdevera	875 ha
Ujla	250 ha
Rasala	500 ha
Akal	400 ha

In this study we have identified 16 unprotected areas in Bikaner, Jodhpur, Jaisalmer, Barmer, Nagur, Jalor and Sanchor districts with fairly large areas ranging from 5 to 7091 km^2 (Table 1.4.2). These areas represent excellent animal-plant communities and traditional land use practices.

Among the various sites protected by the people and the state forest department, we found that a few sites such as Akal Fossil Park in Jaisalmer, Jakharda in Barmer, Gajner and Diyatra in Bikaner and Tal Chapper in Churu district are extremely important. These areas should be included in the Greater Thar Desert (Marusthali) Biosphere Reserve for overall protection of the desert flora and fauna. Therefore, there is a need to prepare a proposal for establishing such a Biosphere Reserve, that encompases all the conservation areas, wildlife sanctuaries as well as the Desert National Park.

Diyatra in Bikaner district

Diyatra Closed Area in Bikaner distirict is an important site for the Great Indian Bustard in the Thar Desert (Rahmani 1997a). In the early 1980s, there were 30-50 bustards in this area, but due to intensification of agriculture, over-grazing and poaching, the number is perhaps halved. The site used to be the hunting reserve of the Maharaja of Bikaner. The site is situated approximately 65 km southwest of Bikaner along the National Highway to Jaisalmer. Various departments of the Rajasthan Government have established pasture enclosures at various periods of time, but most of them are neglected and over-run by livestock. If properly protected, these grassland enclosures would have provided undisturbed breeding sites to the Great Indian Bustard. However, now these enclosures are mainly used by Chinkara *Gazella bennetti*, and Nilgai *Boselaphus tragocamelus*, and rarely by the Great Indian Bustard.

Besides the Great Indian Bustard, Diyatra Closed Area is a regular wintering ground of the Houbara or MacQueen's Bustard *Chlamydotis macqueeni*. It is also one of the major strongholds of the Stoliczka's Bushchat *Saxicola macrorhyncha*. During a survey in 1994, thirty six S. *macrorhyncha* were sighted in one day in Diyatra area, especially near Hadda, Tokla and Niagaon (Rahmani 1997c).

Earlier, a lake near Diyatra village used to be an important watering spot for the Imperial or Black-bellied Sandgrouse *Pterocles orientalis*. The Maharaja of Bikaner had built a hunting lodge beside the lake. This rainfed shallow lake is still present, but the number of Imperial Sandgrouse has drastically decreased; some may have moved away as they get water in many other places due to irrigation by the Indira Gandhi Nahar Project (Rahmani, 1997d).

In winter, vast flocks of Bimaculated Lark *Melanocorypha bimaculata*, Greater Short-toed Lark *Calandrella brachydactyla*, Lesser Short-toed Lark *C. rufescens* and some Hume's Short-toed Lark *C. acutirostris* are seen. In the extant grasslands, Short-eared Owl *Asio flammeus* are often seen, sometimes 15-20 roosting in few square metres area. The Near Threatened Cinereous Vulture *Aegypius monachus* is frequently seen, along with other vultures.

Based on its importance for the protection of the Great Indian Bustard and other rare bird species, Diyatra has been recognized as an Important Bird Area (Islam and Rahmani 2004).

Other fauna of Diyatra includes Chinkara, Red Fox *Vulpes vulpes*, Desert Monitor *Varanus griseus*, and Spiny-tailed Lizard. Nilgai or Bluebull which was not present earlier is now increasingly seen, thanks to availability of water and irrigation facilities due to the Indira Gandhi Nahar Project.

Due to the increase in the number of settlements and villages around the site, the area of Diyatra is being brought under cultivation, resulting in disturbance to the Great Indian Bustard and Stoliczka's Bushchat. Fallow land is decreasing and *Capparis* bushes are being uprooted to clear the ground for human activities.

Since declaring Diyatra as a Closed Area for Shooting, the Forest Department seems to have forgotten its existence! There is practically no patrolling. Sometimes a forest guard is officially posted there, but he rarely visits the area, as a result poaching is quite common here. Hunters mainly come in search of MacQueen's Bustard and Imperial Sandgrouse but kill Great Indian Bustard when they come across one. In 1986 hunting of bustard was observed. During surveys in 1993-94, 1998, and 2001-2004, much evidence, including feathers of bustard and jeep tracks, and reports of local people, indicated that illegal hunting was still quite common. The best indication of poaching is the dramatic decrease of bustard numbers over the last 15 years of monitoring this site.

Only strict control on poaching and an intensive environmental awareness programme among local villagers can save the Great Indian Bustard and other wildlife of Diyatra Closed Area. We strongly suggest that Diyatra should be included in the Greater Thar Desert (Marusthali) Biosphere Reserve.

Tal Chapper in Churu district

The 7.90 km^2 Tal Chapper, in Churu district was notified as a Sanctuary in 1962. It is situated in north-western Rajasthan and thus lies on the migratory path of many birds. It is a vast expanse of treeless depression, which used to get inundated during good rainfall years. Howerver, as the district falls under the arid zone, rainfall is generally insufficient to inundate the Sanctuary. Therefore, for most of the year the depression or *taal* remains dry (Rahmani 1997a). Tal Chapper is famous for Blackbuck *Antilope cervicapra*and Demoiselle Cranes.

This small sanctuary has many problems such as grazing by livestock, killing of Blackbuck fawns by village dogs, and some disturbance by salt extraction at the periphery. Other major mammalian species of Tal Chapper are *Canis aureus, Vulpes bengalensis, Vulpes vulpes pusilla, Felis chaus* and *Lepus nigricollis dayanus* (Rahmani 1997a). Among the reptiles, *Uromastix hardwickii* is abundant.

The major birds of Tal Chapper are Demoiselle Crane *Anthropoides virgo*, Bar-headed Goose *Anser indicus*, Red-headed or King Vulture *Sarcogyps calvus*, Cinereous Vulture *Aegypius monachus*, Common Kestrel *Falco chicquera*, Indian Courser *Cursorious coromandelius and* Black Ibis *Pseudibis papillosa*.

Table 1.4.2: Wildlife sanctuaries and (former) Closed Areas of Rajasthan

S. No	Name	District	Area (km²)	Staus
1	Bajju	Bikaner	100	CA
2	Dechu	Jodhpur	2000	CA
3	Deshnok	Bikaner	25	CA
4	Jakharda	Barmer	69	CA
5	Diyatra	Bikaner	50	CA
6	Dhawa-Doli	Jodhpur	425	CA
7	Gajner	Bikaner	24	WLS
8	Guda-Vishnoian	Jodhpur	425	CA
9	Jambeshwarji	Jodhpur	3500	CA
10	Jaroda	Nagur	30	CA
11	Jodvir	Pali	5	CA
12	Lohawat	Jodhpur	124.31	CA
13	Mukam	Bikaner	168.82	CA
14	Rotu	Nagur	50	CA
15	Sanchor	Jalor	1813	CA
16	Sathin	Jodhpur	245	CA
17	Sawantsar Kotasar	Churu	7091	CA
18	Tal Chhaper	Churu	7.90	WLS

**This table should be seen in conjunction with the proposed Greater Thar Desert (Marusthali) Biosphere Reserve (Chapter 3)*

CA = Closed Area

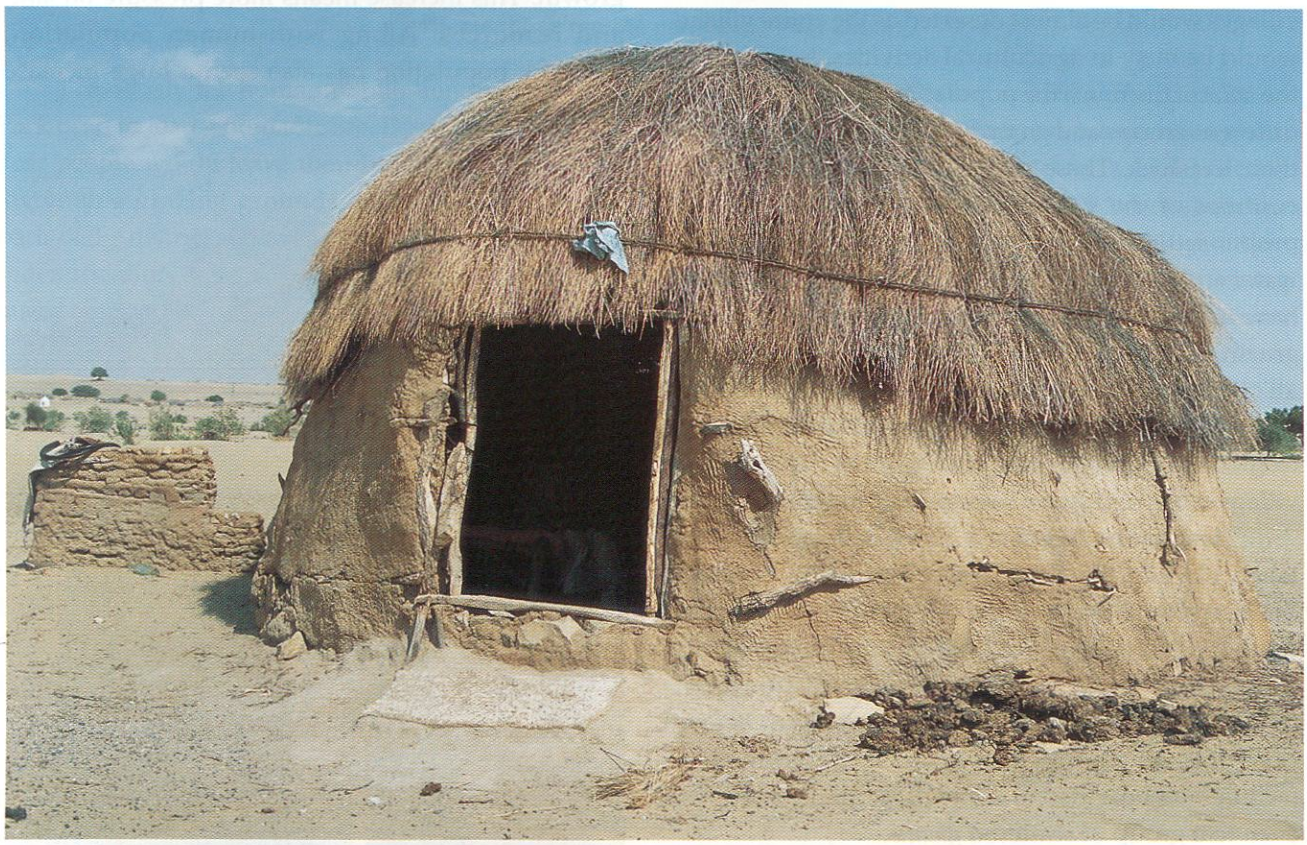
WLS = Wildlife Sanctuary

1.5 SETTLEMENT

Even 25 years after the establishment of the Desert Wildlife Sanctuary, and the state government's preliminary notification to declare the entire area as a national park, the so-called Desert National Park is neither a National Park nor a Biosphere Reserve. The main reason given is that there are 72 villages located inside the Park, with a total human population of about 62,024. Most of these villages are inhabited by Rajputs and Muslims, with few houses of other communities. The cattle population of these villages is approximately 1,82,300 (Appendix 4). In addition to DNP, four satellite areas were also demarcated, which are already fenced to provide protection to wildlife of the region. These satellite areas are located outside the DNP boundary.

Like in rest of the Thar Desert, in the DNP also, the rural people mostly live in small villages and family settlements called *dhanis*. This is largely due to the distinct physical and social characteristics of the desert, like the dunes, scattered location of water sources and the *Jagirdari* system (Sankhala *et. al* 1988). Most of the villages have either only scattered settlement or have both compact and scattered settlements. Most of the villages consist of one religion or community, and even if different communities live in the same village, their *mohallas* remain separate. The so-called lower castes generally live slightly away from the main village. Although there is no official discrimination and all castes and communities have equal status, old social taboos and traditions are still prevalent.

As the natural resources in the desert are scarce and scattered, the *dhani* system of settlement is quite prevalent. *Dhanis* are generally family settlements, with 2-5 huts, generally opening in a common courtyard, surrounded by a large landholding (which is cultivated when rainfall is good), a much larger livestock grazing and fuel wood collection area. The huts are made of mud and local material, with a thatch roof. Most of these *dhanis* have their own water source,



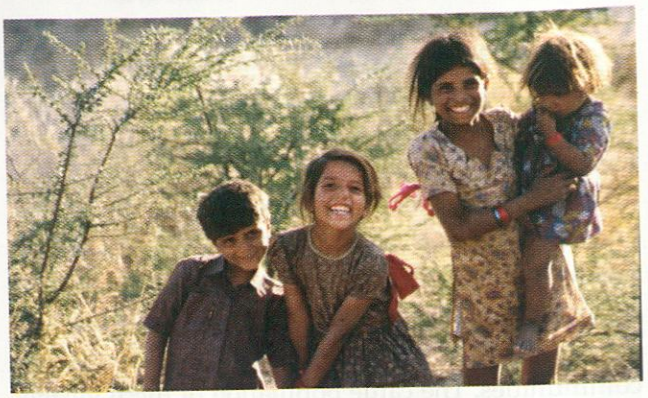
People living in the scattered *Dhanis* have a close contact with land

either in the form of well (rare) and/or cistern or *tankas*. The catchment area of a *tanka* is kept clean, especially during the brief monsoon when most of the water is collected. This water is diligently used by the owner for the whole year. In order to prevent evaporation, the *tanka* has a small opening to take out water and this opening is kept shut most of the time. Some are even locked to prevent water theft!

Due to population pressures, water brought by the IGNP, rapid communication and transport, influence of the army and government policies during the last 30 years, great social changes have taken place in the Thar Desert. Malhotra (1988) has described the earlier way of life, which is no more valid in many areas/cases. Earlier, the type of housing was influenced by the indigenous flora and material available nearby. The form of the settlement used to condition the natures of activities and type of social relationships of the people. People living in villages would make greater use of the community facilities, while those living in the scattered *dhanis* were inadequately covered. In the rainy season, some villages would be almost deserted as the entire village would be busy in agricultural activities. In fact, with the start of the rains, the population would divide into different groups and go to different places along with their livestock. These people would stay within the confines of the village boundary, but outside the proper settlement. They would select an area where water and fodder are available and by convention they have to be allowed the facility of using the water and grazing resources there. It is only when the water in all the *nadis* would get exhausted that the entire population along with their livestock would return to the village proper and then use the water in the village tanks and graze livestock around the village.

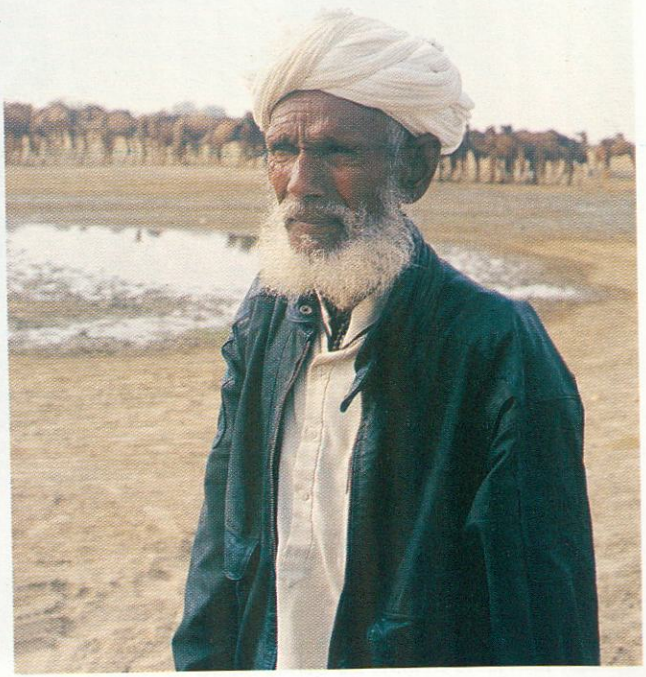
Despite the fact that a lot of development has taken place in the Thar Desert, life is still harsh in *dhanis* and remote villages, with practically no medical facility. Only large villages have government dispensaries and sometimes a small hospital. Otherwise, people have to travel 30-100 km before reaching a hospital. However, basic education facilities are provided to each village, and sometimes even to a group of scattered *dhanis*.

Compared to the other deserts of the world, the Thar desert of India and Pakistan is the most

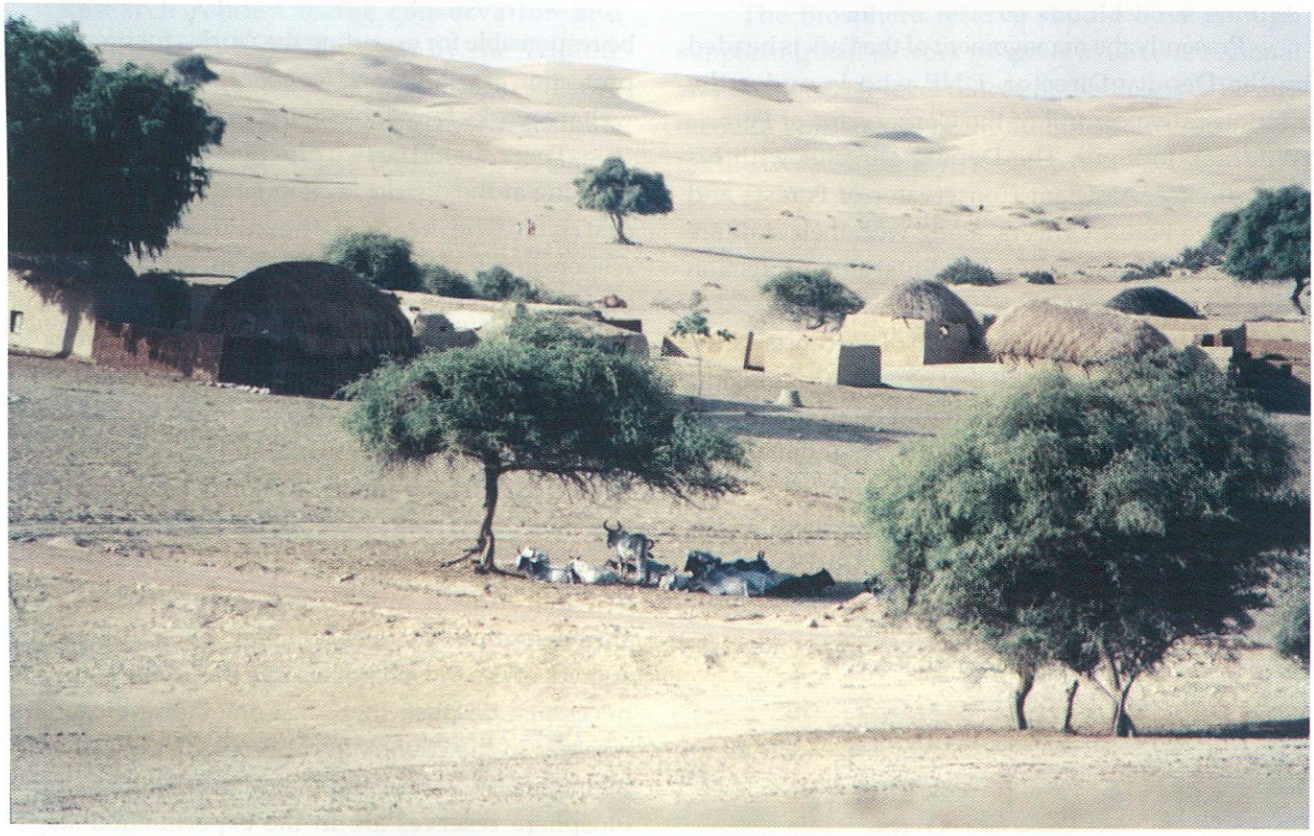


Awareness programme should be initiated especially for children to make them interested in wildlife conservation

populated desert in the world. While in other deserts, the human population varies from 5-6 humans/sq km (lesser in the great Sahara), in the Indian Thar desert, it is 85 humans/sq km! Till the 1920s there was hardly any population growth and sometimes human population even decreased due to drought-related deaths/emigrations. After Indian's Independence in 1947, human population has seen rapid decadal growth. This increase means more pressure on land and resources. Along with human population, livestock population has also seen a huge increase (Appendix 6).



A cattle grazer in Karada-Pocheena village



A settlement in a remote part of the Thar Desert

Previously the human population living in the Park used to lead a nomadic life. During the drought year people would leave their houses and go to the favourable grazing grounds available in the other parts of the district and even outside of the state. Now, sedentirization is taking place more and more. The major occupation is livestock husbandry in the entire area of the sanctuary. People keep large herds of camel, goats and cow. Most of them do live a nomadic life earlier but today they stay with all their cattle in the Park throughout the year. As there is no certainty of rains and the land does not have good productivity, so they go only for *Kharif* (monsoon) crop.

Human habitation

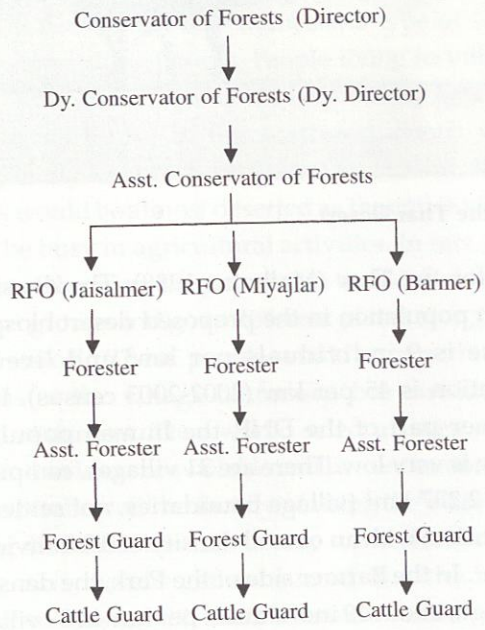
The Thar has shown a high rate of human population growth. While the population growth rate between 1901 and 1981 for India was 187%, it was 249% for the Thar (Malhotra 1988). The density of human population in the proposed desert biosphere reserve is 9 individuals per km^2 and livestock population is 45 per km^2 (2002-2003 census). In the Jaisalmer part of the DNP, the human population density is very low. There are 31 villages, comprising a total 2,237 km^2 (village boundaries, not settlement boundaries) with an overall density of 0.3 individuals per km^2. In the Barmer side of the Park, the density is very high, about 40 individuals per km^2 in 39 villages. The live stock population is also very high in villages and varies from 40 to 55 per sq. km^2 (Map F). The major livestock species are goat, sheep, cow, camel and donkey.

The regions with low human and livestock densities will be additional criteria for planning the limits of the proposed Greater Thar Desert (Marusthali) Biosphere Reserve.

1.6 ADMINISTRATION

Presently the management of the Park is headed by the Deputy Director, DNP who is under the administrative control of the Conservator of Forests (Wildlife), Jodhpur. The Deputy Director with his subordinates, Assistant Conservator of Forests and two Range Forest Officers, along with their staff are posted at different range headquarters, protection posts and enclosures. (eg. Sam, Sudasari etc.).

For effective implementation of the conservation programme, it is important that people managing the administration of the office should be fit to work in the harsh condition of the desert. The administration should be self sufficient and effective. The work conditions in the desert and the work involved is challenging, only hard working and motivated individuals can give result.



The selection of individuals should be based on their aptitude, dedication and physical capacity to work in the tough conditions of the desert. If necessary, the job requirement for this particular Biosphere could be modified.

The lower staff (Forest guard and cattle watchmen) located in remote places for the protection of wildlife should get some extra benefits and two or three members should be posted together. A group of these people should be supervised by a Forester or Assistant Forester. A group of guards or foresters should be controled by the Range Officer, who should be responsible for executing the works, for organizing protection of wildlife and for coordinating other social welfare works for people living in the Park.

There should be two different groups of rangers working at the district level in Jaisalmer and Barmer districts. The head of the division should be responsible for all the activities such as protection, budget, accounts, management etc. The Director of Biosphere should have an office at Jaisalmer to coordinate with all the staff. He should take the responsibility for all functions such as planning, budget, management, research and monitoring of the entire area. The top administration needs to be strong and effective. The Reserve being of a special nature needs to be given independent funds by the Ministry of Environment and Forests (MoEF). This new administration structure will play a vital role for the success of the Biosphere Reserve programme. This is necessary because there are not many biosphere reserves in the country and hence our experience in managing such reserves is limited. Almost all the biosphere reserves are in the experimental stage, therefore very little experience of management and administration of a biosphere reserve is available, therefore, each biosphere reserve should have a special status.

Table: 1.6.1 Present structure of the administration

S.No	Name of the Post	No. of sanctioned posts
1	Dy. Director	1
2	ACF	1
3	Range officers	3
4	Foresters	9
5	Astt. Foresters	3
6	Forest guards	38
7	Junior Accountant	1
8	U.D.C. (Upper Divisional Clerk)	1
9	L.D.C. (Lower Divisional Clerk)	4
10	Drivers	2
11	Helper	1
12	Class-IV	2
13	Cattle guards	38

Research related to the conservation and management is to be undertaken by the Wildlife Institute of India (WII), Bombay Natural History Society (BNHS), Central Arid Research Zone Institute (CAZRI), Zoological Survey of India (ZSI), Botanical Survey of India (BSI) and universities.

The DNP has some very motivated staff but many times they are in weak position due to lack of proper training. They live in extreme environmental conditions - the temperature can go up to 50 °C in summer and 0 °C in winter. Some enclosures are quite remote and ill-connected, with one bus a day to any city! Despite these constrains, the forest staff are doing a good job. Besides the desert allowance, they should be sent regularly to training courses and to other wildlife sanctuaries.

The Biosphere reserve should have enough supporting staff to work properly at district, regional and headquarter level offices of the Reserve. Ideally the following should be the administrative structure for the Desert Biosphere Reserve (DNP):

Deputy Director (1)

↓

Asst. Conservator of Forest(2)

↓

Forest Range Officer(15)

↓

Foresters/Asst. Foresters (61)

↓

Forest Guards (198)

↓

Cattle Guards

1.7. MANAGEMENT — CORE AREA, BUFFER AREA AND TRANSITION ZONES

The concept of the Biosphere Reserve (BR) is promoting *in situ* conservation and sustainable utilization of natural resources. Besides restoring degraded habitats, reducing biotic pressures, and welfare of local communities. Biosphere Reserves (BRs) should also serve as an important field area for research.

Ideally, a Biosphere Reserve should have three zones that take care of the needs and welfare of wildlife, people and livestock.

i) Core zone
ii) Buffer zone
iii) Transition zone

Core Zone

The Core Zone is kept absolutely undisturbed or managed scientifically. It is the area where biodiversity conservation is given the highest priority. The Core Zone should have minimal human interference, and it should be representative of the natural ecosystem with its complements of flora, fauna and their interplay. In a large Biosphere Reserve, national parks and sanctuaries where human interference is minimum are generally considered as Core Zone (e.g. Mukurti National Park in the Nilgiri Biosphere Reserve). However, in the proposed the Desert Biosphere Reserve, we cannot have a contiguous large area of a few hundred sq. km free from human disturbance, therefore, we suggest that the fenced areas (called enclosures) should be declared as Core Zones.

After the establishment of the Desert National Park, a few areas were fenced and closed for grazing. In the initial stages, Sam, Sudasari, Phulia, and Miyajlar enclosures were established. Since then, the Forest Department has added new enclosures every year. Presently, there are 26 enclosures (Table 1.7.1), of which three enclosures - Dab, Koria and Dabri - have been completely destroyed. Out of all these enclosure, few such as Sudasari, Myajlar, Sam and Sundra, are very important for wildlife. The state bird of Rajasthan, Great Indian Bustard - locally called *Godawan* - is mostly confined to these areas. Similarly, the Houbara or Macqueen's Bustard is also seen in good numbers during winter in all these area. Other species such as Chinkara and Desert Fox are also seen in good numbers here compared to other areas.

The enclosures of DNP have very high wildlife diversity and represent the original vegetation of the desert. These enclosures should be zealously protected from encroachment and over-grazing. Fences should be repaired and motivated guards should be appointed to stop illegal grazing.

Satellite Enclosures: Besides, the enclosures present inside the boundary of the DNP, there are four enclosures outside its boundary, which are called satellite conservation areas. These areas are a part of revenue land transferred to DNP (Table 1.4.1).

Satellite areas were declared with the following objectives:

1. To provide awareness for wildlife preservation among the locals.
2. To provide food and shelter for wildlife found in areas other than the DNP.
3. To protect the wildlife of the area and also to control poaching activities, which may take place in these areas.

Suggestions for new enclosures

Establishing new enclosures continued only till 1995. Finance to the enclosures was withdrawn, resulting in the end of enthusiasm of the officers. We strongly propose that development and maintenance of enclosures should start again under the Biosphere Reserve Programme of the Government of India. Satellite data that reveal a few more areas within the Park, especially along Khuri–Miyajlar road can also be declared as Core Zone (enclosures).

We have marked these four potential enclosures on landuse/cover map (Map C).

Enclosure A
Enclosure B
Enclosure C
Enclosure D

To demarcate the exact boundaries of these enclosures, extensive ground surveys are required. Most of these enclosures contain suitable habitat for desert flora and fauna and have potential for attracting endangered species such as the Great Indian Bustard and MacQueen's Bustard. Full protection should be provided to these areas to keep

them free from human pressures. The following guideline should be enforced:

i) Protection should be the top priority.
ii) Entry of visitors, should be restricted at least in the initial stages.
iii) Water guzzlers should be developed to attract wildlife during summer months, when surface water is scarce.
iv) Livestock grazing should be totally stopped so that the vegetation can recover. Limited grazing could be allowed after a few years of the vegetation recovery.
v) Proper documentation of the flora and fauna should be carried out.
vi) Forest guard *chowkis* should be established outside or at the boundary of these enclosures and motivated staff placed.
vii) Higher authorities should regularly camp in these enclosures to see their development.
viii) No tree or grass plantation should be taken up. Nature should be allowed to regenerate itself.

Buffer area

The remaining areas of the DNP should become the Buffer Zone. According to the Guidelines for the Biosphere Reserve, natural resource uses and human activities in buffer zone are managed, such as limited traditional agriculture, livestock grazing, and tourism. Research and education activities should also be encouraged in the Buffer Zone. In the case of DNP, we strongly suggest that human activities and traditional land use such as monsoon cropping (*Kharif*), rain water harvesting and traditional livestock grazing should be allowed. To understand the pattern and processes of the desert ecosystem, research should be allowed in the buffer area (and to some extent in the Core Zone). The Buffer zone can be demarcated using the map produced for this document. The Buffer zone should be maintained to:

i) Develop the area to fulfill the basic needs of people, to reduce the biotic pressure on the core zone.
ii) Provide grazing grounds for the local livestock.
iii) Villagers should be allowed to collect minor forest products within the guidelines of Biosphere Reserve management.

Table 1.7.1: Enclosures of the DNP

S. No.	Enclosures	Area	Year
1	Sudasari A	700	1980-81
2	Miyajlar	500	1980-81
3	Sam A	400	1981-82
4	Sam B	700	1981-82
5	Phulia	400	1981-82
6	Bandra A	235	1981-82
7	Bandra B	422	1981-82
8	Sundra A	700	1981-82
9	Manyari A	40	1983-84
10	Kundal	250	1983-84
11	Piparli	260	1983-84
12	Sudasari B	350	1986-87
13	Manyari B	80	1986-87
14	Khabdala A	350	1986-87
15	Sudasari C	350	1987-88
16	Barsiala	450	1987-88
17	Khabdala B	450	1987-88
18	Dab	450	1988-89
19	Dabri	475	1988-89
20	Koria	450	1988-89
21	Dhagari A	400	1988-89
22	Sam C	100	1990-91
23	Sudasari D	465	1991-92
24	Sundra B	50	1993-94
25	Dhagari B	350	1993-94
26	Sam D	200	1994-95

iv) Village-wise record of all such removal should be maintained at range level.

Transition area

In most of the Biosphere Reserves and protected areas, natural or administrative features form the boundary. This is not easy in the case of DNP because of the vast open landscape and topography. Moreover, the land was never under the control of the Forest Department so beat or range boundaries were not available (unlike forest protected areas). Therefore, we suggest that a 5 km periphery around the existing boundary of the DNP should be considered as the Transition Zone. It would be necessary to demarcate the Transition Zone using pillars. This Transition Zone was demarcated by us using GIS System up to 5 km, outside from the boundary of Desert National Park (Map C). It includes few settlements and croplands.

Management Plan

A 10-year management plan for the DNP under the provision of the Wildlife Protection Act, 1972, and that of the proposed Greater Thar Desert (Marusthali) Biosphere Reserve, under the MAB guidelines (see Appendix: 8, as amended by the Government of India) should be finalized quickly and submitted to the Ministry of Environment and Forests, Government of India for funding. Fortunately, the MoEF has indicated an intention to give full funding to protect this Park.

The management plan should be developed in such a way that local communities are greatly benefited by the development of the Park and the Biosphere Reserve. The present arrangement of having strictly protected enclosures (core areas) scattered all over the Park, and between multiple-use areas (buffer) should be maintained. Animal husbandry and monsoonal agriculture should be allowed only in the buffer and transition zones.

Fenced area (called enclosures) should be declared as Core Zones

Fences should be repaired immediately

1.8 AGRICULTURE

Agriculture in Rajasthan is considerably influenced by the annual variability of rainfall, especially in western Rajasthan, which shows very high rainfall variability (Prakash 1988). On the basis of climatic condition and agriculture produced, Rajasthan has been divided into nine agro-climatic zones (Moghe *et al.* 1994), each one having a special characteristics of its own. The area of DNP and the proposed Greater Thar Desert (Marusthali) Biosphere Reserve comes under the Arid Western Plain. This area does not have any drainage system and flowing stream. Owing to poor rainfall, surface water does not exist, except man-made ponds near some villages, while ground water resources are often deep.

The land distribution is uneven and there is concentration of land holding by a few richer farmers. For example, 11 per cent households possess 50 per cent of the total land in the region, whereas 47 per cent hold only 10 per cent of total land. The man to land ratio is fast declining. For instance in 1951, the total land available per household was 17.77 ha which declined to 14.69 in 1961 and 12.40 ha in 1971. Similarly, the total cultivable land available for each household declined from 13.72 ha in 1951 to 9.95 ha in 1971. By 2001, only 6.03 ha. is likely to be available (Prakash 1988).

The mapping of land use in the study area was carried out through visual analysis of satellite data. The recorded FCC of IRS–1C LISS III dated 7 November 2005 was visually interpreted for making classes, including agriculture areas with the help of ground truth and collateral data. Since 2001, there is hardly any rainfall, so most of villagers were not doing any cultivation during our study period. We calculated that only about 12.4% area is cultivated in 2004 (Map C).

During drought years, which are quite frequent, the land is left fallow and is used for livestock grazing. Otherwise also, the farmers had developed the practice of leaving the land fallow after 4-5 years of its cultivation. The fallow lands provide grazing resources for the livestock, which in turn, provide manure to these fields.

The availability of water from the IGNP in some parts of the desert has resulted in constant use of the land for cropping, thus disturbing the earlier practice of leaving it fallow. The cultivation has also been

Traditional agriculture practices in the DNP should be encouraged

extended to the marginal and sub-marginal lands. In spite of the poor soil fertility and insufficient rainfall (and insufficient water available from the IGNP), the government is promoting crops such as wheat, with dire consequences. Therefore, there is a need to re-look at the whole agriculture policy in the Thar Desert. A beginning can be made from the proposed Greater Thar Desert (Marusthali) Biosphere Reserve management area.

Pearl Millet or Bajra *Pennisetum typhoides* is the main *kharif* (monsoon) crop. The other common crops are Moong *Phaseolus radiatus* and Guar *Cyamopsis tetragonoloba*. In the IGNP command area, these traditional crops are being replaced by cash crops such as Groundnut *Arachis hypogea*, Cotton *Gossypium* spp., Sugarcane *Saccharum officinarum*, Wheat *Triticum sativum* and Barley (Chatterji & Saxena 1988). The crop yield is, however, poor due to the natural condition. In most part of western Rajasthan, and more so in the DNP area, traditional agriculture practices are still followed. Such practices are to be promoted and even subsidized if the unique biodiversity characteristic of the desert biome are to be maintained for posterity.

The climatic condition of any region affects the agriculture cropping pattern. In the Thar Desert, where rainfall is meagre and unpredictable, villagers are never sure of agriculture. In good rainfall years, every 6-7 years, extensive areas are cultivated and there is abundant fodder for livestock, but such years are infrequent. Therefore, most of the villagers depend on animal husbandry, which gives them revenue even during drought years and at least ensures their survival. Land holding in the Thar Desert are comparatively large and sometimes scattered. This further ensures at least some revenue. The farmers thinks that the greater number of scattered land holdings provide some surety for getting harvest from some plots as the rainfall is localized and scattered.

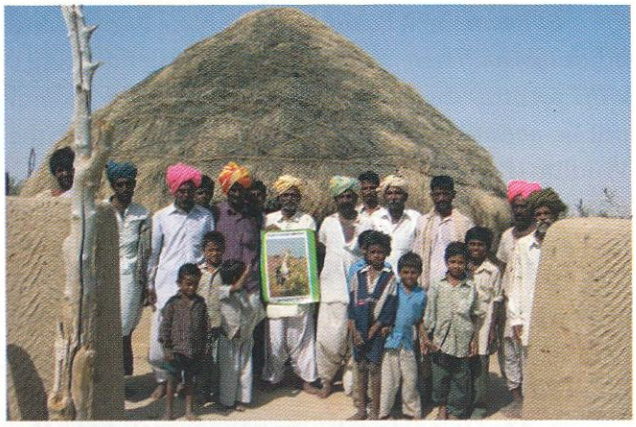
The desert dwellers have also evolved a technique to use the conserved moisture by way of cultivation of '*Khadins*'. *Khadin* is an old method of water harvesting rainwater around the crop field in the valley bottom. Water is left standing for a few weeks/months, which recharges the ground water as well as moistens the soil (Rahmani 1997a).

1.9 ENVIRONMENTAL EDUCATION

Creating awareness among locals about the need and importance of a Desert Biosphere Reserve is one of the major aims of the Biosphere Reserve Programme. For the last 25 years, the Bombay Natural History Society (BNHS) is working for protection of the Great Indian Bustard (GIB) in Rajasthan (*see* Rahmani, 1997b). Earlier the aim of the BNHS was to study this bird, especially its ecology and distribution, but even during these ecological studies, posters of bustards were distributed in the villages. The real campaign for protecting the bird started from the mid 1990s. The Oriental Bird Club funded the first 'Save the Bustard' campaign project. Subsequently, another campaign was funded by the World Wide Fund for Nature (WWF-India) (Rahmani 1997). Extensive Environmental Education (EE) and awareness campaigns were carried out even while surveying the Houbara or Macqueen's Bustard in 1998 (Rahmani 1998). A major campaign project for bustard was funded by the Ministry of Environment and Forests (MoEF) from 2001 to 2002 (Rahmani 2002). During all these campaigns, DNP and its surrounding areas were specially targeted. More than 100 villages were visited, lectures delivered in schools, colleges and interactive meetings were held. Between 2004-2005, Bombay Natural History Society continued its campaign with the help of funds provided by the Royal Netherland Embassy. More than 70 villages were visited only in the Desert National Park (Rahmani & Kalra 2005).

As environmental education (EE) is a continuous process and needs constant improving and changing, we recommend that funds should be provided to NGOs like BNHS, which have experience and expertise to continue this work. We have the following recommendations:

1. Interpretation Centers: As Sam is a major tourist area, an interpretation centre should be established there depicting the flora and fauna, ecology of the desert ecosystem, cultural and societal values of the Biosphere Reserve. One such center/ museum should also be established in Jaisalmer town, depicting the desert ecosystem and especially the Desert Biosphere Reserve. We are sure such a centre would be very popular with tourists and also help impart them knowledge. Small interpretation-cum-information centres should be established in Miyajlar, Khuri and Sundra.



Awareness and Education programme for GIB created lot of interest among the locals

2. Literature in English and Hindi: BNHS has distributed more than 20,000 posters, pamphlets and brochures in Hindi in villages, schools, government offices etc. but there is a need to distribute more material to sensitize the locals. Every government office, village dispensary, bank, school, revenue office and *panchayat* office should have a poster about the importance of the Desert Biosphere Reserve.

3. Education tours: Every year, the Forest Department takes some students on tour of the Park, especially Sudasari; we recommend that this should be done on a much larger scale. Every class and every school should visit the Park at least once a year. For this, buses should be arranged on determined routes. The students should be first brought to the interpretation centers and only then allowed inside

the Reserve, so that they have some knowledge of the Reserve.

4. Godawan Chowk: As Jaisalmer is a developing tourist town, we strongly recommend that one of the traffic circles (*chowk*) of the city should be named as Godawan Circle or *Godawan chowk*, and a statue of this State Bird of Rajasthan placed there.

5. Nature trails or routes: Fixed routes should be developed on existing roads and these should be named after the local flora and fauna or customs, such as Godawan trail, Chinkara trail, Tibba trail (on sand dune), etc.

6. Permanent Posters in Jaisalmer, Barmer, and other towns: There should be permanent hoardings, with pictures of rare species, informing the general public about the penalties for poaching, under the Wildlife (Protection) Act, 1972.

7. Godawan Day: Every year, one day should be fixed, preferably during the Wildlife Week in October, as Godawan Day during which schools should be encouraged to organize painting competition, essay and debates on Godawan and other wildlife of the desert.

8. Multi-sectoral involvement for the protection of the Biosphere Reserve: The Desert National Park spreads to 3,162 sq km, with many satellite enclosures. This areas come under various departments and stakeholders, such as revenue, agriculture, IGNP, army, forests, wildlife and tourism. Moreover, a large portion is private or community land. Therefore, it is essential that all these department/communities should be involved in improving the ecology of the Desert BR. This can happen only if there are regular interactions and the Desert BR is recognized as a important centre of biodiversity and gene pool conservation, and a major tourist attraction of India.

Approach to achieve the objectives:

1. Regular meetings and workshop should be conducted with villagers.
2. Literature should be published in local languages and distributed.
3. Tourist guides should involved to highlight the importance of the area.
4. Awareness programmes should be conducted in schools and colleges for conservation education.
5. Government officers should be involved in organizing seminars on endangered species conservation.
6. The Indian Army should also be involved in the protection of endangered species.
7. Sighting records of bustard, chinkara and other species should be collected through field and questionnaire surveys.

Strategies:

1. To exhibit the flora and fauna of the desert, interpretation centers should be constructed. These centers should be equipped with the latest facilities.
2. Nature trails should be laid out in prominent areas to depict all the special features of the desert and to watch wildlife in its natural habitat.
3. Persons having knowledge about the topography and culture of the area should be selected to work as wildlife guides. This will provide employment for the locals and tourists will benefit while interacting with these guides.
4. A number of camels and camel carts are available in the desert region. These can be registered in the DNP to conduct local visits for tourists at rates fixed by the Goverment. This will generate employment for the locals and will also help to promote wildlife conservation.
5. Watchtowers should be constructed at Sam, Sudasri, Miyajlar and Sundra enclosurses. This will help tourists to watch wildlife without disturbing them.

1.10 RESEARCH AND MONITORING

One of the main aims of a Biosphere Reserves is to promote bench mark studies on natural ecosystems and comparative studies on man-modified ecosystems. According to the preamble of the Biosphere Reserves Programme, research should include diverse fields such as meteorology, hydrology, human and wildlife ecology, anthropology, land use patterns, impacts of human induced changes, etc. Universities, research institutes, NGOs and experts should be involved and encouraged to take up research of their expertise or interest. However, it is also important to develop a mechanism to coordinate these research programmes so duplication is avoided and better interactions take place among researchers, and between researchers and managers of the Reserve. Therefore, it is important to establish a Biosphere Monitoring and Research Committee, which would oversee the research programme. It is important that this Committee does not become too bureaucratic and inflexible. This Committee should be headed by an expert and not by a bureaucrat in his/her ex-office capacity.

The role of the Biosphere Monitoring and Research Committee (BMRC) should be to identify gaps and prioritize problems, identify and actively seek good researchers/institutes and also to see that necessary research permissions are provided quickly and without any prejudice. At regular intervals, the BMRC should see the progress of the research and suggest mid-course solutions. Sometimes the protected area managers are inflexible and non-cooperative (and in few cases downright hostile to research/researchers). The BMRC should interact if such a situation arises. It goes without saying that all research should be done as per the research guidelines developed by the MoEF.

The research and monitoring budget of the Biosphere Reserve should be used to run this long-term research programme. In addition, various scientific groups should be free to propose short-term research projects of their own specific interest.

For the Desert Biosphere Reserve (DBR), we suggest that first detailed mapping of the boundary, enclosures, land use, and terrain should be done on 1: 50,000 scale which will provide the overall view of the area for further monitoring programme. On the basis of current maps, permanent study plots can be located throughout different habitat types and regions of the Biosphere Reserve for regular monitoring programmes.

There should be two annual censuses – one in winter for general wildlife, and another in summer for the Great Indian Bustard and Chinkara. End of May or beginning of June is a good time to conduct census, especially inside enclosures where these species concentrate. As the bustard is semi-nomadic and roams around in a large area, it is very difficult to census it. However, we can easily study the trend of its population by annually conducting summer census in and around enclosures. This census should be conducted by interested locals and NGOs working for wildlife conservation. The BNHS and WII would be happy to develop the protocol of the census and would be willing to conduct some training for wildlife guards.

Some suggested topics for research are:

1. Micro level survey of natural resources.
2. Detail inventory of flora and fauna.
3. Meteorological and geological information
4. Checklist of birds of the Biosphere Reserve with distribution and migration pattern.
5. Habitat utilization, including breeding and feeding behaviour of the Chinkara, Great Indian Bustard, and other wildlife.
6. Human and livestock pressure in the buffer area of the Biosphere Reserve.
7. Fuel wood requirement of the locals and ways to meet the demand.
8. Possibility of conservation breeding for the Great Indian Bustard.
9. Tourist potential of the Biosphere Reserve,including development of interpretation programmes.
10. Land-use and crop patterns changes due to IGNP, and their impact on the endangered species.
11. Impact of invasive species, such as *Prosopis juliflora* on the local flora and fauna.
12. Colonization and distribution patterns of species such as Nilgai, Rose-ringed Parakeet and others due to the IGNP.
13. Impact of climate change on the desert flora.
14. Globalization: effects on agriculture, biodiversity, environment and society.
15. Community and conservation: Development policy in the Biosphere Reserve.
16. Governance and community-based management of the buffer zones.

2. VEGETATION MAPPING OF THE DNP

2.1 General

Remote sensing data is a classic source of information on natural resources of a region and provides a record of the continuum of resource status because of its repetitive coverage. Remote sensing is a powerful and unbiased means of collecting data for wildlife management, particularly for large areas, which are difficult to access (De Wulf *et al.* 1988). The study of satellite imagery gives an excellent opportunity to monitor the quantitative extent of the vegetation cover, as well as qualitative changes due to the changes in the environment. This aspect is important in understanding the dynamics of earth surface features and various ecosystems. Wildlife is an integral part of the any ecosystem, and it is closely linked with the most important element of the ecosystem/viz vegetation cover, density, etc. Any quantitative change in the extent, density etc., or qualitative change will have definite bearing on wildlife (Kushwaha & Madhavan Unni, 1986).

Boundary and vegetation mapping of the DNP and satellite areas was carried out using Remote Sensing (RS) techniques and Geographic Information System (GIS). This work was carried out in three main steps:

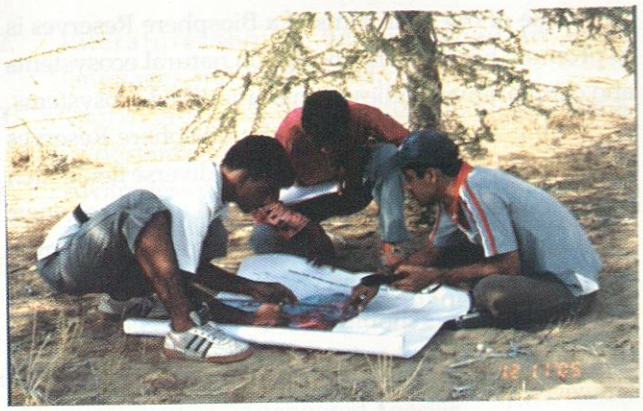
- Creation of boundary
- Creation of input database
- Vegetation type map

2.2 Materials

2.2.1 Satellite Data

IRS-P6 (RESOURCESAT-1)

IRS-P6 is mainly for agriculture applications and has a 3-band multispectral LISS-IV camera with a spatial resolution better than 6 m and a swath of around 25 km with across track steerablity for selected area monitoring. An improved version of LISS-III with four bands (red, green, near IR and SWIR), all at 23.5 m resolution and 140 km swath, provide the essential continuity. These sensors provide data, which is useful for vegetation related applications and allow multiple crop discrimination.



Ground truthing of satellite data

LANDSAT

NASA's Landsat satellite programme was started in 1972. Since then five different types of sensors have been included in various combinations in Landsat missions from Landsat-1 through Landsat-7. The sensors used in Landsat satellite are: Return Beam Vidicon (RBV), the mutispectral sensor (MSS), the Thematic Mapper (TM), Enhanced Thematic Mapper (ETM) and the Enhanced Thematic Mapper plus ETM$^+$. The recent one Landsat ETM$^+$ contains four bands in NIR-VIS region with 30 m ground resolution, two bands in the SWIR region with same resolution, one in the TIR region having a spatial resolution of 120 m and one panchromatic band with 15 m resolution. We used the data of 7 November 2001 (Table 2.1).

2.2.2 Ancillary Data

The available data sets indicated below have been used directly or indirectly:

- Survey of India (SOI) Topographic Maps (Scale 1:50,000)

Table 2.1: Details of satellite data used

Data Used	Sensor	Bands	Path/Row	Date of Pass	Spatial Resolution (m)	Swath (km)
IRS-P6	LISS III	4 (1,2,3)	90/52	7-11-2004	23.5	141
Landsat	ETM+	8 (2,3,4)	152/41	12-8-2001	30	148

2.2.3 Field equipment – Ground Truth

- Magnetic compass
- Measuring Tape
- Garmin GPS

2.2.4 Software used

- ERDAS Imagine 8.7
- Arc view 3.2a
- TWINSPAN
- Arc Info 8.0
- Idirisi

2.3 Methodology

The entire itinerary of the methodology was scheduled into three major steps: the pre- fieldwork, the fieldwork and the post fieldwork. The details of work carried out in each phase are as follows:

2.3.1 Pre-fieldwork

The pre-fieldwork was the foundation for the entire methodology. The most important task of the project was to collect literature and data of the previous work done. The first fifteen days were spent in the library for collecting literature. During this period, literature related to Great Indian Bustard,

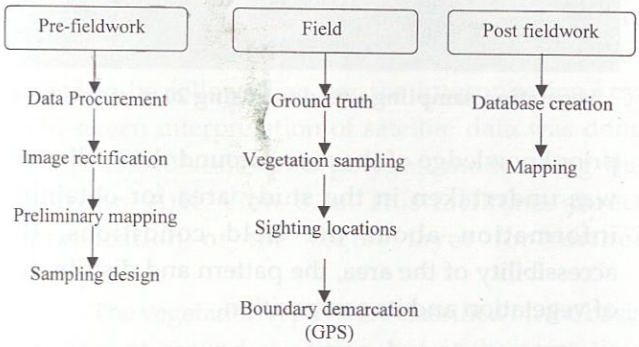


Fig. 2.3.1: Diagramatic representation of methodology

floral and faunal, and diversity of the Thar Desert, was collected and studied.

2.3.2 Boundary of Desert National Park

The boundary of DNP was generated using the GPS locations. More than twelve hundred GPS locations were marked all along the boundary and converted into line mode using ArcView 3.2 software. This vector map was polygonized using clean-build operation and the area calculated for verification. Initially boundary was generated using Geographic Lat-Log projection then re-projected into UTM projection. To check the accuracy, linear feature were marked, such as the boundary of the enclosures. This was overlay on the satellite image and accuracy estimated upto sub pixel level.

2.3.3 Preparation of Baseline Data

The base maps for the survey and other landscape indices were derived from toposheets of Survey of India. Ancillary data were created from these maps.

2.3.4 Image to map registration

Raw digital images usually contain geometric distortions so significant that they cannot be used as maps. By the process of georefrencing, the geometry of an image is made planimetric. The source of these distortions range from variation in altitude, and velocity of sensor platform, to factors such as panoramic distortion, earth curvature, atmospheric refraction, relief displacement and non linearity in the sweep of a sensor's IFOV. The geometric correction aims to compensate for the distortion introduced by these factors, so that the corrected image will have the geometric integrity of a map. Images were registered geometrically using toposheets of Survey of India (SOI) on 1:50,000 scale. The common uniformly distributed Ground Control Points (GCP) were marked with a root mean square error of one third of a pixel, and the image was resampled by the nearest neighbour method. The data sets were then co-registered for further analysis.

2.3.5 Image to image rectification

Image to image registration is the translation and rotation alignment process by which two images of like geometry and of the same geographic area are positioned with respect to one another so that corresponding elements of the same ground area appear in the same place on the registered images (De Wulf *et al.* 1988).

2.3.6 Preliminary vegetation mapping

Supervised classification technique was used to extract useful thematic information. The identity and location of some of the land cover type, such as settlement, agriculture and grassland were known prior through previous fieldwork. An attempt was made to locate specific sites in the remotely sensed

data. These areas are commonly referred to as training sites, because the spectral characteristics of these known areas are used to train the classification algorithm to evaluate land-cover mapping of the remainder of the image. All the pixels, both within and outside these training sites, are then evaluated and assigned to the class of which they have the highest likelihood of being a member. In addition, digitization of the Geo-referenced image and generation of various vector layers in point, line and polygon mode were done using Arc View 3.2a software for the stratification.

2.3.7 Sampling design

Stratified random sampling technique was used on the basis of satellite data derived LU/LC. Area was characterized into homogenous classes as first level stratification and then sampling units were selected from each of them in probability proportion to its size (PPS). The modification in the simple random sampling is necessary because the method of unrestricted random gives good result only if the vegetation is uniform, but in the study area the vegetation cover was heterogeneous. The sample plot is reached on ground based on GPS locations and also important ground bearings available from SOI. Once the desired position was reached, the sample plot was laid with the dimensions of 20 m radius (in case of tree), as per the diagram (Fig. 2.1). The individuals

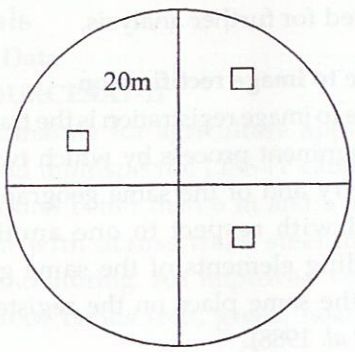


Fig. 2.1: Approach for sample plot laying

with Cbh of >30cm was considered as a tree. For herbaceous layer or ground flora, nested quadrat method with 1 m-radius plot size was taken in three locations. For each plant species present within a quadrat, the data were recorded as: the individual of each species, percentage cover and plant stage.

2.3.8 Fieldwork and Ground data collection

Ground truthing is an important part of any project work. It refers to the acquisition of knowledge of the study area from fieldwork, analysis of the data and personal knowledge. Ground truthed data are considered to be the most accurate data available. Data should be collected at the same time as the remotely sensed data, so they correspond as much as possible. As is the general practice, reconnaissance of the area is an essential step for getting acquainted with the general patterns of vegetation in the area. The FCC (Map: B) hard copy was taken to the study area and the reconnaissance survey was undertaken to relate the image characteristics and actual ground features. It helped in the preparation of the final interpretation key and to make a verification of vegetation types delineated in the satellite images depending upon the interpretation elements and a

Vegetation sampling was done using 20 m radius plot

prior knowledge of the area. Ground data collection was undertaken in the study area for obtaining information about the field conditions, the accessibility of the area, the pattern and distribution of vegetation and its composition.

2.3.9 Post Field Work

The most extensive part of the work starts only after the fieldwork. It is important to correctly compile data for proper analysis. The next most important task was to interpret the satellite data to derive land use/cover map, which is a prelude to the landscape characterization. The steps carried out at each level are as follows:

2.4 Vegetation Mapping

Remote sensing provides a synoptic view of the

status of the ground conditions. Vegetation types are the primary spatial layers generated from satellite data. Vegetation mapping of the DNP was carried out through visual interpretation on the basis of image elements, such as tone, texture, size, shape, pattern, association and shadow. The digital image processing involves pattern recognition techniques, which classes the image data into different forest types on the basis of tonal reflectance information. In desert areas, it is difficult to extract information using low-resolution data. The difference in reflectance of different forest cover classes depends on spatial, spectral, radiometric and temporal resolution, but the difference in spectral radiance of each forest category is the basis for identifying different land use/land cover features on a satellite image.

2.4.1 Visual Interpretation Technique

Identification of objects and their classification, visually from prints or digital images is known as visual interpretation. Interpretation key was prepared using image elements. There are certain fundamental characteristics of an image, which help in interpretation of earth features. These are tone, texture, pattern, size, shape, shadow coupled with site/location and associated features. Prior to visual interpretation optimal band requirements, template depicting different vegetation types and class codes need to be followed as per the interpretation key. On-screen interpretation of satellite data was done on (1:40,000 scale) in a polygon mode using the software ARC View 3.2a. This facilitates direct preparation of the vector layer for further analysis.

The vegetation types were classified on the basis of present ground condition, but at the same time coarse enough to be handled well on medium resolution data. The vegetation types were classified into 16 classes (Table 2.2).

Table 2.2: Landuse/cover in and around DNP

S. No	Classes	Area in km^2
1	*Acacia. senegal*	75.47
2	*A. Prosopis*	9.00
3	*Aerva-Indigofera*	2.89
4	*Capparis-Salvadora-Lasiurus*	579.17
5	Agriculture	588.63
6	Barren	86.97
7	*Brachiaria-Lasiurus*	814.52
8	*Calotropis-Aerva-Indigofera-Laptadenia*	2.76
9	*Calligonum-Lasiurus*	890.87
10	*Capparis-Calotropis*	82.15
11	*Cenchrus-Lasiurus*	19.86
12	*Crotolaria*	312.13
13	Dunes	1.63
14	*Ephedra*-Phail-*Lasiurus*	147.68
15	*Indigofera-Aristida*	97.67
16	*Indigofera-Lasiurus-Calligonum*	434.37
17	*Lasiurus-Dactylotenium*	11.70
18	*Ephedra*-Phail-*Cassia*	543.74
19	Settlement	2.71
20	Water	0.02
21	*Ziziphus scrub*	9.08

2.5 GIS Database

To provide the overall view of the DNP, DEM, slope, village locations with human-livestock populations, Chinkara and Bustard locations, and guzeller locations were mapped. The details of these maps are given in Table 2.3. DEM was download from STRM (Shuttle Radar Topographic Mission) and used to create slope map (Map D).

2.5.1 Digitization

On the basis of ground truth, various land use/

Table 2.3: The list of database layers created in this study

S.N.	Name of Layer	Format Layer	Source	File type	Software used
1	Vegetation Type	Raster	LISS-III	Image file	ERDAS
2	Human-Livestock population	Point	GPS-Locations	Shape file	Arc View GIS
3	Chinkara-Bustard	Point	GPS-Locations	Shape file	Arc View GIS
4	DEM	Raster	SRTM	Image file	ERDAS
5	Slope	Raster	DEM	Image file	Arc View GIS
6	Guzzler	Point	GPS-Location	Shape file	Arc View GIS

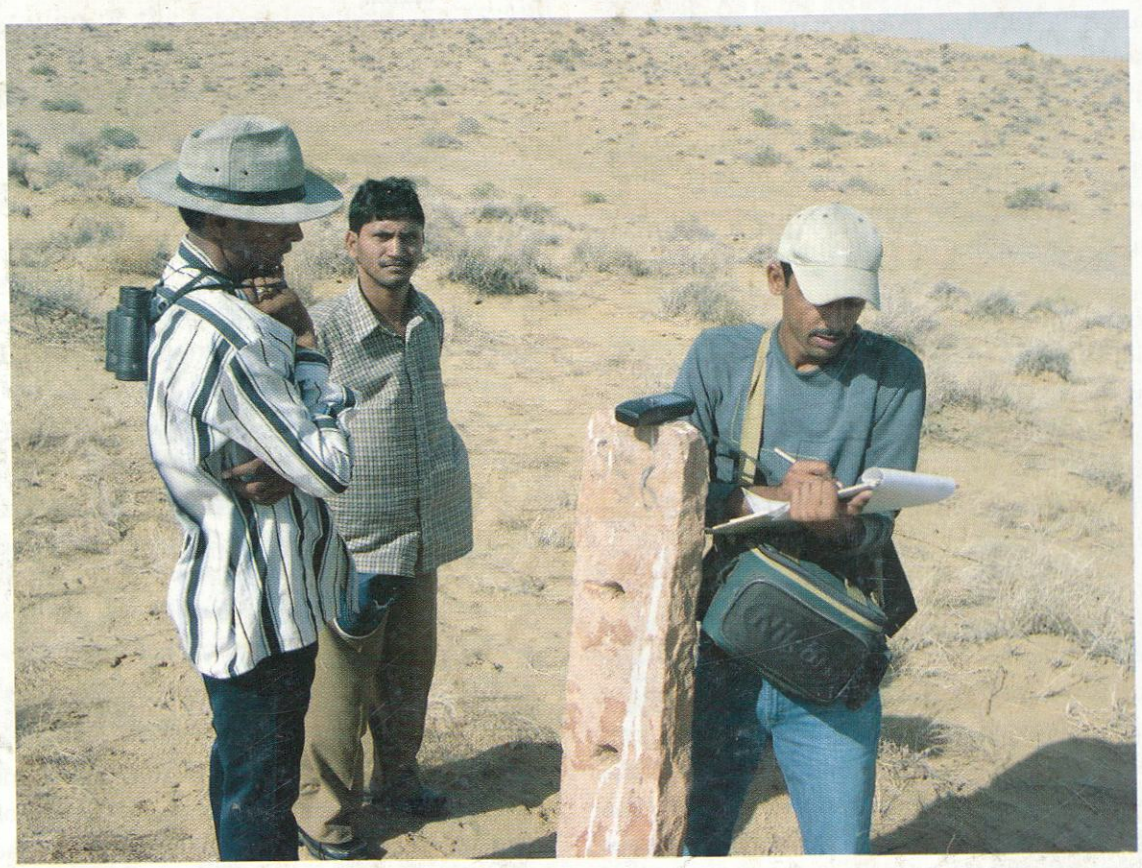
cover were digitized on the image. During digitization, roads were digitized in line mode, whereas settlements were digitized as point locations.

2.5.2 Cleaning and building process

After digitization, the process of clean built was done (making the layer free from over shoot and under shoot) in the ArcGIS.

2.5.3 Topology Creation

The entire digitized vector layer was clean built in ERDAS Imagine 8.7 software. The process of cleaning a vector layer removes any overshoots and undershoots in the layer. To the vector layer generated, relative topological positions among different polygons, were established by assigning attributes.



Boundary of DNP was demarcated using more than 1,200 GPS locations

3. RESULT AND ANALYSIS OF VEGETATION MAPPING

3.1 Landuse /cover Mapping

On the basis of ground truthing, a landuse/cover map was prepared using satellite data (Map: C). The proportion of this area represented by each of the 21 land cover categories is detailed in Table 3.1 A total of 4647.25 km^2 area has been covered for vegetation mapping. The following was the vegetation/land use cover: *Calligonum-Lasiurus* 18.90%, *Brachiaria-Lasiurus* 17.28%, Agriculture 12.49%, *Capparis-Salvadora-Lasiurus* 12.29%, *Ephedera-Phail-Cassia* 17.66%, *Indigofera-Lasiurus-Calligonum* 8.58% *Crotolaria* 6.16%, *Ephedra-Phail-Lasiurus* 3.13%, *Indigofera-Aristida* 2.07%, *Barren* 1.85%, *Capparis-Calotropis* 1.74%, A. *senegal* 1.60%, *Cenchrus-Lasiurus* 0.42%, *Lasiurus-Dactylotenium* 0.25%, *Ziziphus* 0.19%, *Acacia-Prosopis* 0.19%, *Aerva-Indigofera* 0.06%, *Calotropis-Aerva-Indigofera-Laptadeniya* 0.06%, Settelment 0.06%, Dunes 0.03% and Water 0.02%. (Fig. 3.1).

3.2 Vegetation Analysis using TWINSPAN

Initially, 32 classes were mapped using the image element and ground truth information. These were later clubbed into 16 classes. TWINSPAN analysis was done for community classification. TWINSPAN is a useful technique to identify plant communities to map different classes. The programme divides each species into a number of pseudo-species to represent different abundance levels.

Vegetation data were collected at 79 sample points distributed throughout the 4, 647.27 km^2. Each sample point thus represented on an average 20 m-radius. Sample spacing was closer in some portions of the grassland than others. These data were grouped into plant community classifications using Two-Way Indicator Species Analysis (TWINSPAN), a multi-variate ordination technique.

As a classification technique, TWINSPAN was applied to the data set, using species' cover estimates. Species that covered less than 5% were excluded. TWINSPAN is a divisive hierarchical programme that uses indicator species i.e., species with clear ecological preferences, to characterize and separate the classes (Hill, 1979; Okland, 1990). All default settings were used for TWINSPAN. The TWINSPAN analysis divided the plant community into nine vegetation clusters, each cluster representing a specific plant community according to the most abundant characteristic species that reached the highest cover values (Fig 3.2 and 3.3). These included (dominant species are marked with *): **A)** Phail*, *Ephedra foliata**, *Spergula fallax*, *Cassia abtusifolia*, *Lycicum*

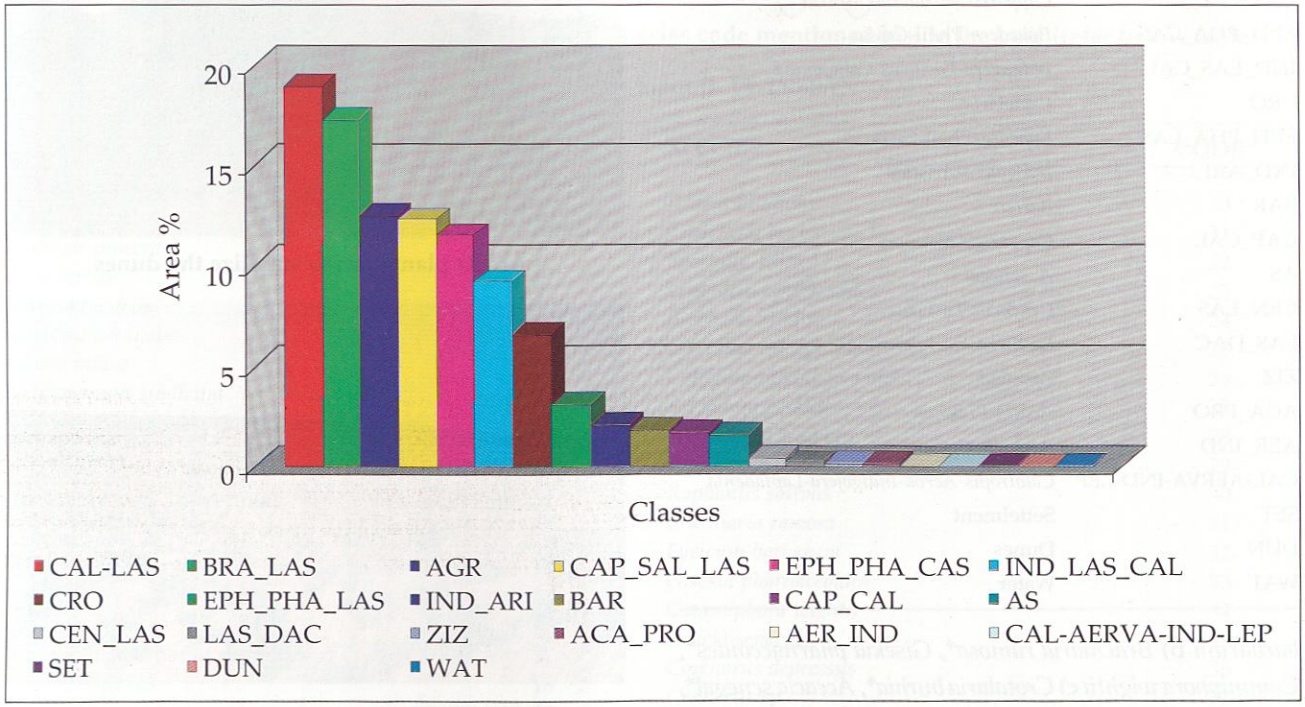


Fig. 3.1: Landuse/cover in and around DNP

Table 3.1: Landuse/cover in DNP

S. No	Classes	Area in Km²
1	*Accacia Senegal*	75.47
2	*Accacia-Prosopis*	9.00
3	*Aerva-Indigofera*	2.89
4	*Capparis-Salvadora-Lasiurus*	579.17
5	Agriculture	588.63
6	Barren	86.97
7	*Brachiaria-Lasiurus*	814.52
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9	*Calligonum-Lasiurus*	890.87
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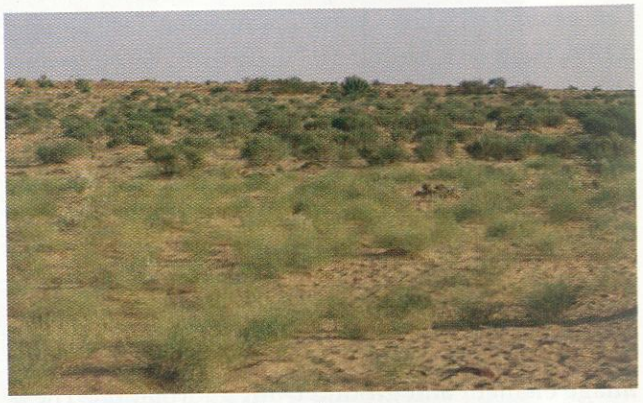
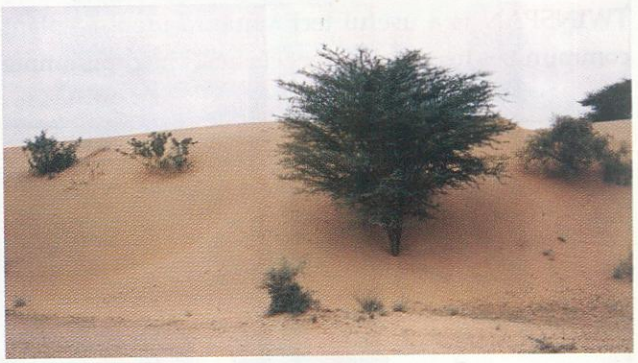
17	*Lasiurus-Dactylotenium*	11.70
18	*Ephedra-Phail-Cassia*	543.74
19	Settlement	2.71
20	Water	0.02
21	*Ziziphus* sp.	9.08

Abbreviation	Classes
CAL-LAS	*Calligonum-Lasiurus*
BRA_LAS	*Brachiaria-Lasiurus*
AGR	Agriculture
CAP_SAL_LAS	*Capparis-Salvadora-Lasiurus*
EPH_PHA_CAS	*Ephedera*-Phail-*Cassia*
IND_LAS_CAL	*Indigofera-Lasiurus-Calligonum*
CRO	*Crotolaria*
EPH_PHA_LAS	*Ephedra*-Phail-*Lasiurus*
IND_ARI	*Indigofera-Aristida*
BAR	*Barren*
CAP_CAL	*Capparis-Calotropis*
AS	*A. senegal*
CEN_LAS	*Cenchrus-Lasiurus*
LAS_DAC	*Lasiurus-Dactylotenium*
ZIZ	*Ziziphus*
ACA_PRO	*Acacia-Prosopis*
AER_IND	*Aerva-Indigofera*
CAL-AERVA-IND-LEP	*Calotropis-Aerva-Indigofera-Laptadenia*
SET	Settelment
DUN	Dunes
WAT	Water

barbarum **b)** *Brachiaria ramosa*, Gisekia pharnaceoides*, Commiphora wightii* **c)** *Crotalaria burhia*, Accacia senegal*, Raphanus sativus* **d)** *Aerva persica*, Leptadenia pyrotecnica** **e)** *Dactylotenium sindicum*, Leptadenia pyrotecnica*, Ziziphus* sp., *Accacia nilotica* **f)** *Lasiurus* sp.*, *Indigofera cordifolia*, Aristida* sp.*, *Cenchrus biflorus, Tribulus lanuginosus, Fagonia indica* **g)** *Euphorbia granulata*, Trianthema triquetra, Salvadora persica* **h)** *Cenchrus sp.*, Blepharis sindica*, Eragrostis termula, Eragrostis cillaris, Tephrosia strigosa, Corchorus depressus* **I)** *Calligonum polygonides*, Citrullus colocynthis*, Convolvulus rhyniospermus, Prosopis cineraria*. No species was recorded in all the clusters.



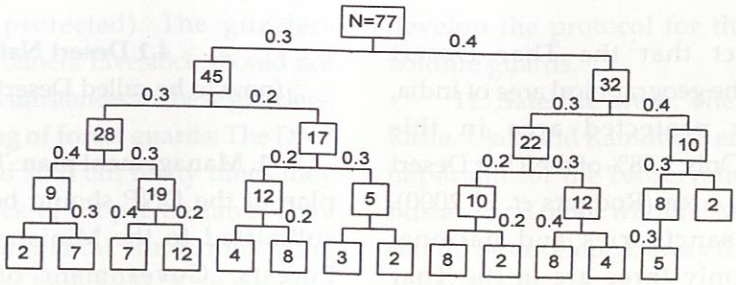
Mosaic of scrub and grassland covers many parts of the Thar Desert



Acacia plantation to stabilize the dunes

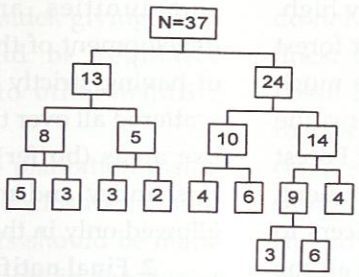
Seven grassland supports species such as the GIB

Fig. 3.2: Dendrogram resulting from TWINSPAN of sites



Vegetation of 79 sites in Desert National Park were classified using TWINSPAN. Above diagram indicates that vegetation is heterogenous there

Fig. 3.3: Dendrogram from TWINSPAN of species



The TWINSPAN classified 33 species of 77 sites into 9 classes/communities

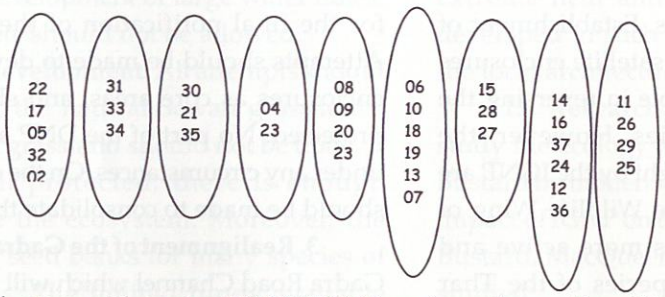


Fig. 3.4: Clusters of communities using TWINSPAN (species code mentioned inside the box) (refer below table)

Species code use as input in TWINSPAN

SPECIES	CODE	SPECIES	CODE
Capparis deciduas	1	*Acacia nilotica*	20
Ephedra foliata	2	*Crotalaria burhia*	21
Calotropis procera	3	*Spergula fallax*	22
Aerva persica	4	*Leptadenia pyrotecnica*	23
Cassia abtusifolia	5	*Blepharis sindica*	24
Indigofera cordifolia	6	*Citrullus colocynthis*	25
Fagonia indica	7	*Calligonum polygonoides*	26
Dactylotenium sindicum	8	*Salvadora persica*	27
Ziziphus sp.	9	*Trianthema triquetra*	28
Lasiurus sp.	10	*Prosopis cineraria*	29
Convolvulus rhyniospermus	11	*Raphanus sativus*	30
Tephrosia strigosa	12	*Brachiaria ramosa*	31
Aristida sp.	13	*Lycicum barbarum*	32
Eragrostis termula	14	*Gisekia pharnaceoides*	33
Euphorbia granulata	15	*Commiphora wightii*	34
Eragrostis cillaris	16	*Acacia senegal*	35
Phail (scientific name not known)	17	*Corchorus depressus*	36
Cenchrus biflorus	18	*Cenchrus sp.*	37
Tribulus lanuginosus	19		

4. RECOMMENDATIONS

Despite the fact that the Thar Desert occupies nearly 9% of the geographical area of India, there are very few protected area in this biogeographical zone. Only 1.78% of the Thar Desert is under the protected area (Rodgers *et. al* 2000). Out of 26 wildlife sanctuaries and national parks in Rajasthan, only three are in the Thar Desert. Owing to rapid changes – ecological, social and cultural – the biodiversity of the Thar Desert is under tremendous pressure and chances of loosing some species and ecosystems are very high.

As the Thar has less than 2% area under forest cover, the Forest Department does not have much influence, notwithstanding plantation along the IGNP (Rahmani 1997a). The Wildlife Wing of Forest Department is neglected by the State Government. For example, there are only two Range Officers to control nearly 3,162 sq. km area. Even with all the neglect, the Thar is still rich in wildlife due to the support of the local communities. Establishment of the Desert National Park and its satellite enclosures have also played a significant role in reversing the decline of some wildlife species. However, the changes and impacts being brought by the IGNP are so overwhelming that unless the Wildlife Wing of the Forest Department becomes more active and effective, the future of many species of the Thar Desert will not be safe.

In this chapter we have given general and area specific recommendations. Our most important recommendation is that the Desert National Park and its five kilometer periphery should be immediately declared **Desert Biosphere Reserve** (DBR). Moreover, in order to protect and enhance the biodiversity of the Thar Desert, development of a much larger **Greater Thar Desert (Marusthali) Biosphere Reserve**, including DNP, Talchhaper, Diyatra and other areas should be explored. The Greater Thar Desert (Marusthali) Biosphere Reserve should have protected areas (e.g. Tal Chhaper, Diyatra and Desert National Park), Community Conservation Areas (e.g. Guda Vishnonian, Dhawa Doli, Kheechan etc.) and Conservation Reserves (e.g. Jakharda etc.).

Below we give area-wise recommendations, starting with the Desert National Park.

4.1 Desert National Park

(now to be called Desert Biosphere Reserve)

1. Management plan: The 10-year management plan of the DNP should be quickly finalized and submitted to the Ministry of Environment and Forests, Government of India for funding. Fortunately, the MoEF has indicated intention to give full funding to protect this Park. The management plan should be developed in such a way that local communities are greatly benefited by the development of the Park. The present arrangement of having strictly protected enclosures (core areas) scattered all over the Park, and in-between multiple-use areas (buffer) should be maintained. Animal husbandry and monsoonal agriculture should be allowed only in the buffer zone.

2. Final notification of the Sanctuary: The State Government should quickly complete the formalities for the final notification of the 3,162 sq km DNP. Attempts should be made to develop the clusters of enclosures as core areas, and should be effectively protected. No part of the DNP should be denotified under any circumstances. On the other hand, attempts should be made to consolidate the Park.

3. Realignment of the Gadra Road Channel: The Gadra Road Channel which will bisect the DNP (Fig. 1.1.1), should be realigned so that it does not fall inside the Park. If due to any reason, this realignment is not possible, then the water should be taken by pipes inside the DNP and not by an open canal.

4. Enclosures: As reported earlier, the enclosures of DNP have very high wildlife values and represent the original vegetation of the desert. These enclosures should be zealously protected from encroachment and over-grazing. Fences should be repaired and motivated guards should be appointed.

5. Development of more enclosures: In the DNP we found four sites which were good repositories of desert fauna and flora. These sites are indicated by A, B, C and D on Map C. These sites should be assigned the status of enclosure after detail survey by the Forest Department.

6. Water guzzlers: During summer, artificial water holes called guzzlers play an important role in attracting wildlife to enclosures (where they are

comparatively better protected). The guzzlers should be properly maintained. Livestock should not be allowed under any circumstances to these guzzlers.

7. Capacity building of forest guards: The DNP has some very motivated staff but many times they are hampered due to lack of proper training. They live in extreme environmental conditions - the temperature can go up as high as 51 °C in summer and as low as 0 °C in winter. Some enclosures are quite remote and ill-connected, with one bus a day to any city! Despite these constrains, the forest guards are doing a good job. Besides giving them desert allowance, they should be regularly sent to training courses and to other wildlife sanctuaries.

8. Plantations: Any type of plantation inside the Park, and particularly in the enclosures should be strictly prohibited. All attempts should be made by the Forest Department to maintain the desert ecosystem intact. Development of large water holes, plantation groves, etc should not be allowed.

9. Grassland development: All attempts should be made to protect the natural Sewan grasslands. Artificial seeding of grassland should not be done. If the habitat is well protected, there is enough rootstock to revive the ecosystem. Moreover, the enclosures serve as seed banks for many species of grasses and shrubs. The limited funds available should be utilized to protect the enclosures and not to plough and artificially seed the grasslands. The famous Sewan grasslands of the Thar desert have survived for thousands of years without artificial seeding and they would survive for many more years only if we leave them alone.

10. Annual census of wildlife: There should be two annual census – one in winter for general wildlife, and another in summer for the Great Indian Bustard and Chinkara. End of May or beginning of June is a good time to conduct census, especially inside enclosures where these species concentrate. As the bustard is semi-nomadic and roams around in a large area, it is very difficult to census it. However, we can easily study the trend of its population by annually conducting summer census in and around enclosures. This census should be conducted by involving interested locals and some conservation NGOs. BNHS-WII will be happy to develop the protocol for the census and to train wildlife guards.

11. Satellite areas: The satellite areas such as Rasla, Ujala and Ramdevra enclosures are extremely important for the conservation of the Great Indian Bustard and other wildlife. More satellite enclosures should be developed, away from the command areas of the IGNP.

12. Interpretation centres: Sam is a popular tourist area where thousands of people visit to see the famous sand dunes. Unfortunately, most of them do not know that they are at the edge of one of the finest wildlife sanctuaries of India. Similarly, Akal Fossil Park, about 15 km from Jaisalmer on Barmer road is also a tourist destination. Good interpretation centres showing the importance of desert ecosystems should be developed at Sam and at Akal. The centres should be developed taking into consideration the local factors like severe power cuts, dust storms, extreme heat and dryness. Buildings should be developed in such a way that they harmonize with the local architecture.

13. Research: Research should be started to study the ecology and movment of the Great Indian Bustard by modern of satellite tracking technique. The impact of IGNP on the distribution of the Great Indian Bustard, MacQueen's Bustard and raptors should be studied.

4.2. Tal Chhaper

1. Illegal Grazing: Tal Chapper sanctuary is surrounded by villages which have a minimum of 10,000 cattle. Illegal grazing goes on throughout the year, but it becomes more severe during the monsoon. The staff of the sanctuary have a tough time chasing away the cattle. Cattle-proof trenches have been dug up by the Forest Department, but have proved ineffective against the determined hordes of cattle and their owners. Strict and honest cattle guards seem to be the only effective measure for controlling grazing inside the sanctuary area.

2. Change in water regime: Besides rainfall, Tal Chapper used to get water overflow from a large depression, some 9 km from the sanctuary near Gopalpura village. But an earthen dam was built and so now water is stored and the overflow has

stooped, resulting in change in the water regime. Another proposal, building of a lift canal of the IGNP beside the sanctuary, will result in spread of agriculture and further exacerbate the crop-damage conflict. However, water from the Canal can be brought to flood the sanctuary for a brief period to bring back the old system of natural flooding.

3. Salt extraction: As the water in the Tal Chapper is brackish, salt extraction units have come up on one side of the Sanctuary, and constant flow of labourers and trucks create disturbance to wildlife. Although the Blackbuck appears to have become used to such din, because they can be seen grazing close by, Desert fox, Jackal, Demoiselle Crane and Bar-headed Goose avoid this area. There is demand by local politicians to expand the salt extraction area, so the Forest Department has demarcated the Sanctuary, but they have to be constantly alert against the danger of denotification of the whole sanctuary or certain parts.

4. Removal of invasive species: *Prosopis juliflora* an exotic weed is coming up everywhere inside the sanctuary area, which if not uprooted regularly will colonize the sanctuary and would ultimately result in the destruction of the grassland habitat. We recommend to remove the species from the entire sanctuary area.

5. Development of Interpretation Centre: Tal Chhaper is becoming quite popular amongst tourists and day visitors. Although there is a four room rest house, there is a need to develop an interpreation center on the desert and grassland ecosystems.

6. School and College visits: Regular visits by school and college students to this sanctuary should be encouraged and facilitated by the Forest Department.

4.3. Diyatra

Diyatra Closed area in Bikaner is one of the most important sites for the Great India Bustard (Rahmani 1997a and Islam & Rahmani 2004). In the early 1980s, there were 30-50 bustards in this area (Islam & Rahmani 2004), but due to intensification of agriculture, over grazing and poaching, there number has perhaps decreased and now it is difficult to locate them. Diyatra is also an important wintering site for MacQueen's or Houbara Bustard. In the wetlands near villages, large flocks of Demoiselle Cranes can be seen. Earlier Diyatra was famous for huge flocks of Imperial Sandgrouse, but now they are not seen in such numbers. White-browed Bushchat or Stoliczka's Winchat is also seen in good numbers in Diyatra region (Rahmani 1994). As Diyatra is close to tourist city Bikaner (60 km) and Gajner (30 km), it can also attract tourists, especially birdwatchers looking for species such as Great Indian Bustard, MacQueen's Bustard, Stoliczka's Winchat, Imperial Sandgrouse, Short-eared Owl, Desert Courser, and various species of wheatears, larks, pipits and raptors. Diyatra is also recognized as an Important Bird Area (Islam & Rahmani 2004), therefore it is in the list of international birdwatchers.

1. Community Reserve: We strongly recommend that Diyatra area should become Community Reserve, under the amended Wildlife Protection Act. Nokh, Nokhra, Kanasar, Dholiya, Baru, Ranjitpura, Hadda, Tankla, Haridas-ki-Dhani and Khara are some of the important villages of this area which could be included in this Community Reserve. Detailed survey of these villages should be conducted to determine the exact boundary of this Community Reserve.

2. Development of enclosures: In Diyatra area, there are many pasture enclosures established by the Rajasthan Government, but now most of them are neglected and over-run by livestock. If properly protected, these grassland enclosures could provide undisturbed breeding areas to the Great Indian Bustard. However, now these enclosures are mainly used by Chinkara and Nilgai and rarely by the Great Indian Bustard. We strongly recommend that at least four *c.* 500 ha enclosures should be established in Diyatra region, much like the satellite enclosures seen in Ramdevra, Rasla and Ujla. There should be strict control on agriculture and grazing inside the enclosures.

2. Control on Poaching: Since declaring Diyatra as a closed area for shooting, the Forest Department seems to have forgotten its existence. There is no patrolling. Sometimes, a forest guard is officially posted there but he rarely visits the area, as a result of which poaching is quite common here. There should be strict control on poaching by regular

patrolling by the Wildlife Wing of the Forest Department.

4.4. Gajner

Gajner is about 32 km from Bikaner on Jaisalmer road. It was the former shooting range of the Maharaja of Bikaner and was very well maintained and protected then. Presently, this 24 sq km Sanctuary is in total neglect due to dual control – land belongs to the former rulers of Bikaner, while wildlife belongs to the Forest Department. We strongly recommend that attempts should be made to transfer the land to the Forest Department. Details of this Sanctuary have been given in Rahmani (1997a), here we give our recommendations:

1. Basic facilities: During Maharajah's time electricity was present in the whole sanctuary, but now even the guard's quarters do not have electricity! No conveyance is given to the guards who patrol this difficult terrain on personal cycles. Flying Squad ranger used to stay in Gajner village, but shifted long back to Bikaner office. There is a need to repair the guard accommodation. Basic facilites such as uniform, motorcycles should be provided to the guards.

2. Fencing: The fence, which once encircled the Sanctuary, is broken. Fence of the sanctuary should be repaired and maintained to stop overgrazing inside the Sanctuary.

3. Tourist attraction: The Sanctuary should be developed as a tourist attraction. It is located on the Bikaner-Jaisalmer national highway and only 32 km from Bikaner, and hence easily accessible.

4.5. Khichan

Khichan, a small village 3 km from Phalodi town of Jodhpur district is now famous for the large number of Demoiselle Cranes that come to this village to feed on the grains provided by the villagers. The cranes are seen from end September to late March. Thousands of cranes are fed each day in fenced areas on the outskirts of Khichan village. Since the Demoiselle Cranes were often disturbed by dogs and passing villagers, a small feeding place was set up by the villagers. However, this area has now become too small for the huge flocks of cranes that come to feed. We recommend setting up more such feeding areas.

Khichan is a classical example of community protection. It can become an exemplary Community Reserve, under the amended Wildlife Protection Act. However, we are greatly concerned about the plans of the Tourism Department who wants to build up tourist facilities right on the main crane area.

Among the globally threatened species, Oriental White-backed *Gyps bengalensis* and Long-billed *Gyps indicus* vultures are still seen, although in very small number. Stoliczka's Winchat *Saxicolla macrorhyncha* could be present in the surrounding scrub areas.

The common mammals found in Kichan are the Desert Fox and Chinkara. Bluebull is spreading due to availability of water from the Indira Gandhi Canal Project.

We have the following recommendations for this interesting area:

1. After taking the consent of local people, Khichan village and surrounding area should be declared as Community Reserve.
2. Khichan Community Reserve should be included in the Greater Thar Desert (Marusthali) Biosphere Reserve.
3. As stored grain is fed to the cranes, which is likely to have pesticide, studies on the pesticide level should be conducted regularly for quality control. It is likely that with all good intentions, we may be giving slow poison (pesticide-laden grains) to these cranes.
4. As the Demoiselle Cranes, like other crane species, live in pairs and bring their offsprings, annual census should be conducted to know the adult-juvenile ratio. This would give us an idea of the annual recruitment rate.
5. No tourist guest house should be built near Khichan. Phalodi city is just 3 km away. Good tourist facilities can be build there.
6. There should be strict restriction on the movement of tourist in the feeding, loafing and roosting areas of the Cranes. However, there should be no restriction on the movement of villagers (as the cranes are not much disturbed by them).

4.6. Dhawa-Doli and Guda Vishnoian

Dhawa-Doli (470 km^2), about 40 km from Jodhpur on Pali road is one of the famous Vishnoi community dominated areas where a large number of Blackbuck and Chinkara are found. The crude density of Chinkara reaches as high as 7 km^2 (Rahmani 1997a). Although Blackbuck numbers is not so high as Chinkara, it is still high in some areas as they are more localized. The crude density of the sampled area was 0.76 Blackbuck/km^2 during a survey in February 1993.

The Government of Rajasthan has declared many Closed Areas for Shooting, but now as this category of protected area has been removed under the amended Wildlife Protection Act in 2003, and replaced by two new categories (Community Reserve and Conservation Reserve), we suggest that Dhawa-Doli should be declared as Community Reserve. Similarly, we also recommend that Guda-Vishnoian area, 8 km from Jodhpur and spread to 425 km^2 should also be declared as Community Reserve. Most of the land in both these areas are under private hands and the community (Vishnoi) is famous for protecting wildlife, especially Chinkara and Blackbuck. If these areas are declared as Community Reserves, there would be no change in the land tenure – only destructive activities such as open cast mining by outsiders, establishment of polluting industries etc would not be allowed. Both these areas are under agriculture where mainly monsoonal cropping is done (some well-irrigation also takes place).

According to Goyal *et al.* (1986), the northern part of the Guda Vishnoin is mainly utilized by Chinkara and domestic animals. It is mainly scrubland with few agricultural fields. The southern part is gravel, with limited cultivation. The river Luni is situated here. However, for most of the year, Luni River does not flow and remains dry. Some pools are left, especially after a good monsoon.

The major vegetation of this area consists of *Prosopis cineraria, Capparis deciduas, Tecomella undulate, Acacia jacquemonti, A. nilotica, Crotalaria burhia, Tephrosia purperea, Zizyphus spp., Calotropis procera, Leptedenia pyrotechnica, Tamarix articulate* and *Balanites aegyptiaca.* The main grass species are *Cyanodon dactylon, Desmostachya bininnata, Eleusine compressa, Sporobolus marginatus* and *Dactyloctenium aegyptium.*

Goyal *et al.* (1986) and Ghosh *et al.* (1986) have studied the eco-physiological characteristic of Blackbuck and Chinkara in Guda Vishnoian area.

Recommendations:

1. Both Dhawa-Doli and Guda-Vishnonian area should be declared as Community Reserves.
2. Both areas should become a part of the Greater Desert (Marusthali) Biosphere Reserve.
3. Proper biodiversity inventory should be made.
4. Regular monitoring of Chinkara, Blackbuck, Nilgai, Wolf and other wildlife should be conducted. This monitoring could be once in two years or once in three years. Proper protocol for censusing and monitoring could be developed by the BNHS and WII.
5. Detailed and long-term ecological studies on Blackbuck and Chinkara should be started.
6. Impact of crop damage by antelopes should be studied and solutions found as how to minimize this damage.
7. Predictive models of the changing crop patterns, demands of globalization and market forces should be studied to devise long-term strategies to maintain the biodiversity and cultural values of these areas.
8. Impact of spread of invasive species such as *Prosopis chilensis* (= *juliflora*) should be studied. Presently, local communities use *Prosopis chilensis* as fuel wood. What would be the impact on the indigenous tree species if this invasive species is totally eradicated?

4.7. Bhagardha-Dhorimanna

In Bhagardha (also spelled Jakharda) near Dhorimanna in Barmer district, a small area of about 10 sq km has been declared as protected by the Forest Department, where Blackbuck and Chinkara are found in very high density. Rahmani (1997a) found 4.76 Chinkara km^2 during survey in July 1993. Despite open cast mining, movement of trucks and people, the animals are quite safe and could be approached very closely. According to the local forest officials, about 200 Blackbuck are found in about 10 km^2 area (Rahmani 1997a). This small area should be included in the

Greater Thar Desert (Marusthali) Biosphere Reserve.

We recommend the following measures to protect Bhagardha (=Jakharda) area:

1. This area, although very small, should become one of the core areas of Greater Thar Desert (Marusthali) Biosphere Reserve. If necessary, this could be declared as a wildlife sanctuary.
2. Ecological and behavioral studies on Blackbuck and Chinkara should be started to study their ecological niche and exact habitat requirements.
3. As the area is saline, fresh water should be supplied to Blackbuck (which cannot live without water more than 2-3 days while Chinkara is not so dependent on water).
4. Basic facilities should be provided for tourists to stay overnight.
5. An interpretation centre should be developed on the importance of desert biome.
6. Spread of *Prosopis chilensis* should be controlled.

4.8. Mohangarh area

Despite the fact that the Indira Gandhi Nahar Project (IGNP) has bisected this large, typical desert area, and has brought many ecological changes due to changes in demography and cropping pattern, the area still supports fairly good populations of globally endangered Great Indian Bustard and the migratory MacQueen's or Houbara Bustard. Moreover, local communities are favourably inclined towards conservation. Digha, Mondha, Sankhala, Khinya, Hamira, Nidai, Deva, Kanod and Fakiron-ki-dhani are the major villages around which the Great Indian Bustards are still seen.

We recommend that a thorough survey should be done to identify exact area (village boundaries) which can be made into Community Reserve, under the recently amended Wildlife Protection Act. Once this is done, this area can be included in the Greater Thar Desert (Marusthali) Biosphere Reserve.

4.9. Ramgarh area

Some of the best extant Sewan grasslands are found in Ramgarh area, especially Sultana and Shahgarh bulge. Most of this area is close to international border and falls under the army but there is a huge area which can be considered as Community Reserve. Tanot, Shadhewala, Longwala, Ghotaru, Shahgarh, Khuiyala, Bhadasar and Ramgarh are the major villages around which this Community Reserve can be established. As the human population is very low, much of the area is under the Revenue Department. Therefore, some parts can be declared as Conservation Reserve. We recommend that Ramgarh-Shahgarh area should be included in the Greater Thar Desert (Marusthali) Biosphere Reserve.

Great Indian Bustard, MacQueen's Bustard, and a large number of other bird species are found in this area. Imperial Sandgrouse *Pterocles orientalis*, Pintail Sandgrouse *Pterocles alchata*, Spotted Sandgrouse *Pterocles senegallus* and Chestnut-bellied Sandgrouse *Pterocles exustus* are found in fairly large numbers. Manoj Kulshreshtha (*pers. comm.* 2006) has also reported Syke's Nightjar *Caprimulgus mahrattensis* and Desert Lark *Ammomanes deserti* from this area. Greater Hoopoe Lark *Alaemon alaudipes* probably breed in this area. The Thar Desert is the eastern most limit of this widely distributed species in the Middle East and northern Africa. In winter, MacQueen's Bustard is found all over this area. Critically endangered White-backed and Long-billed vultures are still found in this area, along with the migratory Cinereous Vulture *Aegypius monachus*.

4.10 Ramdevra

Although Ramdevra enclosure is a part of Desert National Park (as a satellite enclosure), we recommend that more attention should be given to this neglected area. Every year 14-16 Great Indian Bustards are seen here from April onwards for about three months. Ramdevra enclosure has a very high population of Chinkara, Nilgai and Spiny-tailed Lizarad *Uromastix hardwickii*. High density of Spiny-tailed Lizard attracts very large numbers of raptors, especially Steppe Eagle *Aquila nipalensis* which are more or less dependent on this lizard. White-eyed Buzzard *Butastar teesa*, Long-legged Buzzard *Buteo rufinus*, Laggar Falcon *Falco jugger* and Common Kestrel *Falco tinnunculus* are some other raptors. Among vultures, the following are (were) seen in Ramdevra enclosures: White-backed *Gyps bengalensis*, Long-billed *Gyps*

indicus, Griffon *Gyps fulvus*, Cinereous *Aegypius monachus*, Red-headed *Sarcogyps calvus*, and Egyptian Vulture *Neophron percnopterus*. The Vulnerable Stoliczka's Winchat *Saxicola macrorhyncha* is also found in the area. During winter, the enclosure attracts hundreds of thousands larks, mainly: Greater Short-toed Lark *Calandrella brachydactyla*, Ashy-crowned Finch Lark *Eremopterix grisea*, Black-crowned Lark *Eremoterix bimaculata* and Crested Lark *Galerida cristata*.

Ramdevra is also a temple town so it has religious significance. Moreover the surrounding area is inhabited by Vishnoi community, and between Pokhran and Ramdevera, a huge area is under the control of Border Security Force (BSF), hence well protected from poachers. The BSF and the Forest Department also maintain some grasslands that are important for the Great Indian Bustard and other wildlife. Therefore, the area has all the characteristics to be declared as Community Reserve. Ramdevra enclosure is fenced and there is a Forest chowki. This chowki is also connected by wireless to DNP offices at Jodhpur and Jaisalmer. Ramdevra enclosure is on Bikaner-Jaisalmer road and easily accessible to visitors. Despite being a part of DNP and having full time staff, the Ramdevra enclosure is heavily overgrazed by livestock during the fruiting of *Capparis decidua* and *Ziziphus*. A large number of people come inside the enclosure illegally to harvest these berries. Incidentally, one of the main reasons for the presence of the Great Indian Bustard is these fruits. These birds are repeatedly disturbed by freely roaming people inside the enclosures.

We have the following recommendation for Ramdevra enclosure (there are four adjoining enclosures) and the surrounding area:

1. Although Ramdevra enclosures are a part of the DNP, (as satellite enclosures), we recommend that more administrative attention should be given to there enclosures.
2. We recommend that Ramdevra enclosures and the surrounding grasslands should form a part of Greater Thar Desert (Marusthali) Biosphere Reserve.
3. There should be strict control on illegal grazing and collection of berries inside the enclosures.
4. Fence of the enclosures should be repaired immediately.
5. There should be a scientific study on the role of Spiny-tailed Lizard as a major prey base for large number of raptors.
6. Basic facilities for visitors should be provided.
7. Environmental Education programme should be started in the surrounding areas.
8. In some areas, bush cover has increased which is detrimental to the Great Indian Bustard. Some bushes should be removed from selected areas to make the habitat more open.
9. No plantation whatsoever should be attempted inside the enclosures.
10. The invasive *Prosopis chilensis* should be totally eradicated from the enclosures.

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Appendix: 1

So far, 168 species of plants belonging to II group under 46 families have been specifically reported from the DNP (Pandey *et al.* 1985).

S. No	Group	Family	Genera	Species
1	Dicots	Menispermaceae	*Coeculus*	*Coeculus pendulus*
2		Brassicaceae	*Farsetia*	*Farsetia hamiltonii*
3		Cleomaceae	*Celome*	*Celome brachycarpa*
				Celome scaposa
				Celome gynandra
				Celome vahliana
				Celome farsen
				Celome viscose
4		Capparaceae	*Capparis*	*Capparis deciduas*
			Dipterygium	*Dipterygium glaucum*
			Maeura	*Maeura arenaria*
5		Polygalaceae	*Polygala*	*Polygala eripfera*
6		Portulacaceae	*Portulaca*	*Portulaca oleracea*
7		Tamaricacae	*Tamarix*	*Tamarix indica*
8		Elatinaceae	*Bergia*	*Bergia ammannioides*
				Bergia suffruticosa
9		Malvaceae	*Abutilon*	*Abutilon fruticosum*
			Hibiscus	*Hibiscus amblyocarpus*
				Hibiscus micranthus
			Sida	*Sida ovata*
				Sida tiagii
10		Stercullaceae	*Melhania*	*Melhania denhamii*
11		Tiliaceae	*Corchorus*	*Corchorus depressus*
				Corchorus olitorius
				Corchorus tridens
			Grewia	*Grewia tenax*
12		Zygophyllaceae	*Fagonia*	*Fagonia indica*
			Seetzenia	*Seetzenia orientails*
			Tribulus	*Tribulus longipetalus*
				Tribulus longipetalus macropterus
				Tribulus rajasthanesis
				Tribulus terrestris
			Zygophyllum	*Zygophyllum simplex*
13		Geraniaceae	*Monsonia*	*Monsonia senegalensis*
14		Burseraceae	*Commiphora*	*Commiphora wightii*
15		Rhamnaceae	*Ziziphus*	*Ziziphus mauritiana*
				Ziziphus nummularis
				Ziziphus truncate
16		Moringaceae	*Moringa*	*Moringa concanesis*

Appendix: 1 (contd.)

So far, 168 species of plants belonging to II group under 46 families have been specifically reported from the DNP (Pandey *et al.* 1985).

S. No	Group	Family	Genera	Species
17		Fabaceae	*Alysicarpus*	*Alysicarpus heterophyllus*
				Alysicarpus vaginalis
			Aeschynomene	*Aeschynomene indica*
			Crotalaria	*Crotalaria burhia*
				Crotalaria medicaginea
			Cyamopsis	*Cyamopsis tetragonoloba*
			Goniogyna	*Goniogyna hirta*
			Indigofera	*Indigofera argentea*
				Indigofera cordifolia
				Indigofera hochstetteri
				Indigofera linifolia
				Indigofera linnaei
				Indigofera sessiliflora
				Indigofera trigonolloides
			Phaseolus	*Phaseolus trilobus*
			Rhynohosia	*Rhynohosia arenaria*
				Rhynohosia minima
				Rhynohosia shimperi
			Tephrosia	*Tephrosia falciformis*
				Tephrosia purpurea
				Tephrosia strigosa
				Tephrosia villosa
18		Caesalpiniaceae	*Cassis*	*Cassis italica*
19		Mimosaceae	*Accacia*	*Accacia nilotica*
				Accacia Senegal
			Mimosa	*Mimosa hamata*
			Prosopis	*Prosopis cineraria*
20		Rosaceae	*Neurada*	*Neurada procumbens*
21		Vahliaceae	*Bistella*	*Bistella digyna*
23		Lythraceae	*Ammannia*	*Ammannia desertorum*
24		Cucurbitaceae	*Citrullus*	*Citrullus colocynthis*
			Coccinia	*Coccinia grandis*
			Cucumis	*Cucumis melo*
				Cucumis prophetarum
			Mukia	*Mukia maderaspatana*
25		Molluginaceae	*Gisekia*	*Gisekia pharnaceoides*
			Mollugo	*Mollugo cerviana*
				Mollugo nudicanlis
26		Aizoaceae	*Glinus*	*Glinus lotodies*
			Limeum	*Limeum indicum*

Appendix: 1 (contd.)

So far, 168 species of plants belonging to II group under 46 families have been specifically reported from the DNP (Pandey *et al.* 1985).

S. No	Group	Family	Genera	Species
			Sesuvium	*Sesuvium sesuvioides*
			Traianthema	*Traianthema triquetra*
			Zaleya	*Zaleya radimita*
27		Rubiaceae	*Kohautia*	*Kohautia aspera*
28		Asteraceae	*Dicoma*	*Dicoma tomentosa*
			Launaea	*Launaea procumbens*
			Oligochaeta	*Oligochaeta ramosa*
			Pulicaria	*Pulicaria angustifolia*
				Pulicaria crispa
			Vernonia	*Vernonia cinerascens*
29		Salvadoraceae	*Salvadora*	*Salvadora oleoides*
30		Asclepiadaceae	*Calotrpis*	*Calotrpis procera*
			Glossonema	*Glossonema varians*
			Leptadenia	*Leptadenia pyrotechnica*
31		Gentianaceae	*Enicostema*	*Enicostema hyssopifolium*
32		Boraginaceae	*Arnebia*	*Arnebia hispidissima*
			Heliotropium	*Heliotropium baciferum*
				Heliotropium marifolium
				Heliotropium rariflorum
				Heliotropium subulatum
			Sericostoma	*Sericostoma pauciflorum*
33		Ehretiaceae	*Cordia*	*Cordia gharaf*
34		Convolvulaceae	*Convolvulus*	*Convolvulus prostratus*
			Cressa	*Cressa cretica*
			Ipomoea	*Ipomoea sindica*
				Ipomoea verticillata
			Seddera	*Seddera latifolia*
35		Solanaceae	*Datura*	*Datura innoxia*
			Lycium	*Lycium barbarum*
			Solanum	*Solanum surrattense*
36		Scrophulariaceae	*Anticharis*	*Anticharis glandulosa*
				Anticharis senegalensis
			Schweinfurthia	*Schweinfurthia papilionacea*
37		Bigniniaceae	*Tecomella*	*Tecomella undulata*
38		Acanthaceae	*Blepharis*	*Blepharis linarefolia*
			Justicia	*Justicia procumbens*
39		Verbenaceae	*Bouchea*	*Bouchea diffusa*
40		Nyctaginaceae	*Boerhavia*	*Boerhavia diffusa*
				Boerhavia elegans

Appendix: 1 (contd.)

So far, 168 species of plants belonging to II group under 46 families have been specifically reported from the DNP (Pandey *et al.* 1985).

S. No	Group	Family	Genera	Species
			Commicarpus	*Commicarpus verticillatus*
41		Amaranthaceae	*Aerva*	*Aerva javanica*
			Amaranthus	*Amaranthus blitium*
				Amaranthus viridis
			Digera	*Digera muricata*
42		Polygonaceae	*Calligonum*	*Calligonum polygonoides*
			Polygonum	*Polygonum plebeium*
43		Euphorbiaceae	*Euphorbia*	*Euphorbia caducifolia*
				Euphorbia granulata
			Phyllanthus	*Phyllanthus fraternus*
				Phyllanthus maderaspatensis
44	Monocots	Liliaceae	*Dipcadi*	*Dipcadi erythraeum*
45		Cyperaceae	*Cyperus*	*Cyperus arenarius*
				Cyperus conglomeratus
				Cyperus iria
				Cyperus rotundus
46		Poaceae	*Aristida*	*Aristida adscensionis*
				Aristida funiculata
				Aristida hysticula
				Aristida mutabillis
			Brachiaris	*Brachiaris ramosa*
			Cenchrus	*Cenchrus biflorus*
				Cenchrus ciliaris
				Cenchrus prieurii
				Cenchrus setigerus
			Cymbopogon	*Cymbopogon jwarancusa*
			Dactylocrenium	*Dactylocrenium scindium*
			Demostachya	*Demostachya bipinnata*
			Dichanthium	*Dichanthium annulatum*
			Digitaria	*Digitaria adscendens*
			Echinochloa	*Echinochloa colonum*
			Enneapogon	*Enneapogon brachystachyus*
			Eragrostis	*Eragrostis ciliaris ciliaris*
				Eragrostis ciliaris brachystachya
				Eragrostis diarrhena
				Eragrostis japonica
				Eragrostis minor
				Eragrostis tenella
			Eremopogon	*Eremopogon foveolatus*
			Heteropogon	*Heteropogon contortus*

Appendix: 1 (contd.)

So far, 168 species of plants belonging to II group under 46 families have been specifically reported from the DNP (Pandey *et al.* 1985).

S. No	Group	Family	Genera	Species
			Lasiurus	*Lasiurus sindicus*
			Latipes	*Latipes senegalensis*
			Melanocenchris	*Melanocenchris abyssinica*
			Ochthochloa	*Ochthochloa compressa*
			Oropetium	*Oropetium thomaeum*
			Panicum	*Panicum antidotale*
			Panicum	*Panicum turgidum*
			Stipagrostis	*Stipagrostis hirtigluma*
				Stipagrostis plumosa
			Travus	*Travus roxburghii*

Appendix: 2

Mammals of the Thar Desert

Order	Family	Species	IWPA (1972) as amended up to 2002
Insectivora	Erinaceidae	*Hemiechinus microus*	Not listed in any Schedule
		Hemiechinus collaris	Schedule IV
	Soricdae	*Suncus murinus sindensis*	Not listed in any Schedule
		Suncus murinus caerulescens	Not listed in any Schedule
		Suncus stoliczkanus leucogenys	Not listed in any Schedule
Chiroptera	Pteropodidae	*Pteroppus giganteus giganteus*	Schedule V
		Rousettus leschenaulti	Schedule V
		Cynopterus sphinx sphinx	Schedule V
	Megadermatidae	*Megaderma lyra*	Not listed in any Schedule
	Rhinolophidae	*Rhinolophus lepidus lepidus*	Not listed in any Schedule
	Rhinopomatidae	*Rhinopoma microphyllum kinneari*	Not listed in any Schedule
		Rhinopoma hardwickei	Not listed in any Schedule
	Emballonuridae	*Taphozous perforatus perforatus*	Not listed in any Schedule
		Taphozous kachhensis	Not listed in any Schedule
	Molossidae	*Tadarida aegyptiaca*	Not listed in any Schedule
	Vespertilinidae	*Pipistrellus mimus mimus*	Not listed in any Schedule
		Pipistrellus dormeri caurinus	Not listed in any Schedule
		Scotophilus heathi heathi	Not listed in any Schedule
Primates	Cercopithecidae	*Semnopithecus entellus entellus*	Schedule II
		Macaca mulatta mulatta	Schedule II
Carnivora	Canidae	*Canis aureus**	Schedule II
		*Canis lupux pallipes**	Schedule I
		*Vulpes vulpes pusilla**	Schedule I
		*Vulpes bengalensis**	Schedule II
	Viverridae	*Viverricula indica deserti*	Schedule II
	Herpestidae	*Herpestes javanicus pallipes*	Schedule IV
		Herpestes edwardsi nyula	Schedule IV
		Herpestes edwardsi ferrugineus	Schedule IV
		Herpestes smithi	Schedule IV
	Felidae	*Felix silvestris ornate*	Schedule I
		Felix chaus prateri	Schedule II
		Caracal caracal schmitzi	Schedule I
		Panthera pardus fusca	Schedule I
Artiodactyla	Bovidae	*Boselaphus tragocamelus**	Schedule III
		*Antilope cervicapra rajputanae**	Schedule I
		*Gazella bennetii**	Schedule I
Logomorpha	Leporidae	*Lepus nigricollis dayanus**	Schedule IV
		Lepus nigricollis ruficaudatus	Schedule IV

Appendix: 2 (contd.)

Mammals of the Thar Desert

Order	Family	Species	IWPA (1972) as amended up to 2002
Rodentia	Sciuridae	*Faunambulus penant*i*	Schedule IV
	Muridae	*Vandeleuria oleracea oleracea*	Schedule V
		Rattus rattus arboreus	Schedule V
		Rattus rattus rufescens	Schedule V
		Rattus norvegicus	Schedule V
		Cremnomys cutchius	Schedule V
		Mus musculus praetexus	Schedule V
		Mus musculus homourus	Schedule V
		Mus musculus castaneus	Schedule V
		Mus phillipsi	Schedule V
		Mus booduga	Schedule V
		Mus platythrix	Schedule V
		Mus saxicola sadhu	Schedule V
		Bandicota bengalensis bengalensis	Schedule V
		Golunda ellioti ellioti	Schedule V
		Millardia meltada meltada	Schedule V
		Millardia gleadowi	Schedule V
		*Meriones hurrianae**	Schedule V
		*Tatera indica indica**	Schedule V
		Gerbillius gleadowi	Schedule V
		Gerbillius nanus nanus	Schedule V
	Hystricidae	*Hystrix indica**	Schedule IV

Source: Tyagi and Baqri (2005)

Appendix: 3

Birds of Rajasthan

SR. NO	ENGLISH NAME	SCIENTIFIC NAME	ALTERNATIVE NAME	STATUS
1	Black-necked Grebe	*Podiceps nigricollis*		WM
2	Great Crested Grebe	*Podiceps cristatus*		WM, R
3	Little Grebe	*Tachybaptus ruficollis*		R, WM, LM1, LM2
4	Spot-billed Pelican	*Pelecanus philippensis*		R, LM2
5	Dalmatian Pelican	*Pelecanus crispus*		WM
6	Great White Pelican	*Pelecanus onocrotalus*		WM, R
7	Indian Shag (Indian Cormorant)	*Phalacrocorax fuscicollis*		R, LM2
8	Great Cormorant	*Phalacrocorax carbo*		R, LM2
9	**Little Cormorant***	*Phalacrocorax niger*		R, LM2
10	Darter (Oriental Darter)	*Anhinga melanogaster*		R, LM2
11	Western Reef-heron (Western Reef-egret)	*Egretta gularis*		R, LM2
12	**Little Egret***	*Egretta garzetta*		R, LM2
13	Great Egret	*Casmerodius albus*	*Egretta alba*	R, LM2
14	Intermediate Egret	*Mesophoyx intermedia*	*Egretta intermedia*	R, LM2
15	**Eastern Cattle Egret (Cattle Egret)***	*Bubulcus ibis*	*Bubulcus coromandus*	R, AM
16	Grey Heron	*Ardea cinerea*		R, WM, LM1
17	Purple Heron	*Ardea purpurea*		R, WM(?), LM2
18	**Indian Pond-heron***	*Ardeola grayii*		R, LM2
19	Black-crowned Night-heron	*Nycticorax nycticorax*		R, LM1
20	Striated Heron (Green-backed Heron)	*Butorides striatus*	*Butorides striata*	R
21	Black Bittern	*Dupetor flavicollis*		R, LM1, LM2
22	Chestnut Bittern (Cinnamon Bittern)	*Ixobrychus cinnamomeus*		R, LM2
23	Yellow Bittern	*Ixobrychus sinensis*		R, LM2
24	Little Bittern	*Ixobrychus minutus*		R, LM2
25	Eurasian Bittern (Great Bittern)	*Botaurus stellaris*		WM
26	Wooly-necked Stork (White-necked Stork)	*Ciconia episcopus*		R
27	Asian Openbill (Asian Open-billed Stork)	*Anastomus oscitans*		R, LM2
28	White Stork	*Ciconia ciconia*		WM
29	Painted Stork	*Mycteria leucocephala*		R, LM2
30	Black Stork	*Ciconia nigra*		WM
31	Black-necked Stork	*Ephippiorhynchus asiaticus*		R
32	Glossy Ibis	*Plegadis falcinellus*		R, WM, LM2
33	Black-headed Ibis (Asian White Ibis)	*Threskiornis melanocephalus*		R, LM2
34	Eurasian Spoonbill	*Platalea leucorodia*		R, LM2
35	Indian Black Ibis (Black Ibis)	*Pseudibis papillosa*		R, LM2
36	Lesser Adjutant	*Leptoptilos javanicus*		R, LM2
37	Greater Adjutant	*Leptoptilos dubius*		R, LM2
38	Lesser Flamingo	*Phoenicopterus minor*	*Phoeniconaias minor*	R, LM1, LM2
39	Greater Flamingo	*Phoenicopterus ruber*	*Phoenicopterus roseus*	R, WM, LM1, LM2
40	Bar-headed Goose	*Anser indicus*		WM, LM1

Appendix: 3 (contd.)

Birds of Rajasthan

SR. NO	ENGLISH NAME	SCIENTIFIC NAME	ALTERNATIVE NAME	STATUS
41	Greylag Goose	*Anser anser*		WM
42	Lesser Whistling-duck	*Dendrocygna javanica*		R, LM2
43	Common Shelduck (Redbilled Shelduck)	*Tadorna tadorna*		WM
44	Comb Duck	*Sarkidiornis melanotos*		R, LM2
45	Common Teal	*Anas crecca*		WM
46	Garganey	*Anas querquedula*		WM
47	Falcated Duck	*Anas falcata*		WM
48	Gadwall	*Anas strepera*		WM
49	Eurasian Wigeon	*Anas penelope*		WM
50	Northern Shoveller	*Anas clypeata*		WM
51	Northern Pintail	*Anas acuta*		WM
52	Indian Spot-billed Duck (Spot-billed Duck)	*Anas poecilorhyncha*		R, LM1, LM2, WM
53	Mallard	*Anas platyrhynchos*		WM, R
54	White-headed Duck	*Oxyura leucocephala*		WM
55	Greater Scaup	*Aythya marila*		WM, V
56	Tufted Duck (Tufted Pochard)	*Aythya fuligula*		WM
57	Ferruginous Duck (Ferruginous Pochard)	*Aythya nyroca*		WM, R
58	Common Pochard	*Aythya ferina*		WM
59	Red-crested Pochard	*Rhodonessa rufina*	*Netta Rufina*	WM
60	Cotton Teal (Cotton Pygmy-goose)	*Nettapus coromandelianus*	*Rhodonessa (106) caryophyllacea*	R, LM2
61	**Black-winged Kite (Black-shouldered Kite)***	*Elanus caeruleus*		R
62	Brahminy Kite	*Haliastur indus*		R, LM2
63	**Black Kite***	*Milvus migrans migrans/govinda*		R, LM1
64	Besra Sparrowhawk	*Accipiter virgatus*		R, AM
65	Shikra		*Accipiter badius cenchroides*	
66	Northern Goshawk	*Accipiter gentilis*		R, WM
67	Eurasian Sparrowhawk	*Accipiter nisus*	*melaschistos*	R, WM, AM
68	**Steppe Buzzard (Eurasian Buzzard) (Desert Buzzard)***	*Buteo buteo*	*vulpinus*	WM
69	**Long-legged Buzzard***	*Buteo rufinus*		WM, AM
70	Oriental Honey-buzzard	*Pernis ptilorhyncus*		R, WM, LM2
71	**White-eyed Buzzard***	*Butastur teesa*		R
72	Crested Serpent-eagle	*Spilornis cheela*		R, LM1
73	**Short-toed Eagle (Short-toed Snake-Eagle)***	*Circaetus gallicus*		R
74	Booted Eagle	*Hieraaetus pennatus*		WM, R
75	Bonelli's Eagle	*Hieraaetus fasciatus*		R, WM
76	Changeable Hawk-eagle	*Spizaetus cirrhatus*	*Spizaetus limnaeetus*	R
77	Crested Hawk-eagle	*Spizaetus cirrhatus*		

Appendix: 3 (contd.)

Birds of Rajasthan

SR. NO	ENGLISH NAME	SCIENTIFIC NAME	ALTERNATIVE NAME	STATUS
78	Black Eagle	*Ictinaetus malayensis*		R
79	**Indian Spotted Eagle (Lesser Spotted Eagle)***	*Aquila pomarina*	*Aquila hastata*	R
80	Greater Spotted Eagle	*Aquila clanga*		R, WM
81	**Steppe Eagle***	*Aquila nipalensis*		WM
82	**Tawny Eagle***	*Aquila rapax*		R
83	Golden Eagle	*Aquila chrysaetos*		R
84	Eastern Imperial Eagle (Imperial Eagle)	*Aquila heliaca*		WM, R
85	Osprey	*Pandion haliaetus*		WM, R
86	Grey-headed Fish-eagle (Greater Grey-headed Fish-Eagle)	*Ichthyophaga icthyaetus*		R
87	White-bellied Sea-eagle	*Haliaeetus leucogaster*		R
88	Pallas's Fish-eagle	*Haliaeetus leucoryphus*		R, LM1
89	White-tailed Eagle	*Haliaeetus albicilla*		WM
90	**White-rumped Vulture (Indian White-backed Vulture)***	*Gyps bengalensis*		R
91	**Indian Vulture (Long-billed Vulture)***	*Gyps indicus*		R, AM
92	**Griffon Vulture (Eurasian Griffon-Vulture)***	*Gyps fulvus*		R, AM, LM1
93	Himalayan Vulture (Himalayan Griffon-Vulture)	*Gyps himalayensis*		R, AM
94	**Egyptian Vulture***	*Neophron percnopterus*		R, AM
95	**Red-headed Vulture (King Vulture)***	*Sarcogyps calvus*	*Aegypius calvus*	R
96	**Cinereous Vulture***	*Aegypius monachus*		WM, R
97	**Montagu's Harrier***	*Circus pygargus*		WM
98	**Pallid Harrier (Pale Harrier)***	*Circus macrourus*		WM, SM
99	Pied Harrier	*Circus melanoleucos*		WM, R, LM2
100	Hen Harrier	*Circus cyaneus*		WM
101	**Western Marsh Harrier (Eurasian Marsh Harrier)***	*Circus aeruginosus*		WM
102	Merlin	*Falco columbarius*	*insignis*	WM
103	Lesser Kestrel	*Falco naumanni*		WM
104	**Common Kestrel (Kestrel)***	*Falco tinnunculus*		R, WM
105	Oriental Hobby	*Falco severus*		R, AM, LM1
106	Eurasian Hobby (Northern Hobby)	*Falco subbuteo*		WM, R, AM, LM1
107	**Red-headed Falcon (Red-headed Merlin)***	*Falco chicquera*		R, LM1
108	Peregrine Falcon (Shaheen)	*Falco peregrinus*	*peregrinator*	R, WM
109	Peregrine Falcon	*Falco peregrinus*	*calidus*	
110	Red-capped Falcon	*Falco peregrinus*	*babylonicus*	
111	**Laggar Falcon***	*Falco biarmicus jugger*		R, NE, LM1
112	Saker Falcon	*Falco cherrug*		WM
113	Eastern Saker Falcon	*Falco cherrug*	*milvipes*	

Appendix: 3 (contd.)

Birds of Rajasthan

SR. NO	ENGLISH NAME	SCIENTIFIC NAME	ALTERNATIVE NAME	STATUS
114	**Grey Francolin***	*Francolinus pondicerianus*		R
115	Black Francolin	*Francolinus francolinus*		R
116	Painted Francolin	*Francolinus pictus*		R, E, LM2
117	**Common Quail (Grey Quail)***	*Coturnix coturnix*		R, WM
118	**Rain Quail***	*Coturnix coromandelica*		R, LM1, LM2
119	Blue-breasted Quail	*Coturnix chinensis*		R, LM2
120	Jungle Bush-quail	*Perdicula asiatica*		R, E
121	Rock Bush-quail	*Perdicula argoondah*		R, E
122	Barred Buttonquail (Common Bustard-Quail)	*Turnix suscitator*		R, LM2
123	Yellow-legged Buttonquail (Yellow-legged Bustard-Quail)	*Turnix tanki*		R, LM1
124	Small Buttonquail (Little Bustard-Quail)	*Turnix sylvatica*		R, LM1, LM2
125	Red Spurfowl	*Galloperdix spadicea*		R, E
126	Painted Spurfowl	*Galloperdix lunulata*		R
127	Grey Junglefowl	*Lophophorus sonneratii*	*Gallus sonneratii*	R, E
128	Indian Peafowl	*Pavo cristatus*		R, E
129	Common Crane	*Grus grus*		WM
130	Demoiselle Crane	*Grus virgo*		WM
131	Sarus Crane	*Grus antigone*		R
132	Siberian Crane	*Grus leucogeranus*		WM
133	Lesser Florican	*Sypheotides indica*	*Sypheotides indicus*	R, LM2, E, WM
134	**Houbara Bustard (MacQueen's Bustard)***	*Chlamydotis macqueeni*	*Chlamydotis undulata*	V, R
135	**Great Indian Bustard***	*Ardeotis nigriceps*		R, E, LM2
136	Slaty-breasted Rail	*Gallirallus striatus*	*Rallus striatus*	R, LM2
137	European Water Rail (Water Rail)	*Rallus aquaticus*		WM, R
138	Eastern Baillon's Crake (Baillon's Crake)	*Porzana pusilla*		WM, R
139	Spotted Crake	*Porzana porzana*		WM
140	Ruddy-breasted Crake	*Porzana fusca*		R, LM2
141	Brown Crake	*Amaurornis akool*	*Porzana akool*	R, LM2
142	White-breasted Waterhen	*Amaurornis phoenicurus*		R
143	Watercock	*Gallicrex cinerea*		R, LM2
144	Purple Swamphen	*Porphyrio porphyrio*	*poliocephalus*	R, LM2
145	Common Moorhen	*Gallinula chloropus*		R, WM
146	Eurasian Coot (Common Coot)	*Fulica atra*		R, WM
147	Greater Painted-snipe	*Rostratula benghalensis*		R
148	Pied Avocet	*Recurvirostra avosetta*		WM, R, LM2
149	**Black-winged Stilt***	*Himantopus himantopus*		R, E, LM2
150	Bronze-winged Jacana	*Metopidius indicus*		R, LM2
151	Pheasant-tailed Jacana	*Hydrophasianus chirurgus*		R, LM2
152	**Oriental Pratincole (Collared Pratincole)***	*Glareola maldivarum*		R, SM, WM, LM2(?)
153	Small Pratincole	*Glareola lactea*		R, LM2

Appendix: 3 (contd.)

Birds of Rajasthan

SR. NO	ENGLISH NAME	SCIENTIFIC NAME	ALTERNATIVE NAME	STATUS
154	**Cream-coloured Courser***	*Cursorius cursor*		R, WM, LM2
155	**Indian Courser***	*Cursorius coromandelicus*		R, E, LM2
156	Great Thick-knee	*Esacus recurvirostris*		R, E, LM2
157	**Eurasian Stone-curlew (Stone-curlew)***	*Burhinus oedicnemus*		
158	**Red-wattled Lapwing***	*Vanellus indicus*		R, LM2
159	Yellow-wattled Lapwing	*Vanellus malarbaricus*		R, E, LM2
160	River Lapwing	*Vanellus duvaucelii*		R, LM2
161	Grey-headed Lapwing	*Vanellus cinereus*		WM
162	Sociable Plover (Sociable Lapwing)	*Vanellus gregarius*		WM
163	White-tailed Lapwing	*Vanellus leucurus*		WM
164	Northern Lapwing	*Vanellus vanellus*		WM
165	Grey Plover	*Pluvialis squatarola*		WM
166	Pacific Golden Plover	*Pluvialis fulva*		WM
167	Greater Sand Plover	*Charadrius leschenaultii*		WM, R
168	**Lesser Sand Plover***	*Charadrius mongolus*		WM, R
169	Common Ringed Plover	*Charadrius hiaticula*		WM
170	**Little Ringed Plover***	*Charadrius dubius*	*curonicus*	WM, R, LM2
171	**Kentish Plover***	*Charadrius alexandrinus*		WM, R
172	Eurasian Curlew	*Numenius arquata*		WM
173	Western Black-tailed Godwit (Black-tailed Godwit)	*Limosa limosa*		WM
174	Bar-tailed Godwit	*Limosa lapponica*		WM
175	Terek Sandpiper	*Xenus cinereus*		WM
176	Common Greenshank	*Tringa nebularia*		WM
177	Wood Sandpiper	*Tringa glareola*		WM, R
178	**Green Sandpiper***	*Tringa ochropus*		WM, R
179	Common Sandpiper	*Actitis hypoleucos*		WM, R
180	Marsh Sandpiper	*Tringa stagnatilis*		WM
181	Common Redshank	*Tringa totanus*		WM, R
182	Spotted Redshank	*Tringa erythropus*		WM
183	Ruddy Turnstone	*Arenaria interpres*		WM
184	Ruff (M) and Reeve (F)	*Philomachus pugnax*		WM
185	Curlew Sandpiper	*Calidris ferruginea*		WM
186	Dunlin	*Calidris alpina*		WM
187	**Temminck's Stint***	*Calidris temminckii*		WM
188	**Little Stint***	*Calidris minuta*		WM
189	Red-necked Phalarope	*Phalaropus lobatus*		WM
190	Jack Snipe	*Lymnocryptes minimus*		WM
191	Pintail Snipe	*Gallinago stenura*		WM
192	Eurasian Woodcock	*Scolopax rusticola*		WM, LM1, AM
193	Caspian Gull (Yellow-legged Gull)	*Larus cachinnans*		WM
194	Great Black-headed Gull	*Larus ichthyaetus*		WM
195	Brown-headed Gull	*Larus brunnicephalus*		WM, R
196	Common Black-headed Gull	*Larus ridibundus*		WM
197	Little Tern	*Sterna albifrons*		R, LM1, LM2

Appendix: 3 (contd.)

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SR. NO	ENGLISH NAME	SCIENTIFIC NAME	ALTERNATIVE NAME	STATUS
198	Common Tern	*Sterna hirundo*		WM, LM1, R
199	Black-bellied Tern	*Sterna acuticauda*		R
200	Gull-billed Tern	*Gelochelidon nilotica*		WM, R
201	**River Tern***	*Sterna aurantia*		R
202	Whiskered Tern	*Chlidonias hybridus*		WM, R, LM1
203	White-winged Tern (White-winged Black Tern)	*Chlidonias leucopterus*		WM
204	Indian Skimmer	*Rynchops albicollis*		R, LM1
205	**Black-bellied Sandgrouse (Imperial Sandgrouse)**	*Pterocles orientalis*		WM
206	Pin-tailed Sandgrouse (White-bellied Sandgrouse)	*Pterocles alchata*		WM
207	**Chestnut-bellied Sandgrouse (Indian Sandgrouse)***	*Pterocles exustus*		R, LM2
208	**Spotted Sandgrouse***	*Pterocles senegallus*		WM, R
209	Painted Sandgrouse	*Pterocles indicus*		R, E, LM2
210	**Rock Pigeon (Blue Rock Pigeon)***	*Columba livia*		R, AM
211	Yellow-eyed Pigeon	*Columba eversmanni*		WM
212	Oriental Turtle-dove	*Streptopelia orientalis*		R, WM, LM1
213	Oriental Turtle-dove		*Streptopelia orientalis meena*	
214	**Laughing Dove (Little Brown Dove)***	*Streptopelia senegalensis*		R, LM2
215	Red Collared-dove	*Streptopelia tranquebarica*		R, LM2, LM1
216	Spotted Dove	*Streptopelia chinensis*		R, LM2, AM
217	**Eurasian Collared-dove (Indian Ring Dove)***	*Streptopelia decaocto*		R, LM2, AM
218	Yellow-footed Green-pigeon (Yellow-legged Green-pigeon)	*Treron phoenicoptera*		R, LM2
219	Plum-headed Parakeet	*Psittacula cyanocephala*		R, E, LM2
220	Rose-ringed Parakeet	*Psittacula krameri*		R
221	Alexandrine Parakeet	*Psittacula eupatria*		R, LM2
222	Grey-bellied Cuckoo	*Cacomantis passerinus*		R, E, LM1, LM2
223	**Jacobin Cuckoo (Pied Crested Cuckoo)***	*Clamator jacobinus*		R, SM, LM2
224	Asian Koel	*Eudynamys scolopacea*	*Eudynamys scolopaceus*	R, LM2
225	Indian Cuckoo	*Cuculus micropterus*		R, LM1, LM2
226	Common Cuckoo	*Cuculus canorus*		Scatter, SM, LM1
227	Oriental Cuckoo	*Cuculus saturatus*		SM, R(?)
228	Common Hawk-cuckoo (Indian Hawk-Cuckoo)	*Hierococcyx varius*		R, LM2
229	Sirkeer Malkoha	*Phaenicophaeus leschenaultii*	*Taccocua leschenaultii*	R, E
230	Greater Coucal	*Centropus sinensis*		R
231	Brown Hawk-owl	*Ninox scutulata*		R
232	Common Barn-owl	*Tyto alba*		R
233	Brown Fish-owl	*Ketupa zeylonensis*		R
234	Dusky Eagle-owl	*Bubo coromandus*		R

Appendix: 3 (contd.)

Birds of Rajasthan

SR. NO	ENGLISH NAME	SCIENTIFIC NAME	ALTERNATIVE NAME	STATUS
235	Eurasian Eagle-owl	*Bubo bubo*		R
236	Northern Long-eared Owl (Long-eared Owl)	*Asio otus*		WM, R
237	**Short-eared Owl***	*Asio flammeus*		WM
238	Mottled Wood-owl	*Strix ocellata*		R, E
239	Indian Scops-owl (Collared Scops-owl)	*Otus bakkamoena*		R
240	Oriental Scops-owl	*Otus sunia*		R
241	**Spotted Owlet***	*Athene brama*		R
242	Jungle Owlet	*Glaucidium radiatum*		R
243	Sykes's Nightjar	*Caprimulgus mahrattensis*		R, LM2
244	European Nightjar (Eurasian Nightjar)	*Caprimulgus europaeus*		SM
245	Indian Jungle Nightjar (Grey Nightjar)	*Caprimulgus indicus*		R, AM, LM2
246	Indian Little Nightjar (Indian Nightjar)	*Caprimulgus asiaticus*		R, LM2
247	Large-tailed Nightjar	*Caprimulgus macrurus*		R, LM1
248	Savanna Nightjar (Franklin's Nightjar)	*Caprimulgus affinis*		R, SM, LM2
249	Crested Treeswift	*Hemiprocne coronata*		R, LM2
250	Asian Palm-swift	*Cypsiurus balasiensis*		R
251	Little Swift (House Swift)	*Apus affinis*		R, LM2
252	Pacific Swift (Fork-tailed Swift)	*Apus pacificus*		Scatter, LM1
253	Alpine Swift	*Tachymarptis melba*		R(?), LM1, LM2
254	**European Roller***	*Coracias garrulus*		SM, R
255	**Indian Roller***	*Coracias benghalensis benghalensis*		R, LM2
256	**Common Hoopoe (Hoopoe)***	*Upupa epops epops*		R, WM
257	Stork-billed Kingfisher	*Halcyon capensis*	*Pelargopsis capensis*	R
258	Black-capped Kingfisher	*Halcyon pileata*		R, LM2
259	White-throated Kingfisher	*Halcyon smyrnensis*		R, LM2
260	Lesser Pied Kingfisher	*Ceryle rudis*		R
261	Common Kingfisher	*Alcedo atthis*		R, LM1
262	European Bee-eater	*Merops apiaster*		SM, R
263	**Blue-cheeked Bee-eater***	*Merops persicus*		SM
264	Blue-tailed Bee-eater	*Merops philippinus*		LM1, R, LM2
265	**Little Green Bee-eater (Green Bee-eater)***	*Merops orientalis*		R, LM1, LM2
266	Indian Grey Hornbill	*Ocyceros birostris*		R, E, LM2
267	Coppersmith Barbet	*Megalaima haemacephala*		R
268	Brown-headed Barbet	*Megalaima zeylanica*		R, E
269	Eurasian Wryneck	*Jynx torquilla*		WM, R
270	Indian Pygmy Woodpecker (Brown-capped Pygmy-Woodpecker)	*Dendrocopos nanus*		R, E
271	**Yellow-fronted Pied Woodpecker***	*Dendrocopos mahrattensis*		R, NE

Appendix: 3 (contd.)

Birds of Rajasthan

SR. NO	ENGLISH NAME	SCIENTIFIC NAME	ALTERNATIVE NAME	STATUS
272	Streak-throated Woodpecker	*Picus xanthopygaeus*		R
273	Rufous Woodpecker	*Celeus brachyurus*	*Micropternus brachyurus*	R
274	Black-rumped Flameback (Black-rumped Flamebacked Woodpecker)	*Dinopium benghalense*		R, NE
275	White-naped Flameback (Black-shouldered Woodpecker)	*Chrysocolaptes festivus*		R, E
276	Indian Pitta	*Pitta brachyura*		R, E, LM1
277	Singing Bushlark	*Mirafra cantillans*		R
278	**Indian Bushlark (Redwinged Bush-Lark)***	*Mirafra erythroptera*		R, E
279	Bengal Bushlark	*Mirafra assamica*		R
280	Eurasian Skylark	*Alauda arvensis*		WM
281	Oriental Skylark (Eastern Skylark)	*Alauda gulgula*		R, WM, LM2
282	**Crested Lark***	*Galerida cristata*		R, LM2, LM1
283	Sykes's Lark	*Galerida deva*		R, E, LM2
284	**Ashy-crowned Finch Lark***	*Eremopterix grisea*	*Eremopterix griseus*	R, E, LM2
285	**Black-crowned Finch Lark***	*Eremopterix nigriceps*		R, LM2
286	**Bimaculated Lark (Eastern Calandra Lark)***	*Melanocorypha bimaculata*		WM
287	**Greater Hoopoe Lark (Hoopor Lark)***	*Alaemon alaudipes*		R
288	**Rufous-tailed Lark**	*Ammomanes phoenicurus*	*Ammomanes phoenicura*	R, E, LM1
289	Desert Lark	*Ammomanes deserti*		R
290	**Greater Short-toed Lark (Short-toed Lark)***	*Calandrella brachydactyla longipennis*		WM, LM1
291	Greater Short-toed Lark	*Calandrella brachydactyla dukhunensis*		
292	Hume's Short-toed Lark	*Calandrella acutirostris*		SM, WM, LM1
293	Sand Lark (Sand Short-toed Lark)	*Calandrella raytal*		R, NE
294	Grey-throated Sand-martin (Plain Martin)	*Riparia paludicola*	*Riparia chinensis*	R, LM2
295	Pale Sand-martin		*Riparia diluta diluta*	
296	Dusky Crag-martin	*Hirundo concolor*	*Ptyonoprogne concolor*	R, LM2
297	Eurasian Crag-martin	*Hirundo rupestris*	*Ptyonoprogne rupestris*	R, LM1
298	Streak-throated Swallow	*Hirundo fluvicola*		R, LM1
299	**Barn Swallow (Swallow)***	*Hirundo rustica*		R, WM, LM1
300	Red-rumped Swallow	*Hirundo daurica*		R, WM, AM, LM1
301	Wire-tailed Swallow	*Hirundo smithii*		R, LM1
302	Western Yellow Wagtail (Yellow Wagtail)	*Motacilla.flava leucocephala*		R, LM2, SM, WM
303	Western Yellow Wagtail		*Motacilla flava feldegg*	
304	Western Yellow Wagtail		*Motacilla flava thunbergi*	
305	Western Yellow Wagtail		*Motacilla flava beema*	
306	Grey Wagtail	*Motacilla. Cinerea*		R, LM1, AM, WM

Appendix: 3 (contd.)

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SR. NO	ENGLISH NAME	SCIENTIFIC NAME	ALTERNATIVE NAME	STATUS
307	Citrine Wagtail	*Motacilla.citreola citreola*		R, LM1, WM, SM
308	Citrine Wagtail		*Motacilla citreola calcarata*	
309	Forest Wagtail	*Dendronanthus indica*	*Dendronanthus indicus*	R, WM
310	White Wagtail	*Motacilla. alba dukhunensis*		R, LM1, SM, WM(?)
311	White Wagtail		*Motacilla alba personata*	
312	White Wagtail		*Motacilla alba alboides*	
313	White-browed Wagtail (Large Pied Wagtail)	*Motacilla. Maderaspatensis*		R, E
314	Olive-backed Pipit	*Anthus hodgsoni hodgsoni*		R, WM, AM, LM1
315	Olive-backed Pipit	*Anthus hodgsoni yunnanensis*		
316	Tree Pipit	*Anthus trivialis trivialis*		R, LM1, WM
317	Tree Pipit	*Anthus trivialis haringtoni*		
318	Red-throated Pipit	*Anthus cervinus*		WM
319	Rosy Pipit	*Anthus roseatus*		R, LM1, WM, AM
320	Buff-bellied Pipit	*Anthus rubescens*		WM
321	Water Pipit	*Anthus spinoletta*		WM
322	Richard's Pipit	*Anthus richardi*		WM
323	Paddyfield Pipit	*Anthus rufulus*		R, LM2
324	**Tawny Pipit***	*Anthus campestris*		WM
325	Blyth's Pipit	*Anthus godlewskii*		WM
326	**Long-billed Pipit (Brown Rock Pipit)**	*Anthus similis*		R, LM1, AM
327	White-breasted Woodswallow	*Artamus leucorynchus*		R
328	Common Woodshrike (Lesser Woodshrike)	*Tephrodornis pondicerianus*		R
329	Black-winged Cuckooshrike	*Coracina melaschistos*		R, AM, LM1
330	Black-headed Cuckooshrike	*Coracina melanoptera*		R, LM2
331	Large Cuckooshrike	*Coracina macei*		R, LM2, AM
332	Long-tailed Minivet	*Pericrocotus ethologus*		R, AM, LM1
333	Orange Minivet (Scarlet Minivet)	*Pericrocotus flammeus*		R, AM
334	White-bellied Minivet	*Pericrocotus erythropygius*		R
335	Small Minivet	*Pericrocotus cinnamomeus*		R
336	**Red-vented Bulbul***	*Pycnonotus cafer*		R
337	Red-whiskered Bulbul	*Pycnonotus jocosus*		R
338	**White-eared Bulbul***	*Pycnonotus leucotis*		R, LM2
339	Common Iora	*Aegithina tiphia*		R, LM2
340	Marshall's Iora	*Aegithina nigrolutea*		R, E
341	Blue-winged Leafbird (Jerdon's Leafbird)	*Chloropsis cochinchinensis*		R
342	Black-headed Long-tailed Shrike	*Lanius schach tricolor*		R, LM1,LM2
343	Rufous-backed Long-tailed Shrike	*Lanius schach erythronotus*		
344	**Southern Grey Shrike (Grey Shrike)**	*Lanius meridionalis*		R, WM, LM1, LM2

Appendix: 3 (contd.)

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SR. NO	ENGLISH NAME	SCIENTIFIC NAME	ALTERNATIVE NAME	STATUS
345	Grey-backed Shrike	*Lanius tephronotus*		WM, R, AM
346	Brown Shrike	*Lanius cristatus cristatus*		WM
347	Isabelline Shrike (Rufous-tailed Shrike)	*Lanius isabellinus*		WM, LM1
348	**Bay-backed Shrike***	*Lanius vittatus*		R, LM1
349	**Red-backed Shrike (Pale Brown Shrike)***	*Lanius collurio*		WM
350	Black-naped Blue Monarch (Black-naped Monarch)	*Hypothymis azurea*		R, LM1
351	Asian Paradise Flycatcher	*Terpsiphone paradisi*		R, LM1, LM2
352	White-browed Fantail	*Rhipidura aureola*		R, LM2
353	White-throated Fantail	*Rhipidura albicollis*		R, LM2, AM
354	Blue Rock-thrush	*Monticola solitarius*		R, LM1, WM
355	Blue-headed Rock-thrush	*Monticola cinclorhynchus*		SM, LM1
356	Orange-headed Thrush	*Zoothera citrina*		R, LM1
357	Malabar Whistling-thrush	*Myiophonus horsfieldii*		R, E
358	Black-throated Thrush (Dark-throated Thrush)	*Turdus ruficollis atrogularis*		WM
359	Red-throated Thrush	*Turdus ruficollis ruficollis*		
360	Tickell's Thrush	*Turdus unicolor*		R, E, AM, LM1
361	Common Blackbird (Eurasian Blackbird)	*Turdus merula*		R, AM, LM1
362	Grey-winged Blackbird	*Turdus boulboul*		R, AM
363	Small-billed Scaly Thrush (Scaly Thrush)	*Zoothera dauma*		R, AM, LM1
364	**Bluethroat***	*Luscinia svecica svecica*		SM, R, WM
365	Bluethroat		*Luscinia svecica abbotti*	
366	Himalayan Rubythroat (White-tailed Rubythroat)	*Luscinia pectoralis*		R, AM
367	Siberian Rubythroat	*Luscinia calliope*		WM
368	**Rufous-tailed Scrub-robin (Rufous Chat)**	*Cercotrichas galactotes*		WM
369	Oriental Magpie-Robin	*Copsychus saularis*		R, LM1
370	Indian Black Robin (Indian Robin)	*Saxicoloides fulicata*		R, E
371	**Brown Rock-chat***	*Cercomela fusca*		R, E
372	**Black Redstart***	*Phoenicurus ochruros rufiventris*		R, AM, LM1
373	Black Redstart	*Phoenicurus ochruros phoenicuroides*		
374	Blue-fronted Redstart	*Phoenicurus frontalis*		R, AM
375	**Isabelline Wheatear (Isabelline Chat)***	*Oenanthe isabellina*		WM, R
376	Northern Wheatear	*Oenanthe oenanthe*		WM
377	**Desert Wheatear***	*Oenanthe deserti deserti*		R, WM
378	**Variable Wheatear (Pied Chat)***	*Oenanthe picata capistrata*		WM, R, LM1
379	Variable Wheatear		*Oenanthe picata opistholeuca*	
380	Variable Wheatear		*Oenanthe picata picata*	
381	**Red-tailed Wheatear (Rufous-tailed Wheatear)***	*Oenanthe xanthoprymna*	*Oenanthe chrysopygia*	WM, R

Appendix: 3 (contd.)

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SR. NO	ENGLISH NAME	SCIENTIFIC NAME	ALTERNATIVE NAME	STATUS
382	**Pied Bushchat***	*Saxicola caprata*		R, AM, LM1
383	**Common Stonechat (Collared Bush-Chat)***	*Saxicola torquata*	*Saxicola torquatus indicus /maurus*	R, AM,LM1
384	**White-browed Bushchat (Stoliczka's Bushchat)***	*Saxicola macrorhyncha*	*Saxicola macrorhynchus*	R, E
385	Grey Bushchat	*Saxicola ferrea*	*Saxicola ferreus*	R, AM, LM1
386	Spotted Flycatcher	*Muscicapa striata*		WM, R
387	Asian Brown Flycatcher	*Muscicapa dauurica*		R, LM1, WM
388	Rusty-tailed Flycatcher	*Muscicapa ruficauda*		R, LM1
389	Ultramarine Flycatcher	*Ficedula superciliaris*		R, LM1, AM
390	Red-breasted Flycatcher (Red-throated Flycatcher)	*Ficedula parva*		WM
391	Slaty-blue Flycatcher	*Ficedula tricolor*		R, AM
392	Tickell's Blue Flycatcher	*Cyornis tickelliae*		R, LM1, LM2
393	Verditer Flycatcher	*Eumyias thalassina*	*Eumyias thalassinus*	R, LM1, AM
394	Yellow-eyed Babbler	*Chrysomma sinense*		R
395	Tawny-bellied Babbler	*Dumetia hyperythra*		R, E
396	**Common Babbler***	*Turdoides caudatus*	*Turdoides caudata*	R
397	Striated Babbler	*Turdoides earlei*		R, NE
398	Large Grey Babbler	*Turdoides malcolmi*		R, E
399	Jungle Babbler	*Turdoides striatus*	*Turdoides striata*	R, E
400	Indian Scimitar-babbler	*Pomatorhinus horsfieldii*	*Pomatorhinus schisticeps horsfieldii*	R, E
401	Puff-throated Babbler	*Pellorneum ruficeps*		R
402	**Zitting Cisticola (Streaked Fantail Warbler)***	*Cisticola juncidis*		R, LM2
403	Lanceolated Warbler	*Locustella lanceolata*		WM
404	Grasshopper Warbler	*Locustella naevia*		WM
405	Ashy Prinia	*Prinia socialis*		R, E
406	Grey-breasted Prinia	*Prinia hodgsonii*		R, LM2
407	Jungle Prinia	*Prinia sylvatica*		R, E,
408	Plain Prinia	*Prinia inornata*		R, LM2
409	Rufous-fronted Prinia	*Prinia buchanani*		R, E, LM2
410	Rufous-vented Prinia (Swamp Prinia)	*Prinia burnesii*		R, E
411	Graceful Prinia	*Prinia gracilis*		R
412	Cetti's Bush-warbler	*Cettia cetti*		WM
413	Moustached Warbler	*Acrocephalus melanopogon*		WM, R(?)
414	Indian Reed-warbler (Clamorous Reed-Warbler)	*Acrocephalus stentoreus brunnescens*		R, WM, LM1
415	Thick-billed Warbler	*Acrocephalus aedon*		WM
416	Blyth's Reed-warbler	*Acrocephalus dumetorum*		WM, R(?)
417	Paddyfield Warbler	*Acrocephalus agricola*		WM, R
418	Blunt-winged Reed-warbler	*Acrocephalus concinens stevensi*		SM, R, LM1
419	**Booted Warbler***	*Hippolais caligata*		WM, R
420	Common Tailorbird	*Orthotomus sutorius*		R
421	Green-crowned Warbler (Gold-spectacled Warbler)	*Seicercus burkii*		R, LM1, AM

Appendix: 3 (contd.)

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SR. NO	ENGLISH NAME	SCIENTIFIC NAME	ALTERNATIVE NAME	STATUS
422	Grey-headed Canary-flycatcher (Grey-headed Flycatcher)	*Culicicapa ceylonensis*		R, AM,LM1
423	**Siberian Chiffchaff (Common Chiffchaff)***	*Phylloscopus collybita tristis*		WM
424	Mountain Chiffchaff	*Phylloscopus sindianus*		R, LM1
425	Plain Leaf-warbler	*Phylloscopus neglectus*		R, LM1, WM
426	Dusky Warbler	*Phylloscopus fuscatus fuscatus*		WM
427	Smoky Leaf-warbler (Smoky Warbler)	*Phylloscopus fuligiventer*		R, LM1, AM
428	Sulphur-bellied Warbler	*Phylloscopus griseolus*		R, LM1
429	Tickell's Leaf-warbler	*Phylloscopus affinis*		R, LM1
430	Greenish Warbler	*Phylloscopus trochiloides trochiloides*		
431	Large-billed Leaf-warbler	*Phylloscopus magnirostris*		R, WM, LM1
432	Western Crowned Warbler	*Phylloscopus occipitalis*		R, WM, LM1
433	Hume's Leaf-warbler (Hume's Warbler)	*Phylloscopus humei*		R, LM1, WM
434	Brooks's Leaf-warbler	*Phylloscopus subviridis*		WM, LM1
435	Eastern Orphean Warbler (Orphean Warbler)	*Sylvia hortensis*	*Sylvia crassirostris*	WM, R
436	Common Whitethroat (Greater Whitethroat)	*Sylvia communis*		WM, R(?)
437	Asian Desert Warbler (Desert Warbler)	*Sylvia nana*		WM
438	Lesser Whitethroat	*Sylvia curruca halimodendri*		R, WM
439	White-naped Tit (Pied Tit)	*Parus nuchalis*		R, E, LM2
440	Great Tit	*Parus major*		R, AM
441	Black-lored Yellow Tit	*Parus xanthogenys*		R, E, AM
442	Spotted Creeper	*Salpornis spilonotus*		R
443	Fire-capped Tit	*Cephalopyrus flammiceps*		R, AM, LM1
444	Indian Nuthatch (Chestnut-bellied Nuthatch)	*Sitta castanea*		R
445	Pale-billed Flowerpecker (Tickell's Flowerpecker)	*Dicaeum erythrorynchos*		R, NE, AM
446	Thick-billed Flowerpecker	*Dicaeum agile*		R, AM
447	Oriental White-eye	*Zosterops palpebrosus*		R, LM2
448	Purple-rumped Sunbird	*Nectarinia zeylonica*	*Leptocoma Zeylonica*	R
449	**Purple Sunbird***	*Nectarinia asiatica*	*Cinnyris asiaticus*	R, AM, LM1, LM2
450	Mrs. Gould's Sunbird	*Aethopyga gouldiae*		R, AM
451	Crested Bunting	*Melophus lathami*		R, AM
452	Thick-billed Reed Bunting	*Emberiza schoeniclus pyrrhuloides*		
453	Reed Bunting	*Emberiza schoeniclus pallidior*		WM
454	White-capped Bunting	*Emberiza stewarti*		R, LM1
455	Striolated Bunting	*Emberiza striolata*		R, LM2
456	Black-headed Bunting	*Emberiza melanocephala*		WM
457	Red-headed Bunting	*Emberiza bruniceps*		WM, R
458	Grey-necked Bunting	*Emberiza buchanani*		WM, R
459	Ortolan Bunting	*Emberiza hortulana*		V

Appendix: 3 (contd.)

Birds of Rajasthan

SR. NO	ENGLISH NAME	SCIENTIFIC NAME	ALTERNATIVE NAME	STATUS
460	Trumpeter Finch	*Bucanetes githagineus*		R, LM2
461	Mongolian Finch	*Bucanetes mongolicus*		R, LM1, LM2
462	Common Rosefinch	*Carpodacus erythrinus roseatus*		R, LM1, AM
463	Common Rosefinch	*Carpodacus erythrinus erythrinus*		
464	**Green Avadavat (Green Munia)***	*Amandava formosa*		R, E
465	Red Avadavat (Red Munia)	*Amandava amandava*		R
466	Tricoloured Munia (Black-headed Munia)	*Lonchura malacca*		R
467	**Indian Silverbill (Plain Munia) (White-throated Munia)**	*Lonchura malabarica*	*Euodice malabarica*	R, LM2
468	White-rumped Munia	*Lonchura striata*		R, AM
469	Scaly-breasted Munia	*Lonchura punctulata*		R, AM
470	**House Sparrow***	*Passer domesticus*		R, LM1
471	Eurasian Tree Sparrow	*Passer montanus*		R, AM
472	**Spanish Sparrow***	*Passer hispaniolensis*		WM
473	**Yellow-throated Sparrow (Chestnut-shouldered Petronia)***	*Petronia xanthocollis*		R, LM1
474	Indian Baya Weaver (Baya Weaver)	*Ploceus philippinus philippinus*		R, LM2
475	Streaked Weaver	*Ploceus manyar*		R
476	Black-breasted Weaver	*Ploceus benghalensis*		R, E, LM2
477	European Golden Oriole (Eurasian Golden Oriole)	*Oriolus oriolus*		R, LM1
478	Black-hooded Oriole	*Oriolus xanthornus*		R, LM2
479	Black Drongo	*Dicrurus macrocercus*		R, AM, LM2
480	Ashy Drongo	*Dicrurus leucophaeus*		R, WM(?), AM, LM1
481	White-bellied Drongo	*Dicrurus caerulescens*		R, E, LM2
482	Greater Racket-tailed Drongo	*Dicrurus paradiseus*		R
483	Hair-crested Drongo (Spangled Drongo)	*Dicrurus hottentottus*		R, LM2
484	**Common Starling (Starling)**	*Sturnus vulgaris*		WM, R, LM1
485	Brahminy Starling	*Sturnus pagodarum*	*Temenuchus pagodarum*	R, LM1, LM2
486	**Rosy Starling***	*Sturnus roseus*		WM
487	Grey-headed Starling (Chestnut-tailed Starling)	*Sturnus malabaricus*	*Sturnia malabarica*	R, LM1, LM2
488	Asian Pied Starling	*Sturnus contra*	*Gracupica contra*	R, LM2
489	**Bank Myna***	*Acridotheres ginginianus*		R, E, LM2
490	**Common Myna***	*Acridotheres tristis*		R
491	Jungle Myna	*Acridotheres fuscus*		R, LM2
492	**House Crow***	*Corvus splendens*		R, AM
493	Indian Jungle Crow (Jungle Crow)	*Corvus macrorhynchos culminatus*		R, AM
494	**Common Raven (Raven)***	*Corvus corax tibetanus*		R, WM
495	Rufous Treepie	*Dendrocitta vagabunda*		R

E=Endemic to the Indian Subcontinent; W=Winter visitor; N=Near-endemic; V=Vagrant, accidental or rare visitor; R=Resident; L=Local; B=Breeder; I=introduced; S=Summer visitor; X=Extralimital (not recorded in the Indian subcontinent) A=Altitudinal migrant; *=Bird occurs in DNP; M=Migrates within the subcontinent; P=passage migrant

Appendix: 4

Livestock and Human populations in the DNP (2001)

S. No	Village	Panchayat	District	Human Pop	Livestock Pop	Area (ha.)
1	Ganga	Sam	Jaisalmer	375	4656	5997
2	Kanoi	Kanoi	Jaisalmer	1870	2925	9552
3	Sam	Sam	Jaisalmer	1266	1250	3494
4	Dabri	Lunar	Jaisalmer	1220	2373	7373
5	Mehboob Ka Par	Bida	Jaisalmer	98	1194	2736
6	Matwaon Ki Basti	Sam	Jaisalmer	224	2243	2543
7	Neemba	Bida	Jaisalmer	1091	14062	5304
8	Bida	Bida	Jaisalmer	479	3612	7121
9	Jamra	Sipla	Jaisalmer	315	2057	6476
10	Sipla	Sipla	Jaisalmer	729	3115	5818
11	Kumhar Kotha	Sipla	Jaisalmer	286	409	1909
12	Barana	Khuree	Jaisalmer	503	3472	8880
13	Tejsi	Khuree	Jaisalmer	326	2154	1356
14	Dhaneli	Bersiyala	Jaisalmer	635	2817	6390
15	Hattar	Dav	Jaisalmer	334	2221	7417
16	Koriya	Neemba	Jaisalmer	227	2624	3486
17	Sam Dani/Phaledi	Bida	Jaisalmer	1185	6674	9079
18	Myajlar	Myajlar	Jaisalmer	2909	7653	39094
19	Dav	Dav	Jaisalmer	931	5168	29204
20	Bersiyala	Bersiyala	Jaisalmer	1077	7363	11338
22	Khuree	Khuree	Jaisalmer	1614	4210	7350
23	Dhoba	Khuree	Jaisalmer	1228	5848	10885
24	Khariya	Bersiyala	Jaisalmer	320	3210	14066
25	Katha	Bersiyala	Jaisalmer	147	980	4962
27	Phuliya	Satto	Jaisalmer	631	1133	8125
28	Satto	Satto	Jaisalmer	2522	1364	25137
29	Tejrawa	Tejrawa	Jaisalmer	701	361	6924
30	Shidar	Tejrawa	Jaisalmer	1123	1279	3286
31	Antia	Trjrawa	Jaisalmer	135	137	4587
32	Bhambarha	Chhatangar	Jaisalmer	942	1283	8907
33	Sagron Ki Basti	Sam	Jaisalmer	967	12163	4973
34	Harsani	Harsani	Barmer	2385	4210	4380
35	Tuhdbi	Harsani	Barmer	1219	4023	3335
36	Magra	Kharchi	Barmer	571	2804	2857
37	Girab	Girab	Barmer	1341	3588	5507
38	Shastri village	Girab	Barmer	775	1578	1836
39	Asadi	Asadi	Barmer	678	3292	3090
40	Agasari	Asadi	Barmer	609	2617	3261
41	Bandhra	Bandhra	Barmer	1478	2302	8847
42	Kundal	Bandhra	Barmer	290	1131	4860
43	Dabar	Bandhra	Barmer	476	1034	4404
44	Ratredi Kala	Bandhra	Barmer	701	1367	3244

Appendix: 4 (contd.)

Livestock and Human populations in the DNP (2001)

S. No	Village	Panchayat	District	Human Pop	Livestock Pop	Area (ha.)
45	Ratredi Kurd	Girab	Barmer	520	512	1807
46	Jeene Ki Basti	Girab	Barmer	460	1736	4053
47	Haphia	Vijaval	Barmer	205	585	1912
48	Chetrodi	Chetrodi	Barmer	1158	5210	3537
49	Ugeri	Chetrodi	Barmer	610	2206	4071
50	Sadho Ki Basti	Chetrodi	Barmer	601	2865	4464
51	Khudanee	Ranasar	Barmer	1669	2859	4292
52	Rawat Sar	Chetrodi	Barmer	996	1089	5076
53	Salm Singh Ki Basti		Barmer	460	646	1884
54	Shahdad Ka Par	Rohadi	Barmer	774	1065	1178
55	Khalife Ki Bawri	Khalife Ki Bawri	Barmer	560	1685	1770
56	Pabusari	Khalife Ki Bawri	Barmer	1107	2591	4486
57	Vaniyali	Khalife Ki Bawri	Barmer	5000	1500	3372
58	Khadanee	Khalife Ki Bawri	Barmer	624	1721	3921
59	Draba	Khabdala	Barmer	370	823	7496
60	Dhagari	Khabdala	Barmer	361	616	3062
61	Sirguala	Khabdala	Barmer	531	1396	6307
62	Khabdala	Khabdala	Barmer	450	1937	2796
63	Pinj Raj Ka Par	Khabdala	Barmer	214	440	5019
64	Bachiya	Khabdala	Barmer	362	660	3996
65	Modadi	Sundra	Barmer	377	675	4677
66	Bijawal	Bijawal	Barmer	545	2275	2523
67	Samad Ka Par	Vijaval	Barmer	420	934	2553
68	Bikusi	Bandhra	Barmer	1000	1000	N. available
69	Sankahli	Bandhra	Barmer	1017	1000	N. available
70	Sagorani	Khabdala	Barmer	3000	250	N. available
71	Nodiyala	Khabdala	Barmer	1000	3000	N. available
72	Bhala	Chertrodi	Barmer	700	3120	N. available

Appendix: 5

NUMBER OF BUSTARDS REPORTED BY VILLAGERS

S. No	Name of Village	Gram Panchayat	District	No of Bustard	Year
1	Ganga	Sam	Jaisalmer	NR	
2	Kanoi	Kanoi	Jaisalmer	Y	FB
3	Sam	Sam	Jaisalmer	NR	—
4	Dabri	Lunar	Jaisalmer	NR	—
5	Mehboob Ka Par	Bida	Jaisalmer	NR	—
6	Matwaon Ki Basti	Sam	Jaisalmer	NR	—
7	Neemba	Bida	Jaisalmer	NR	—
8	Bida	Bida	Jaisalmer	NR	—
9	Jamra	Sipla	Jaisalmer	NR	—
10	Sipla	Sipla	Jaisalmer	NR	—
11	Kumhar Kotha	Sipla	Jaisalmer	NR	—
12	Barana	Khuree	Jaisalmer	3	2003
13	Tejsi	Khuree	Jaisalmer	5	2004
14	Dhaneli	Bersiyala	Jaisalmer	NR	—
15	Hattar	Dav	Jaisalmer	NR	—
16	Koriya	Neemba	Jaisalmer	10	2003
17	Sam Dani	Bida	Jaisalmer	2	2003
18	Myajlar	Myajlar	Jaisalmer	1	2001
19	Dav		Jaisalmer		
20	Bersiyala	Bersiyala	Jaisalmer	1	2003
22	Khuree	Khuree	Jaisalmer	7	2003
23	Dhoba	Khuree	Jaisalmer	NR	—
24	Khariya	Bersiyala	Jaisalmer	NR	—
25	Katha	Bersiyala	Jaisalmer	NR	—
26	Chhatangar		Jaisalmer	NR	—
27	Phuliya	Satto	Jaisalmer	2	2002
28	Satto	Satto	Jaisalmer	6	2003
29	Tejrawa	Tejrawa	Jaisalmer	Y	FB
30	Shidar	Tejrawa	Jaisalmer	NR	—
31	Antia	Trjrawa	Jaisalmer	5	2003
32	Bhambarha	Chhatangar	Jaisalmer	2	2003
33	Sagron Ki Basti	Sam	Jaisalmer	NR	—
34	Harsani	Harsani	Barmer	NR	—
35	Tuhdbi	Harsani	Barmer	Y	FB
36	Magra	Kharchi	Barmer	NR	—
37	Girab	Girab	Barmer	NR	—
38	Shastri village	Girab	Barmer	2	2002
39	Asadi	Asadi	Barmer	NR	—
40	Agasari	Asadi	Barmer	NR	—
41	Bandhra	Bandhra	Barmer	NR	—
42	Kundal	Bandhra	Barmer	Y	FB
43	Dabar	Bandhra	Barmer	NR	—

Appendix: 5

NUMBER OF BUSTARDS REPORTED BY VILLAGERS

S. No	Name of Village	Gram Panchayat	District	No of Bustard	Year
44	Ratredi Kala	Bandhra	Barmer	2	2003
45	Ratredi Kurd	Girab	Barmer	2	2003
46	Jeene Ki Basti	Girab	Barmer	NR	—
47	Haphia	Vijaval	Barmer	2	2002
48	Chetrodi	Chetrodi	Barmer	1	FB
49	Bahala	Satto	Barmer	3	2003
50	Ugeri	Chetrodi	Barmer	1	2003
51	Sadho Ki Basti	Chetrodi	Barmer	NR	—
52	Khudanee	Ranasar	Barmer	NR	—
53	Rawat Sar	Chetrodi	Barmer	Y	1989
54	Salm Singh Ki Basti		Barmer	NR	—
55	Lamra	Chetrodi	Barmer	Y	1994
56	Shahdad Ka Par	Rohadi	Barmer	NR	—
57	Goraliya	Shaddad Ka Par	Barmer	NR	—
58	Khalife Ki Bawri	Khalife Ki Bawri	Barmer	NR	—
59	Pabusari	Khalife Ki Bawri	Barmer	NR	—
60	Baniyali	Khalife Ki Bawri	Barmer	Y	1994
61	Khadanee	Khalife Ki Bawri	Barmer	NR	—
62	Draba	Khabdala	Barmer	NR	—
63	Dhagari	Khabdala	Barmer	2	2003
64	Sirguala	Khabdala	Barmer	1	FB
65	Khabdala	Khabdala	Barmer	NR	—
66	Pinj Raj Ka Par	Khabdala	Barmer	7	2001
67	Bachiya	Khabdala	Barmer	NR	—
68	Modadi	Sundra	Barmer	2	2003
69	Bijawal	Bijawal	Barmer	NR	—
70	Samad Ka Par	Vijaval	Barmer	NR	—
71	Minuo Ki Basti	Sam	Jaisalmer	NR	—
72	Bikusi	Bandhra	Barmer	2	FB
73	Sahala	Chetrodi	Barmer	Y	2001
74	Thananni Ka Par	Khabdala	Barmer	NR	—
75	Madusar	Chetrodi	Barmer	15	FB
76	Mayani	Khabdala	Barmer	1	1998
77	Vijaval	Vijaval	Barmer	NR	—
78	Sankahli	Bandhra	Barmer	1	2004
79	Manihari	Girab	Barmer	NR	—
80	Sagorani	Khabdala	Barmer	NR	—
81	Piparli	Khabdala	Barmer	2	2003
82	Nodiyala	Khabdala	Barmer	2	2003
83	Dabariya	Shaddad Ka Par	Barmer	1	2003
84	Bhala	Chertrodi	Barmer	NR	—

NR = Not Reported; FB = Few Year Back

Human population census data of Rajasthan (2001)

Appendix: 6

District	Population 2001			Decadal growth rate		Sex ratio		Density	
	Persons	Males	Females	1981-1991	1981-2001	1991	2001	1991	2001
Ganganagar	1788487	955027	833460	18.25	27.53	865	873	176	224
Hanumangarh	1517390	800796	716594	44.6	24.34	891	895	96	120
Bikaner	1673562	885722	787840	42.7	38.18	885	889	44	61
Churu	1922908	986867	936041	30.84	24.6	937	948	92	114
Jhunjhunun	1913099	983158	929941	30.61	20.9	931	946	267	323
Alwar	2990862	1585046	1405816	30.82	30.23	880	887	274	357
Bharatpur	2098323	1130010	968313	27.14	27.05	832	857	326	414
Dhaulpur	982815	537733	445082	28.1	31.13	795	828	247	324
Karauli	1205631	648837	556794	28.66	29.96	840	858	168	218
Sawai Madhopur	1116031	590716	525315	27.22	27.44	870	889	195	248
Dausa	1316790	693438	623352	30.81	32.42	884	899	290	384
Jaipur	5252388	2769096	2483292	38.73	35.1	892	897	349	471
Sikar	2287229	1172129	1115100	33.81	24.11	946	951	238	296
Nagaur	2773894	1421455	1352439	31.69	29.33	942	951	121	157
Jodhpur	2880777	1509563	1371214	29.12	33.77	891	908	95	126
Jaisalmer	507999	278973	229026	41.73	47.45	807	821	9	13
Barmer	1963758	1035813	927945	28.27	36.83	891	896	51	69
Jalor	1448486	736029	712457	26.52	26.78	942	968	107	136
Sirohi	850756	437534	413222	20.66	30.08	949	944	127	166
Pali	1819201	917320	901881	16.63	22.39	956	983	120	147
Ajmer	2180526	1128763	1051763	20.05	26.1	918	932	204	257
Tonk	1211343	625719	585624	24.42	24.24	923	936	136	168
Bundi	961269	503827	457442	25.85	24.8	889	908	139	173
Bhilwara	2009516	1023086	986430	21.58	26.14	945	964	152	192
Rajsamand	986269	492736	493533	17.97	19.88	991	1002	213	256
Udaipur	2632210	1335017	1297193	24.52	27.37	956	972	154	196
Dungarpur	1107037	546096	560941	28.07	26.58	995	1027	232	294
Banswara	1500420	758379	742041	30.34	29.84	969	978	229	298
Chittaurgarh	1802656	917023	885633	20.42	21.46	950	966	137	166
Kota	1568580	827647	740933	35.88	28.52	881	895	224	288
Baran	1022568	535745	486823	27.3	26.19	896	909	116	146
Jhalawar	1180342	612357	567985	21.91	23.34	918	928	154	190

Source: http://educationforallindia.com/page163.html

Livestock census data of Rajasthan (2003)

Appendix: 7

Disrtict	Buffalo	Sheep	Goat	Horse	Donkey	Camel	Pig	Dog	Rabbit	Cross Breed	Indigenous cattle
Ajmer	275673	392945	602604	607	2189	2564	26951	82017	256	13056	282385
Alwar	917185	90758	437470	967	2648	16372	20264	144814	1585	7588	168906
Banswara	259946	22705	451193	253	5459	1552	1036	62406	119	1447	642354
Baran	190154	12471	239512	407	2044	984	11781	36440	92	1140	317264
Barmer	130863	1067210	1460772	1583	28400	69712	8003	108908	415	186	512112
Bharatpur	696460	70152	144211	646	2452	4054	25181	100086	1573	4924	98133
Bhilwara	312743	446680	740352	1365	2942	5951	11388	64199	356	54613	526877
Bikaner	132732	928892	686507	242	12482	61861	4551	103668	404	20354	555100
Bundi	244901	66921	308107	819	2006	3742	8823	46379	221	3599	248334
Chittorgarh	408618	104751	637965	1249	2729	4533	7381	73652	190	21229	651344
Churu	194524	381005	595899	335	6615	46822	4324	60094	260	4659	200686
Dausa	381533	57371	256049	432	356	6258	11344	39000	353	4770	112717
Dholpur	306259	9515	96413	467	1355	748	6241	35993	149	1680	54168
Dungarpur	215991	124158	375028	302	3202	2861	2789	46507	134	1209	407369
Hanumangarh	307615	261284	192179	986	5020	46946	5576	104161	2060	30161	299356
Jaipur	889461	305403	803689	1245	2415	15845	34815	91628	890	67499	329691
Jaisalmer	2205	890181	588000	633	10642	36952	1427	21170	22	156	232314
Jalore	356496	563130	451248	1535	7231	9304	7067	116506	441	221	234012
Jhalwar	264087	14317	321609	1500	2468	693	9309	49237	84	712	410284
Jhunjhanu	378942	162537	490318	902	2594	24477	5286	49010	593	38327	81083
Jodhpur	180087	884191	1036696	549	5611	30240	3087	134697	1565	32323	463506
Karauli	359224	36857	252303	588	1165	5534	15242	38340	271	977	99095
Kota	190272	24649	189046	375	1053	2678	17456	35178	134	2449	219440
Nagaur	420007	747003	1082967	1179	4088	17148	9591	127239	405	7850	337401
Pali	285992	892895	632287	819	4147	11935	12981	123710	1406	4814	270752
Rajsamand	200184	120641	499334	818	2227	3815	4097	32127	182	14626	229840
Sawai Madhopur	231501	76884	261515	399	1889	5231	15211	40102	208	3163	145330
Shri Ganganagar	268376	336574	272431	765	4234	21448	3931	135214	4774	55797	334386
Sikar	507678	237225	879601	730	2705	20538	16649	44244	1249	37067	150800
Sirohi	144806	294866	332843	349	3137	5925	2832	55968	173	385	179183
Tonk	228914	225430	326056	898	910	2176	12283	46611	2123	887	210356
Udaipur	530405	204491	1164316	1379	6163	9125	10865	122194	252	25739	980992

Source: Govt. of India, Ministry of Agriculture, Dept. of Animal Husbandry, Dairying and Fisheres

http://dahd.nic.in/census.htm

Statutory Framework of a Biosphere Reserves

Appendix: 8

Article 1 - Definition

Biosphere reserves are areas of terrestrial and coastal/marine ecosystems or a combination thereof, which are internationally recognized within the framework of UNESCO's programme on Man and the Biosphere (MAB), in accordance with the present Statutory Framework.

Article 2 - World Network of Biosphere Reserves

1. Biosphere reserves form a worldwide network, known as the World Network of Biosphere Reserves, hereafter called the Network.
2. The Network constitutes a tool for the conservation of biological diversity and the sustainable use of its components, thus contributing to the objectives of the Convention on Biological Diversity and other pertinent conventions and instruments.
3. Individual biosphere reserves remain under the sovereign jurisdiction of the States where they are situated. Under the present Statutory Framework, States take the measures which they deem necessary according to their national legislation.

Article 3 – Functions

In combining the three functions below, biosphere reserves should strive to be sites of excellence to explore and demonstrate approaches to conservation and sustainable development on a regional scale:

(i) conservation - contribute to the conservation of landscapes, ecosystems, species and genetic variation;
(ii) development - foster economic and human development which is socio-culturally and ecologically sustainable;
(iii) logistic support - support for demonstration projects, environmental education and training, research and monitoring related to local, regional, national and global issues of conservation and sustainable development.

Article 4 – Criteria

General criteria for an area to be qualified for designation as a biosphere reserve:

1. It should encompass a mosaic of ecological systems representative of major biogeographic regions, including a gradation of human interventions.
2. It should be of significance for biological diversity conservation.
3. It should provide an opportunity to explore and demonstrate approaches to sustainable development on a regional scale.
4. It should have an appropriate size to serve the three functions of biosphere reserves, as set out in Article 3.
5. It should include these functions, through appropriate zonation, recognizing:

   (a) a legally constituted core area or areas devoted to longterm protection, according to the conservation objectives of the biosphere reserve, and of sufficient size to meet these objectives;
   (b) a buffer zone or zones clearly identified and surrounding or contiguous to the core area or areas, where only activities compatible with the conservation objectives can take place;
   (c) an outer transition area where sustainable resource management practices are promoted and developed.

6. Organizational arrangements should be provided for the involvement and participation of a suitable range of inter alia public authorities, local communities and private interests in the design and carrying out the functions of a biosphere reserve.
7. In addition, provisions should be made for:
   (a) mechanisms to manage human use and activities in the buffer zone or zones;
   (b) a management policy or plan for the area as a biosphere reserve;
   (c) a designated authority or mechanism to implement this policy or plan;
   (d) programmes for research, monitoring, education and training.

Article 5 - Designation procedure

1. Biosphere reserves are designated for inclusion in the Network by the International Co-ordinating Council (ICC) of the MAB programme in accordance with the following procedure:

   (a) States, through National MAB Committees where appropriate, forward nominations with supporting documentation to the secretariat after having reviewed potential sites, taking into account the criteria as defined in Article 4;
   (b) the secretariat verifies the content and supporting documentation: in the case of incomplete nomination, the secretariat requests the missing information from the nominating State;
   (c) nominations will be considered by the Advisory Committee for Biosphere Reserves for recommendation to ICC;
   (d) ICC of the MAB programme takes a decision on nominations for designation. The Director-General of UNESCO notifies the State concerned of the decision of ICC.

2. States are encouraged to examine and improve the adequacy of any existing biosphere reserve, and to propose extension as appropriate, to enable it to function fully within the Network. Proposals for extension follow the same procedure as described above for new designations.
3. Biosphere reserves which have been designated before the adoption of the present Statutory Framework are considered to be already part of the Network. The provisions of the Statutory Framework therefore apply to them.

Article 6 - Publicity

1. The designation of an area as a biosphere reserve should be given appropriate publicity by the State and authorities concerned, including commemorative plaques and dissemination of information material.
2. Biosphere reserves within the Network, as well as the objectives, should be given appropriate and continuing promotion.

Article 7 - Participation in the Network

1. States participate in or facilitate co-operative activities of the Network, including scientific research and monitoring, at the global, regional and subregional levels.
2. The appropriate authorities should make available the results of research, associated publications and other data, taking into account intellectual property rights, in order to ensure the proper functioning of the Network and maximize the benefits from information exchanges.
3. States and appropriate authorities should promote environmental education and training, as well as the development of human resources, in co-operation with other biosphere reserves in the Network.

Article 8 - Regional and thematic subnetworks

States should encourage the constitution and co-operative operation of regional and/or thematic subnetworks of biosphere reserves, and promote development of information exchanges, including electronic information, within the framework of these subnetworks.

Article 9 - Periodic review

1. The status of each biosphere reserve should be subject to a periodic review every ten years, based on a report prepared by the concerned authority, on the basis of the criteria of Article 4, and forwarded to the secretariat by the State concerned.
2. The report will be considered by the Advisory Committee for Biosphere Reserves for recommendation to ICC.
3. ICC will examine the periodic reports from States concerned.
4. If ICC considers that the status or management of the biosphere reserve is satisfactory, or has improved since designation or the last review, this will be formally recognized by ICC.

5. If ICC considers that the biosphere reserve no longer satisfies the criteria contained in Article 4, it may recommend that the State concerned take measures to ensure conformity with the provisions of Article 4, taking into account the cultural and socio-economic context of the State concerned. ICC indicates to the secretariat actions that it should take to assist the State concerned in the implementation of such measures.
6. Should ICC find that the biosphere reserve in question still does not satisfy the criteria contained in Article 4, within a reasonable period, the area will no longer be referred to as a biosphere reserve which is part of the Network.
7. The Director-General of UNESCO notifies the State concerned of the decision of ICC.
8. Should a State wish to remove a biosphere reserve under its jurisdiction from the Network, it notifies the secretariat. This notification shall be transmitted to ICC for information. The area will then no longer be referred to as a biosphere reserve which is part of the Network.

Article 10 – Secretariat

1. UNESCO shall act as the secretariat of the Network and be responsible for its functioning and promotion. The secretariat shall facilitate communication and interaction among individual biosphere reserves and among experts. UNESCO shall also develop and maintain a worldwide accessible information system on biosphere reserves, to be linked to other relevant initiatives.
2. In order to reinforce individual biosphere reserves and the functioning of the Network and subnetworks, UNESCO shall seek financial support from bilateral and multilateral sources.
3. The list of biosphere reserves forming part of the Network, their objectives and descriptive details, shall be updated, published and distributed by the secretariat periodically.

SOURCE: http://www2.unesco.org

International Year of Deserts and Desertification — 2006

Desertification, in the words of UN Secretary-General Kofi Annan, is one of the world's most alarming processes of environmental degradation.

With the adoption in 1994 of the United Nations Convention to Combat Desertification (UNCCD), the issue was given proper recognition. Desertification as a global challenge, together with Climate Change and Biodiversity, now enjoys the support of a strong coalition of partners. But public awareness has not kept pace. In relation to the true scope and magnitude of the problem, Desertification still receives too little attention and is little understood by the public at large.

In fact, Desertification is about land degradation: the loss of the land's biological productivity, caused by human-induced factors and climate change. It affects one third of the earth's surface and over a billion people. Moreover, it has potentially devastating consequences in terms of social and economic costs.

The 22nd session of the United Nations Environment Programme (UNEP), recalling the UNCCD, the Plan of Implementation of the World Summit on Sustainable Development and the Environment Initiative of the New Partnership for Africa's Development (NEPAD), invited the General Assembly of the United Nations to consider declaring an international year of deserts and desertification.

Subsequently, at its 58th ordinary session, the General Assembly declared 2006 the International Year of Deserts and Desertification (IYDD). In doing so, the General Assembly underlined its deep concern for the exacerbation of desertification, particularly in Africa, and noted its far-reaching implications for the implementation of the Millennium Development Goals (MDGs) which must be met by 2015. At the 2002 World Summit on Sustainable Development, the UNCCD was singled out as a key instrument for poverty eradication in dry land areas.

The IYDD therefore presents a golden opportunity to get the message across strongly and effectively that Desertification is a global problem which we ignore at our peril. It also provides an impulse to strengthen the visibility and importance of the drylands issue on the international environmental agenda, while providing a timely reminder to the international community of the immense challenges that still lie ahead.

It is important to recognize, however, that drylands are also home to some of the most magnificent ecosystems of this world: the deserts. These unique natural habitats with their incredibly diverse fauna have been home to some of the world's oldest civilizations. They stand like open-air museums, bearing witness to bygone eras. The Year will therefore also celebrate the fragile beauty and unique heritage of the world's deserts, which deserve protection.

www.iydd.org


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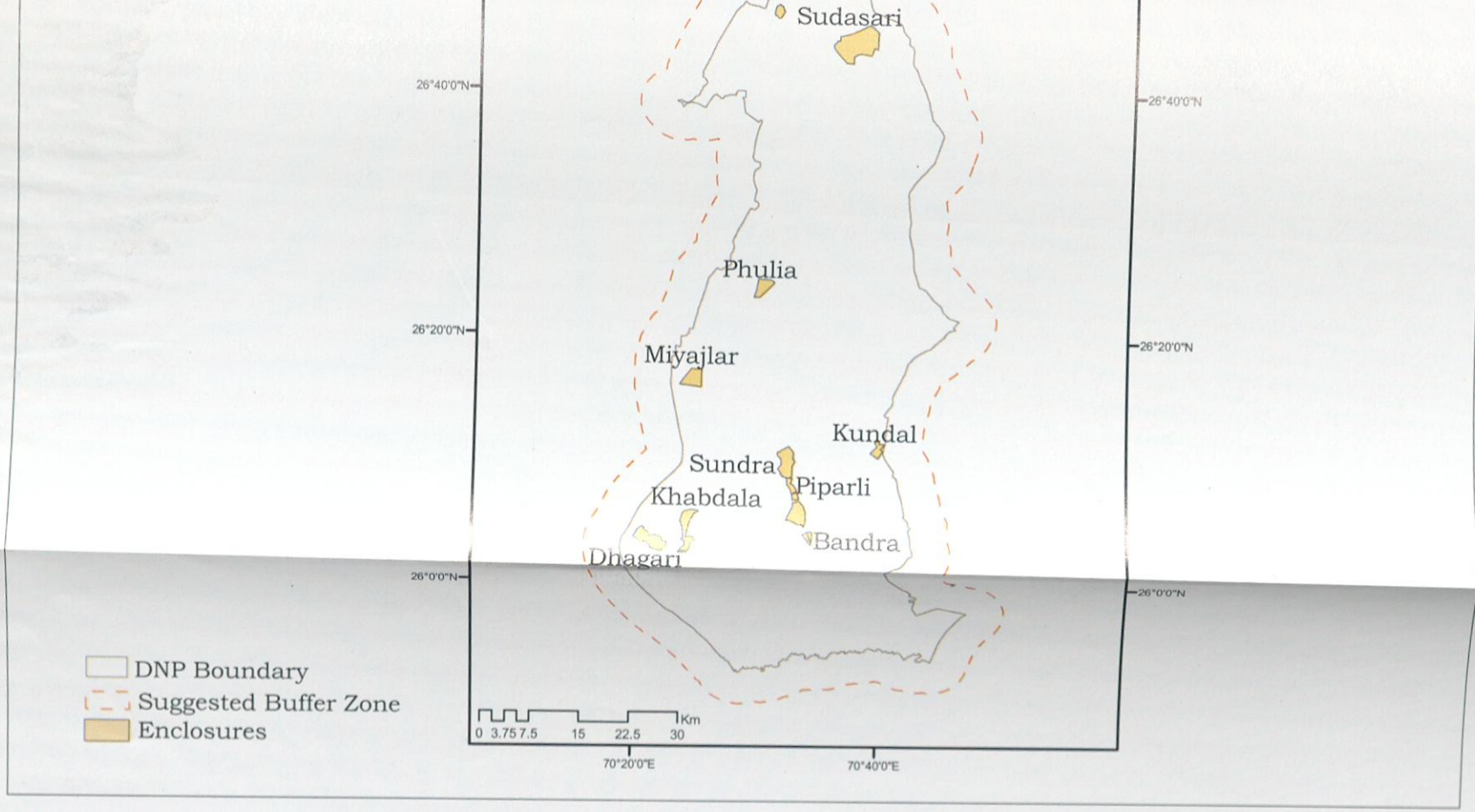
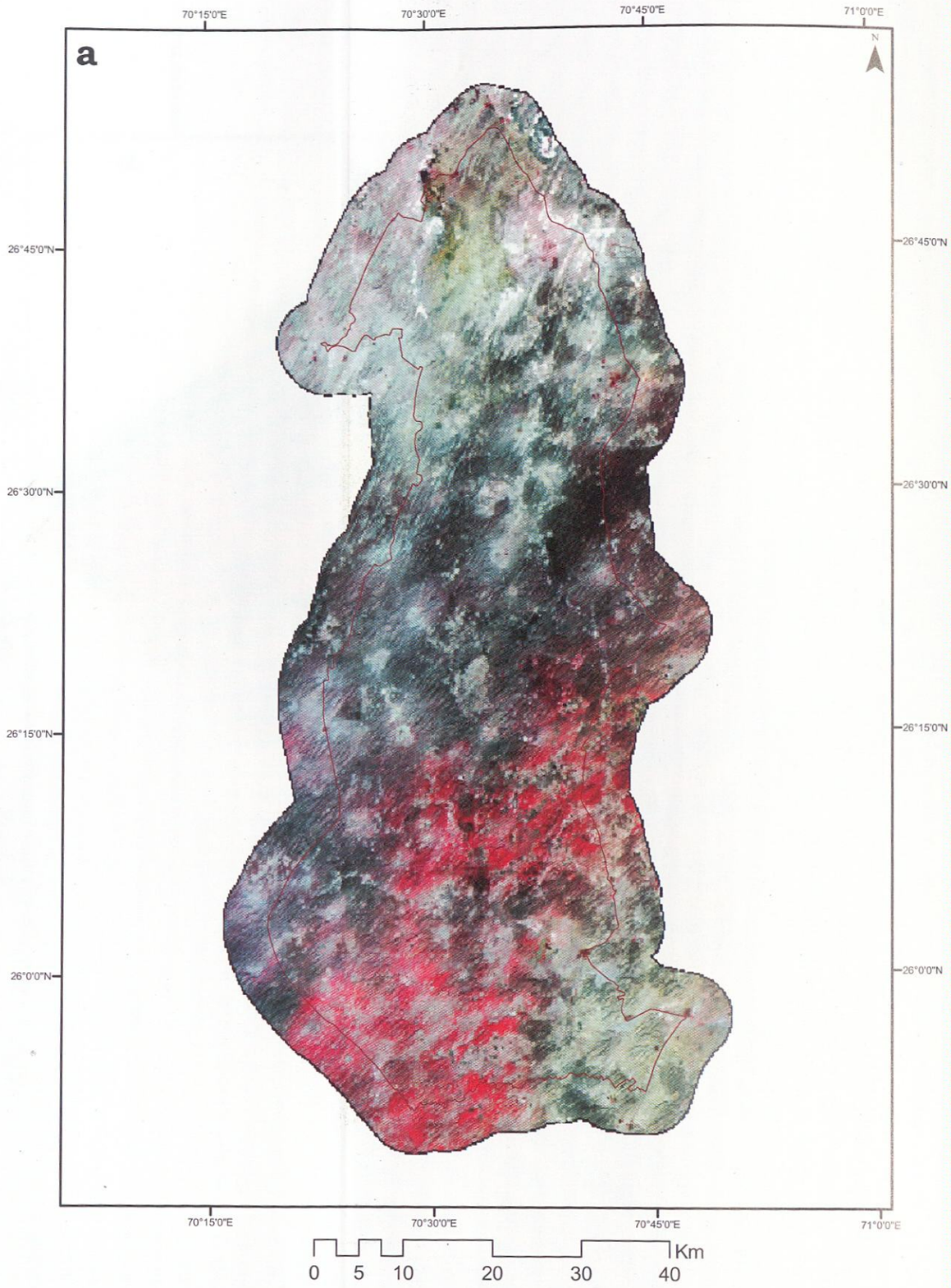
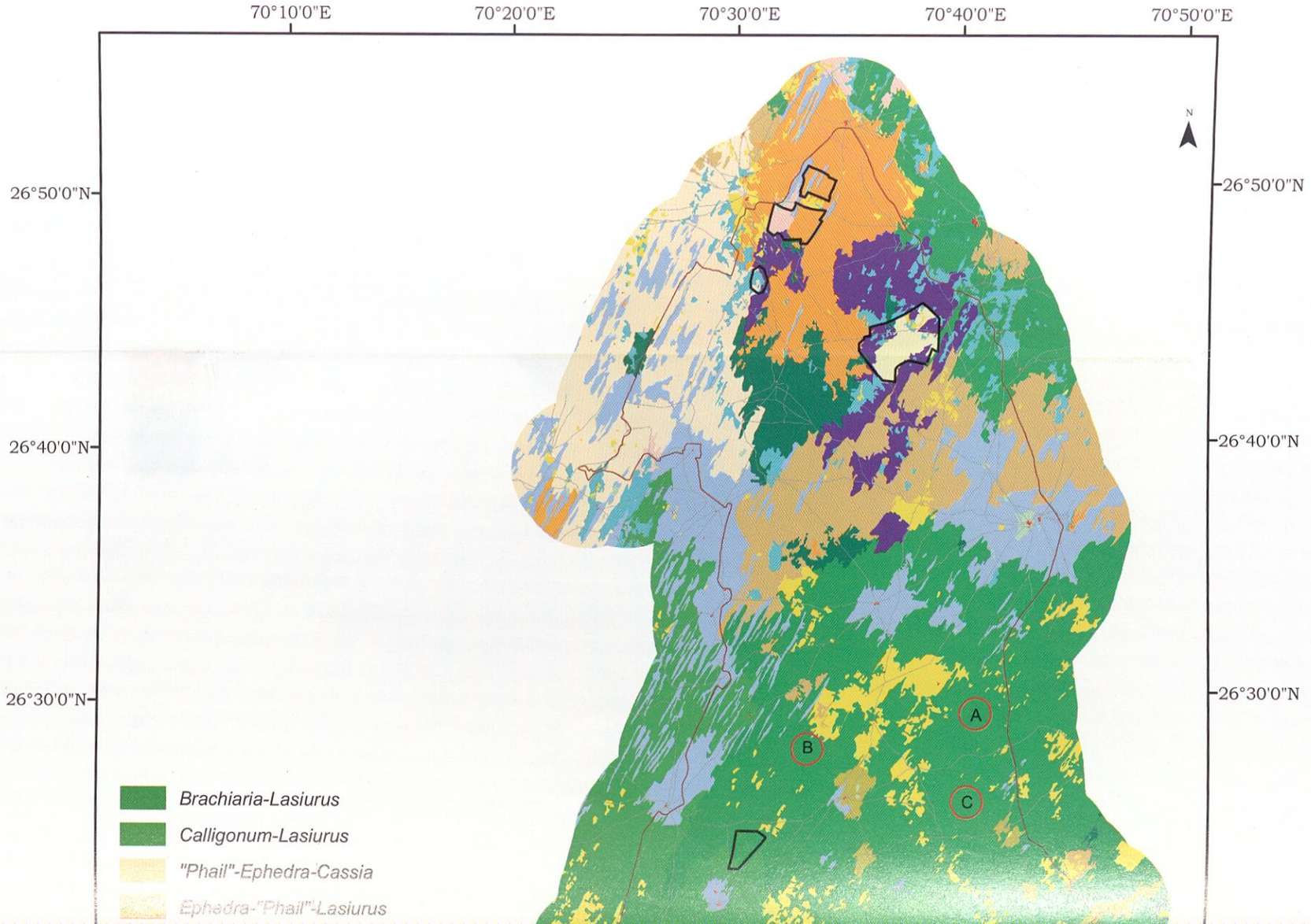


MAP A: Location of the Desert National Park in India

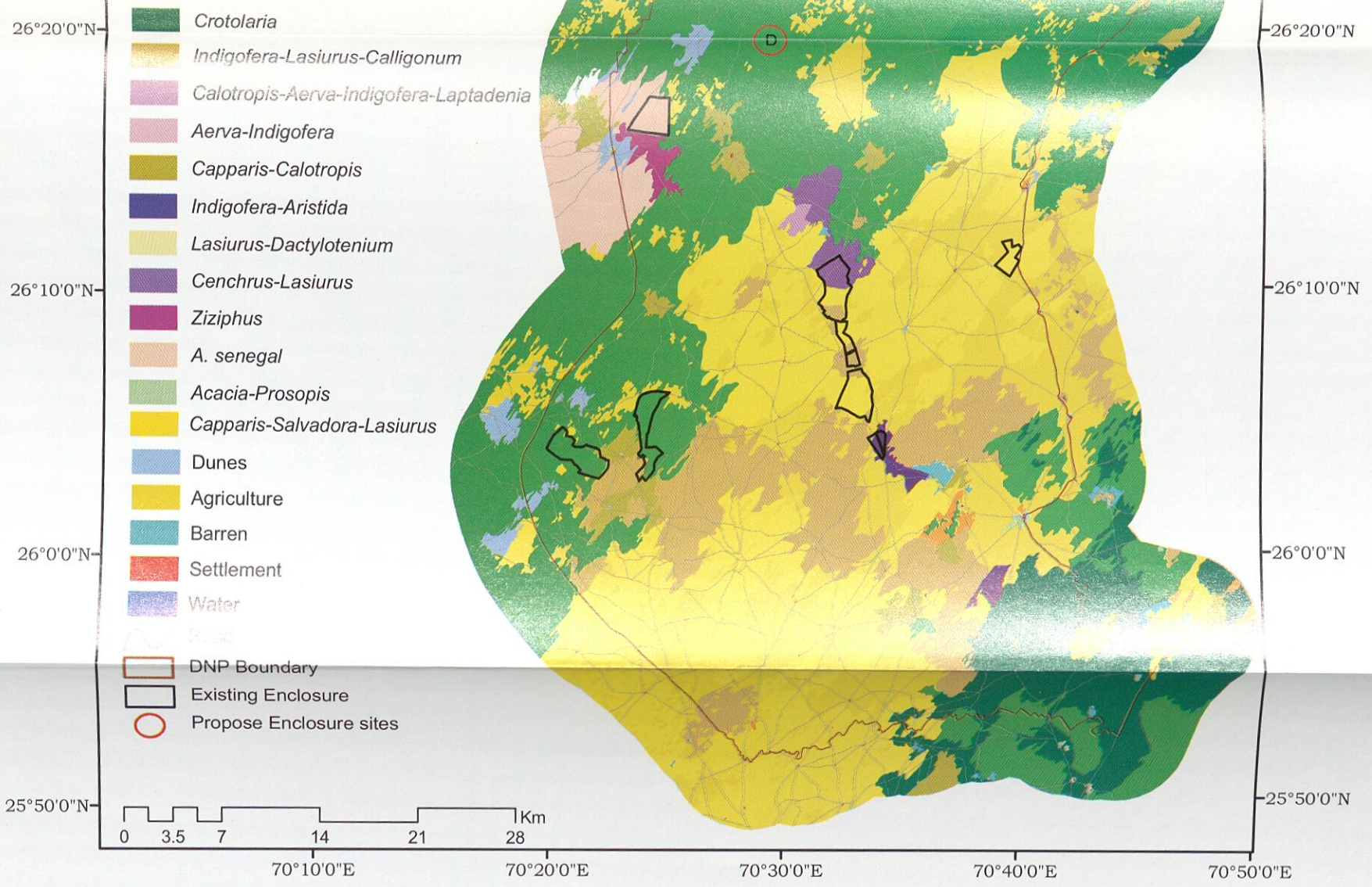


MAP B: False Colour Composite (FCC), of the DNP, a)

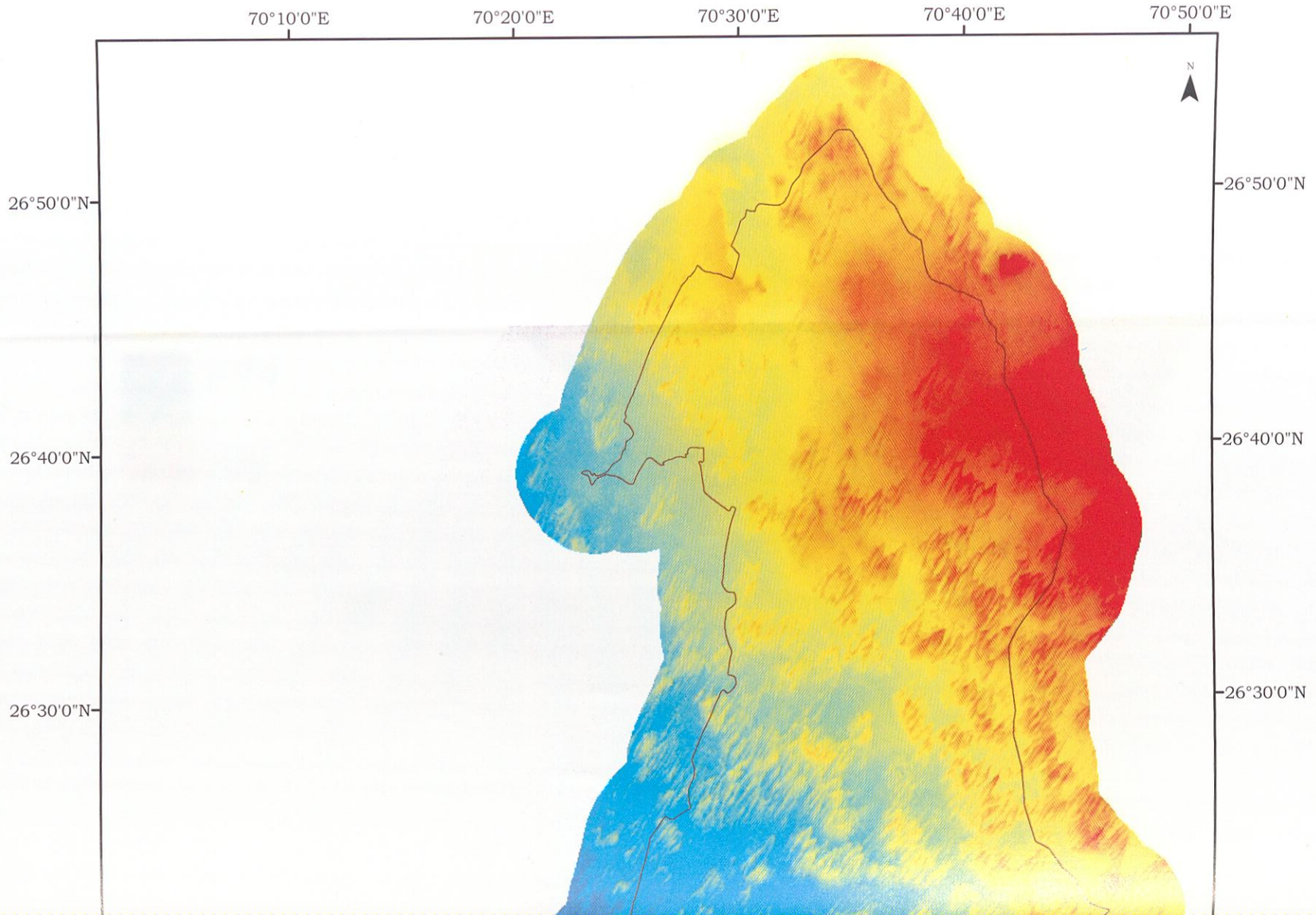
IRS-P6 LISS III, 2004 and b) Landsat ETM+, 2001



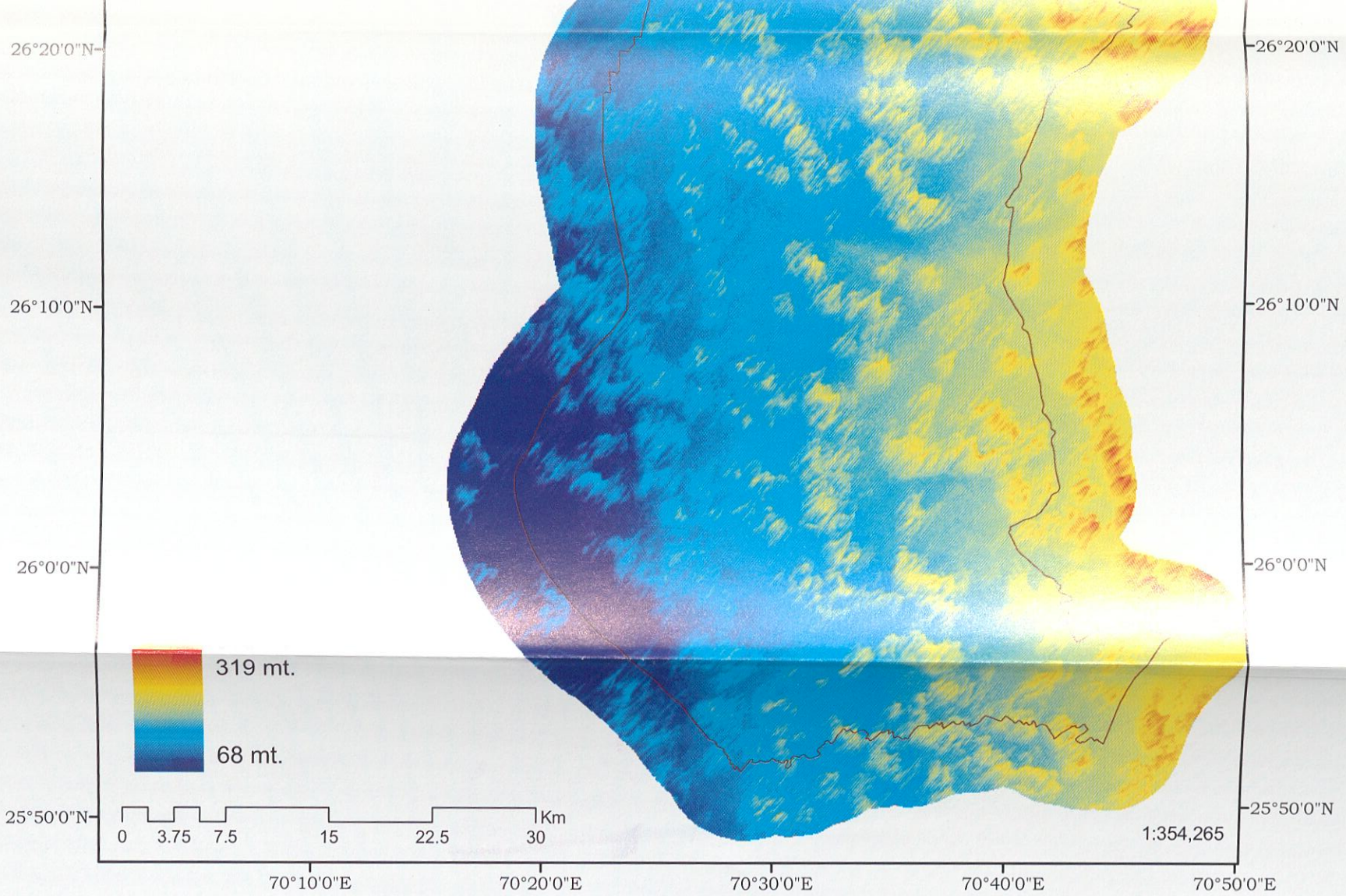
DEVELOPMENT OF DESERT NATIONAL PARK AS BIOSPHERE RESERVE



MAP C: Vegetation type and Land use Map of the Desert National Park (Including the proposed 5 km buffer)

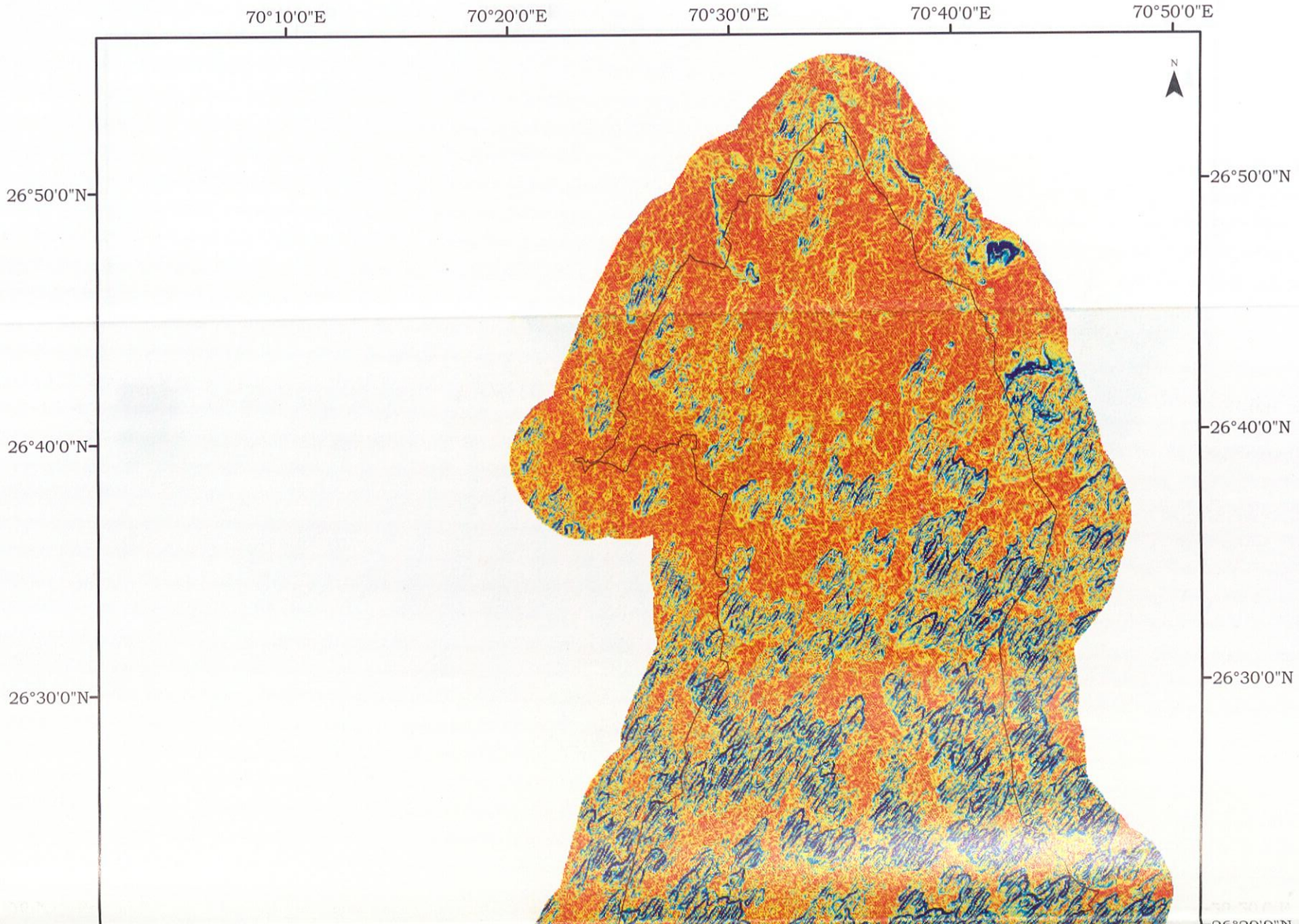


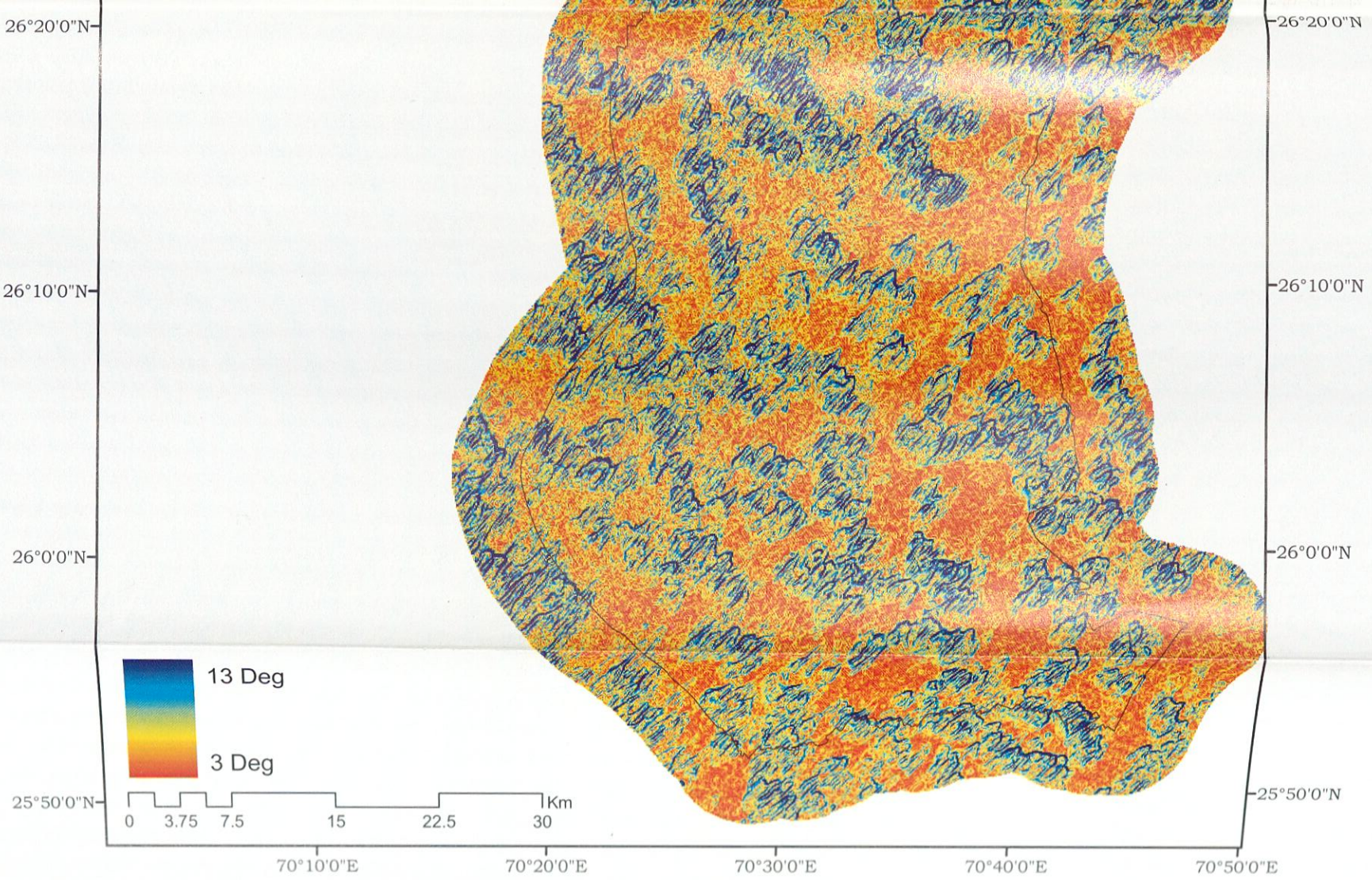
DEVELOPMENT OF DESERT NATIONAL PARK AS BIOSPHERE RESERVE



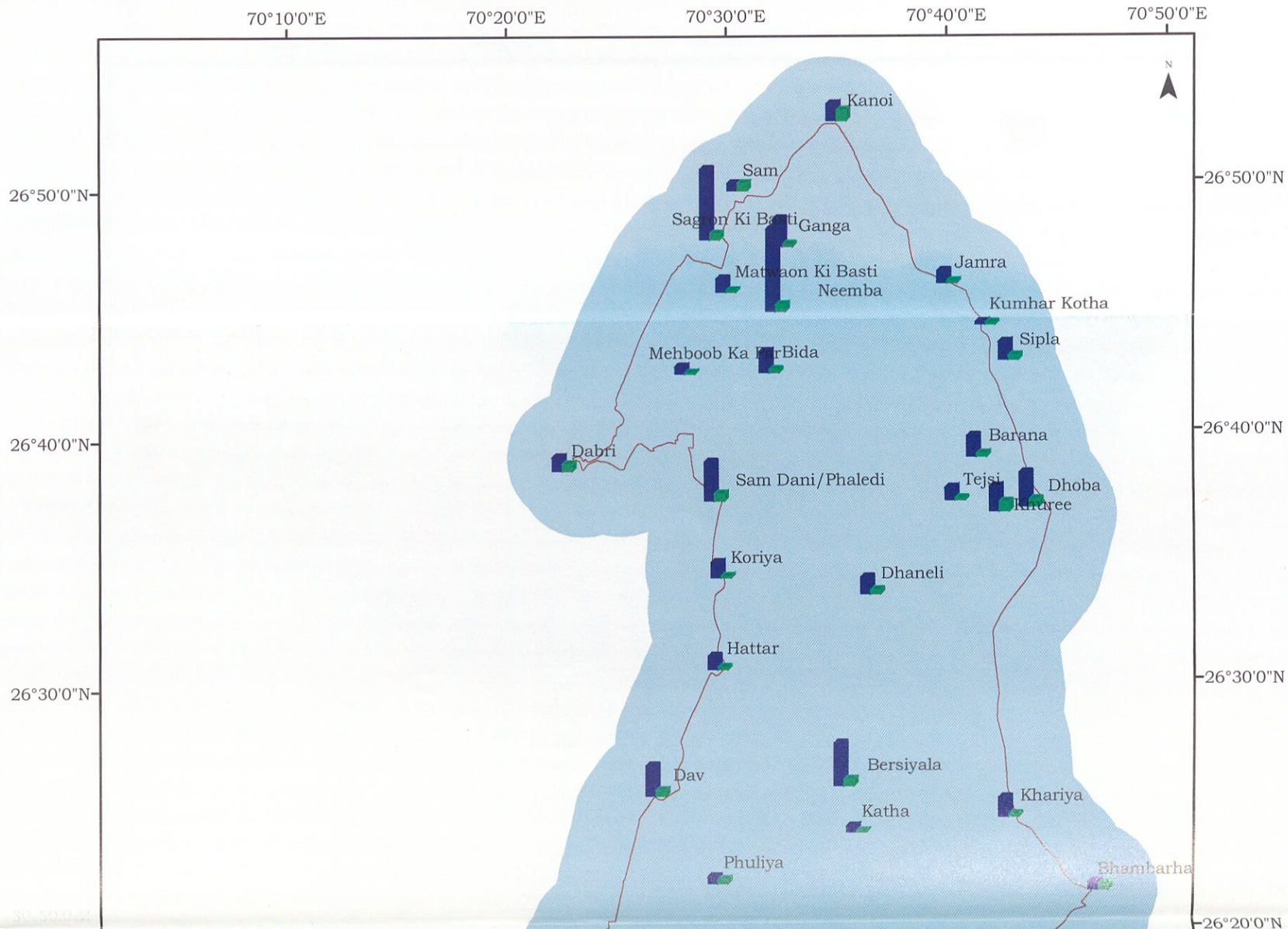
MAP D: Elevation Map of Desert National Park
(Including the proposed 5 km buffer)

DEVELOPMENT OF DESERT NATIONAL PARK AS BIOSPHERE RESERVE

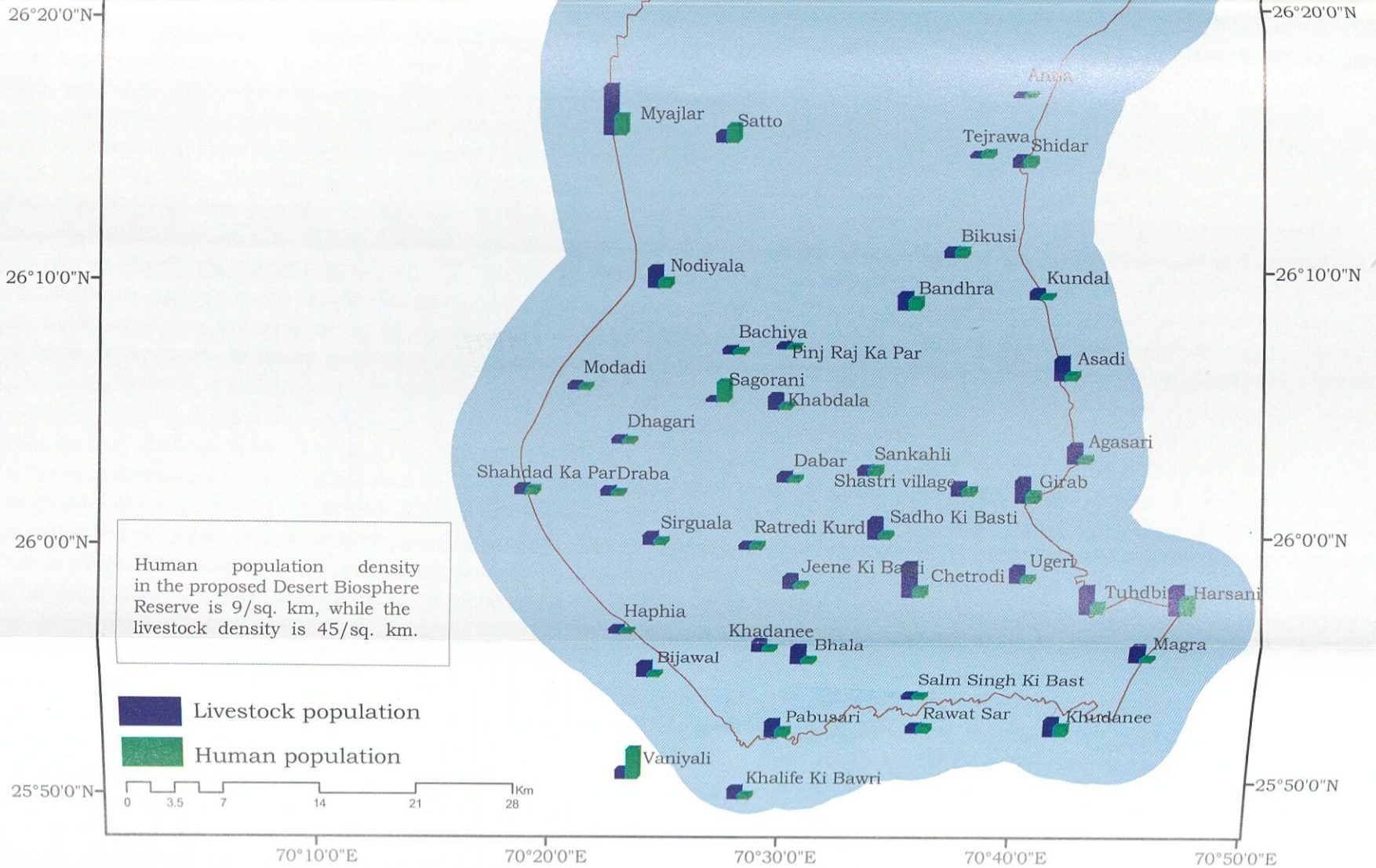




MAP E: Slope Map of the Desert National Park
(Including the proposed 5 km buffer)

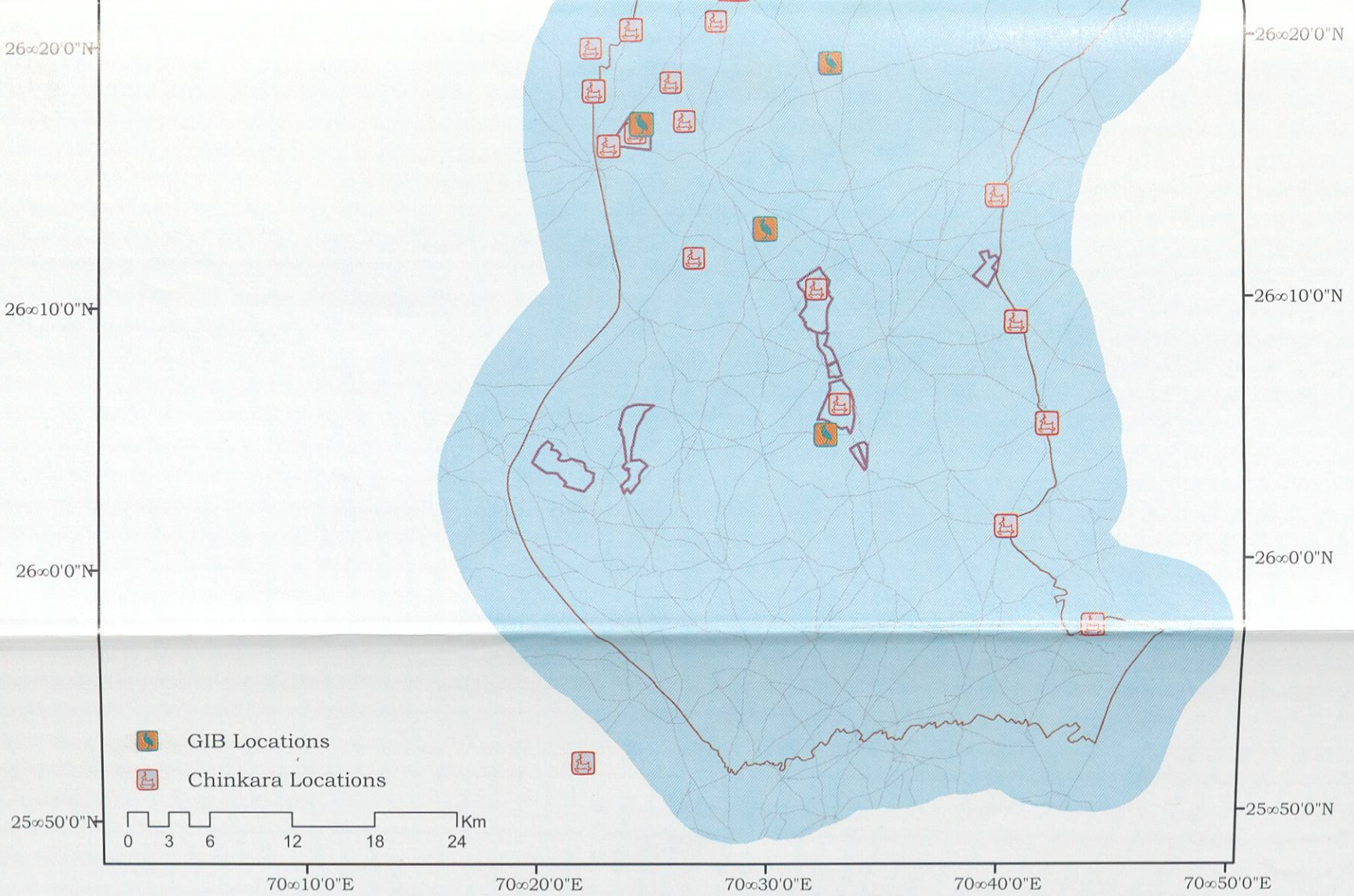


DEVELOPMENT OF DESERT NATIONAL PARK AS BIOSPHERE RESERVE

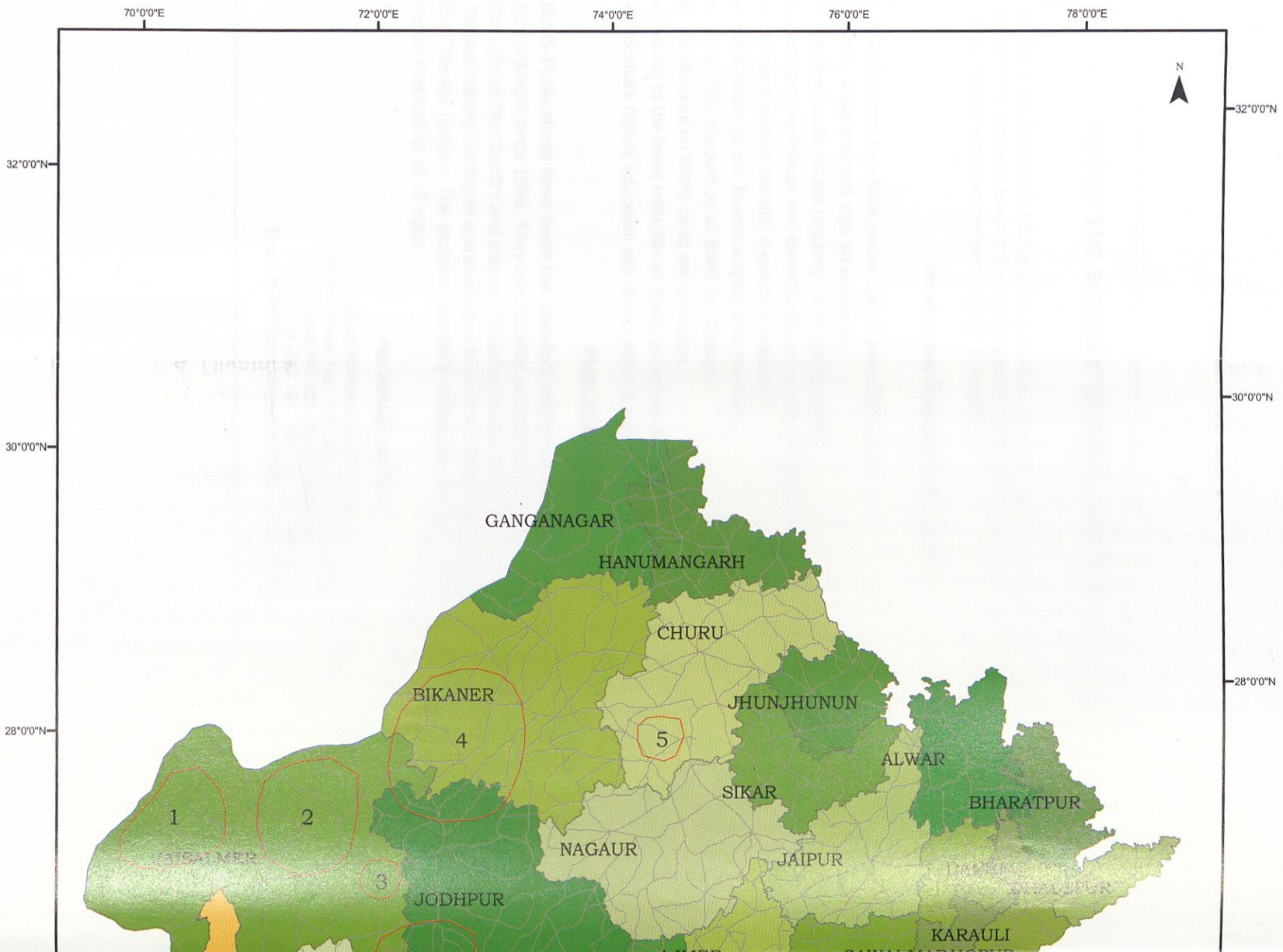


MAP F: Location Map of villages in the Desert National Park (Including the proposed 5 km buffer)

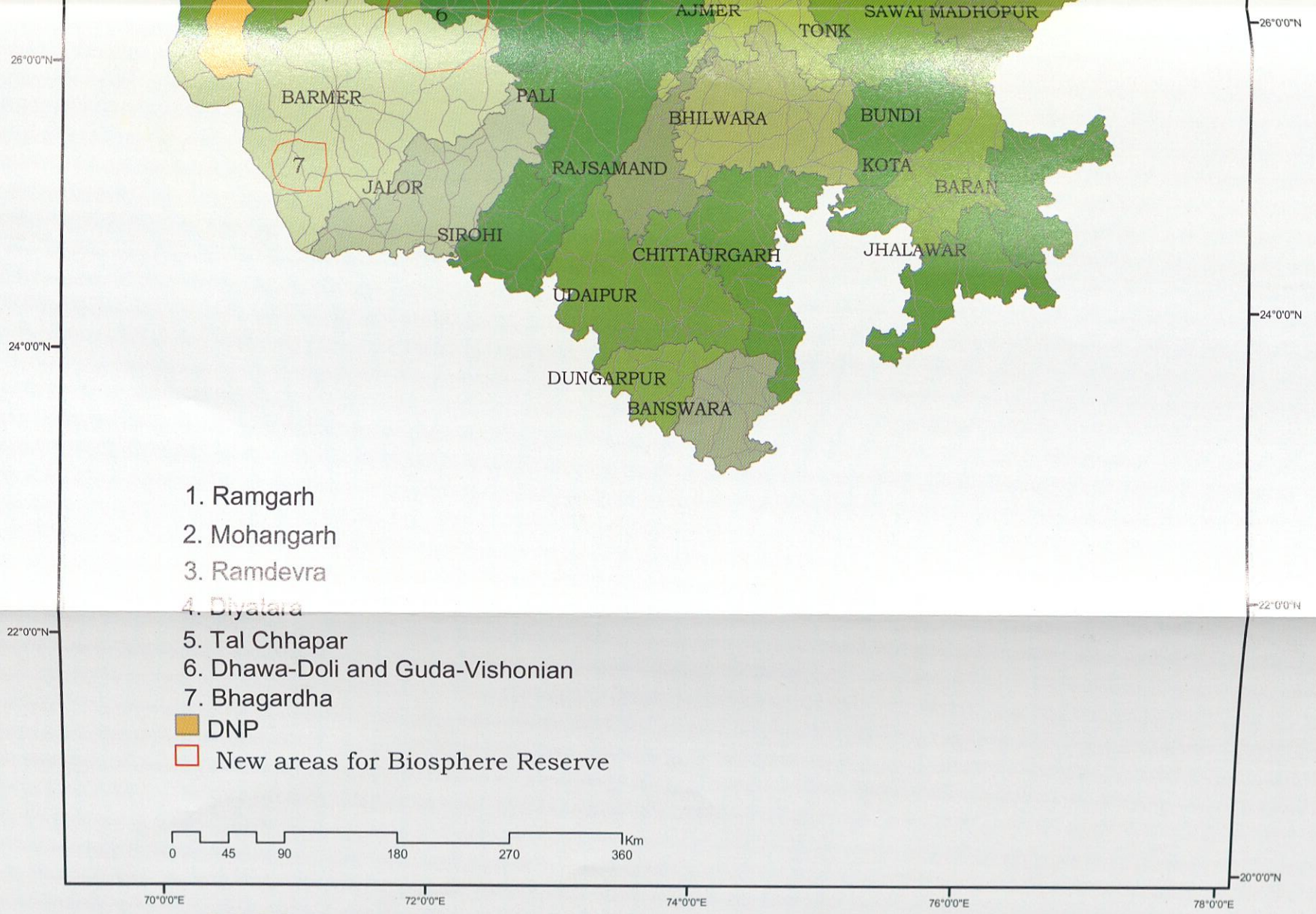
DEVELOPMENT OF DESERT NATIONAL PARK AS BIOSPHERE RESERVE



MAP G: Locations of Chinkara and GIB in the Desert National Park, including the proposed 5 km buffer.(Based on our survey)



DEVELOPMENT OF DESERT NATIONAL PARK AS BIOSPHERE RESERVE



MAP I: Proposed community and conservation reserves to be included in the Greater Desert Biosphere Reserve in Rajasthan

ABOUT THE BOMBAY NATURAL HISTORY SOCIETY

The BNHS was founded in 1883 and today it is the prime non-governmental conservation organisation in the Subcontinent. We work towards the conservation of nature and natural resources, education and research in natural history, and have members in over 25 countries.

Membership Activities and Benefits

- Nature camps to wildlife places both in and outside India.
- Treks, walks and field trips on weekends.
- Excellent audio-visuals regularly presented by experts.
- Seminars, workshops and correspondence courses on specific natural history subjects.
- Members receive *Hornbill*, a quarterly magazine.
- Subscription to the *Journal* is optional to members.
- Up to 25% discount on all BNHS publications.
- 5% discount on BNHS cards and calendars.
- Access to the finest collection of books on natural history.
- Voluntary Nature Education and Conservation activities.

PUBLICATIONS

BNHS Publications have been the standard reference works on the natural history of the Indian subcontinent since 1886. They are essential acquisitions for naturalists, amateurs and professionals throughout the country and abroad. Published uninterrupted since 1886, the *Journal of the Bombay Natural History Society* is acknowledged to be one of the finest scientific natural history sources for the Oriental Region. The popular quarterly magazine *Hornbill*, published since 1976, caters to a varied readership of all ages.

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