Management of Forests in India for Biological Diversity and Forest Productivity

A New Perspective

WII-USDA Forest Service Collaborative Project

Grant No. FG-In-780 (In-FS-120)

Volume V

Satpura Conservation Area (SCA)

Anjana Pant
Shivaji G. Chavan
Sunil B. Banubakode
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Project Overview

Background

The Wildlife Institute of India-U.S. Forest Service Collaborative Project entitled "Management of Forests for Biological Diversity and Forest Productivity – A New Perspective" was conceived in 1992 and formally approved by the Government of India in 1995. An Memorandum of Understanding was signed between the parties for this project under the Indo-US Scientific Collaboration on Science and Technology on November 24, 1995 with a sanctioned grant of Rs. 13,455,000 (USIF). The project evolved from the earlier collaboration of the US Forest Service (USFS) and the Wildlife Institute of India (WII) on a project in the Satpura Hills of Central India.

The project is first of its kind in India to address the primary mandate of forest managers in the country to sustain forest biodiversity. The National Forest Policy (NFP) of 1988 by recognizing the maintenance of biological diversity in forests as the principle mandate was materially different than the previous NFP passed in 1952. It is obvious that the traditional forest management approach had to undergo a major shift in emphasis and strategies. The shift in traditional training for budding foresters needed to be inseparable from changes that must happen in the field. Both were under review in India at the time of project initiation. This project was, thus, expected to play a significant role in demonstrating the integration of science and management in a planning process that establishes the complementary roles of protected areas and the large surrounding landscapes of managed forests in maintaining forest-based biological activity.

In view of the above, the principal aim of the project was to demonstrate an approach to achieving integration of concerns in India for biological diversity, forest based products, and their sustained flow in support of technological, economic and social benefits to urban and rural sector lifestyles. To accomplish this, the project set forth the following six objectives that addressed ecological assessment in "conservation areas" that included relatively undisturbed forest ecosystems, managed forests with current forestry interventions under a variety of harvest systems, and intervening matrix landscapes that support subsistence and related market based rural economies.

Project Objectives

- Assess, document, and map the kinds, extent and distribution of plant and animal diversity in selected "conservation areas" through rapid survey methods.
- Use existing status and habitat relationships information to set up baseline habitat relationships information system.
- From stand-to landscape-level perspectives, evaluate the impact of existing forestry practices and use of forest-based resources by local people, including methods of harvests and collection, fires, operation of varied concessions and rights on micro habitat elements, key habitats, species, communities, the overall forest productivity and diversity.
- Rapidly assess the social and economic systems of surrounding villages in terms of varied land use and forest resource dependency, including raising and grazing of domestic livestock, other vocations, skills, economy, and markets. These will be seen in relationship to forest systems. Threats to ecological harmony and economical status of people will be documented.
- Use modern ecological concepts to develop practical management tools and practices for bringing about harmony within and between forest and village systems through sustainable land use practices that make social and economic sense. Document problems and threat mitigation prescriptions, and develop site specific field guides to management.
- Conduct workshops and seminars to share experiences, disseminate knowledge, and begin the process of training scientists and managers.

Project Sites

The project was field based at four conservation areas (CA) that covered some 15,500 sq km of forested and nonforested matrix areas representing a variety of biogeographic patterns in wild plant and animal

communities, forestry practices, ethnic human societies and their forest based cultures, economies and tradition, and the range of administrative realities. Each of the CAs included select Protected Areas (PAs) – National Parks or Wildlife Sanctuaries; Managed Forests (MFs), and the intervening matrix of other Government, community or private lands so as to constitute a larger delineated landscape. The four CAs were the Anaimalai Conservation Area (ACA) in south India; Garo Hills Conservation Area in the north east India (GCA); Satpura Conservation Area (SCA) in Central India; and Terai Conservation Area (TCA) in the foothills of Himalaya and on the India-Nepal border.

Project Partners

The Project engaged in early 1996 five field researchers with varied backgrounds in Forestry and Life Sciences. They were given orientation training, then posted at the chosen CA with full logistical support from field line personnel at established field stations and camps. In addition, a Co-Investigator (CI) among the participating WII faculty and a counterpart USFS scientist were assigned to each CA. Besides the scientists and managers from WII and the USFS, senior decision-makers from the respective forest departments supported the team of personnel to conduct the work envisaged under the project. Accordingly, the Principal Chief Conservator of Forests and Chief Wildlife Wardens of the five States (Tamil Nadu, Meghalaya, Madhya Pradesh, Maharashtra, and Uttar Pradesh) fully supported the project. Further, the collaborating Institution i.e. the Indira Gandhi National Forest Academy (IGNFA) identified and pledged the services of two senior faculty members for the cause of the project, each of whom has been a line forest officer prior to their assignment at the IGNFA. In all, nearly 40 people from the WII, USFS, collaborating institutes, and the state forest departments were involved in project.

Project Planning Workshop

A Planning Workshop for the project was conducted at WII, Dehra Dun on June 10-12, 1996. The workshop objectives were to increase understanding of the overall project and to gain the support of the key stakeholders. The individual CA descriptions and the critical issues to be addressed were written for each CA. A specific action plan was to be developed for each CA along with the programme of work to accomplish the identified tasks over the project period. Appropriate coordination structure, monitoring and evaluation efforts were identified. Mr. Tom Darden, Dr. Martin Prather and Mr. Elton Thomas representing the US Forest Service, Mr. G.K. Gupta and Mrs. Usha Kapur representing FERRO, New Delhi, participated in the workshop. The other participants included faculty from WII (17) and IGNFA (3), and managers from the field representing ACA (1), GCA (4), SCA (4) and TCA (1). The proceedings were prepared and provided to the participants and circulated to others separately. The Planning Workshop facilitated the development of a framework of actions during the project period and coordination mechanisms.

Project Approach

The work programme for the project was charted in the Planning Workshop, attended by representatives of all the partners in the project. It is worth mentioning that the wildlife science is of recent origin in India. There is excellent scientific information on plant and animal taxonomy but weak information on species-habitat relationships or species biology. There are no central databases, and retrieval of local information is not easy as automation in data bases is just beginning. One of the most important steps to be taken at the outset was to ascertain, collate, and review the kind and spread of information - maps, unpublished data, research publications, and working plans of agencies. Indents for maps and imageries were decided on the basis of what was available. The ACA, SCA, and TCA had the advantage of a few researchers having worked on some endangered vertebrates, plant communities, and human social systems. Except for GCA, the rest of the three sites had excellent documented forest management histories and current plans.

The project aimed at incorporating modern ecological concepts into a framework applied to CA-specific guides for managers that synthesized technical information and provided strategies for achieving synergy between ecology and forest based economies. Further, the project planned to incorporate project principles, guide books, and management strategies into a managerial training.

Field Work – The Data Realms

Broadly four data realms – ecological, socio-economic, management, and administrative (mechanism of programme delivery through multi-agencies) - were

visualized as critical components for each of the project sites. Sampling strategies were challenging since the project dealt with large landscapes. Established techniques were used to investigate the components under each of the realm appropriately:

- The **ecological** realm considered the status and distribution patterns of plants and animals. Those under special focus included plant species of economic and cultural importance, animals that are culturally important, and those plants and animals that are endangered, threatened, endemic and rare. Elements under threat of illegal exploitation were integral to the foregoing. Besides the species, plant communities of conservation importance, sensitive and key sites and systems were included.

  Past and current forestry practices, including silvicultural systems and marking rules, were evaluated for their impact on forest composition and structure, including impacts on special and unique micro-habitats such as snags and logs. Fuel wood collection was integral. There was a much better understanding of silvicultural treatments and their broad impacts on vegetation dynamics than for the species, locations, ecology, productivity, sustainability, and harvest systems of non-timber forest produce. Medicinal plants were of special concern.

- The **socio-economic** realm investigated the relationships between the people and forest based resources. Local people were considered as key players in mitigation and sustainability. This realm has a fluid interface with the ecological data realm as people's interest and activities meld ecological and economic concerns. People's lifestyles and their influences both on the people themselves and on forest systems were also investigated through standard techniques *viz.,* questionnaires, household surveys, rapid assessment and micro planning.

  Livestock rearing, grazing and the articulating influences, likewise fuel wood collection constitute very long-term pressures on the forests. Agricultural practices within enclave villages and among peripheral villages are directly related to the nature of pressures on the forests. For example, cropping pattern, crop-depredation by wild herbivores, livestock predation by wild carnivores, injuries and death of humans as a result of encounters with wild animals were major issues of study. Poaching is another activity that has complex linkages. Mining, quarrying, collection of sand, use of water from streams and water holes were also included as a part of the information base development.

- The **management** realm included understanding and interpreting the impacts of infrastructure development (e.g. roads, fire lines, water holes, hides, etc) and current management practices.

- The **administrative** realm of information includes all management processes for conservation or human development of the region, thus includes multiple agencies and their programmes. The programme targets and dimensions can be varied – from local rural interest through activities of national interest. Information was collected on objectives, mechanisms of delivery, and the outputs of these socio-economic programmes of the Government and private sectors especially evolved for the inhabitants of villages in the forest.

Project Accomplishments

Generating ecological and land use maps to fit the project objectives was a necessity for all sites. Each CA stratified the area based on significant forest/ vegetation/habitat types, and established a system of randomly placed transects to assess vegetation structure, composition, distribution, and frequencies of plants of conservation and economic importance. While tree and shrub communities were addressed in detail, the grass and herb communities were addressed in terms of key assemblages and sensitive sites, except in the TCA where tall riverine grasslands and upland dry grasslands constituted significant ecosystems.

Assessments were made on plots of varying sizes placed at regular intervals on the transects. Along with plants, distribution and abundance of larger vertebrates were recorded by indirect evidences with the plots and sightings along the transects. TCA also used a modified experimental design to assess grassland by testing established intervention practices of prescribed burning, harrowing, and grass cutting in different combinations across grass communities. GCA adopted a system of existing natural and man-made trails in an extremely challenging field situation.

Following were the major outputs:

- **Resource Maps** - The project has been able to generate resource maps for all the four sites using the remote sensing and GIS technologies. A spatial data base has been, thus, created for each CA incorporating different layers viz., drainage, administrative/management units, land use/land cover, vegetation, animal distribution, villages, and infrastructure.
- **Baseline Information** – The project has significantly contributed in providing a baseline information on the floral and faunal diversity, land use, historic development, socio-economic condition, wildlife – people conflict, etc. The project has also addressed different biotic pressure in each of the sites.
- **Wildlife Habitat Relationships (WHR)** – A large number of vertebrate species representing the four sites and those unique to each CA based on a species selection criteria were short-listed. The project provided a detailed description on each in each CA and in the overall WHR database.
- **Capacity Building** – The capacity building of the frontline staff was an integral component of the project. New training curricula in the training module for the Post-Graduate Diploma Course in Wildlife Management were formulated for the frontline staff of the forest departments, especially related to habitat assessment and habitat management. A new approach to planning integrated disparate management units (e.g., PAs, MFs, matrix) at hierarchical spatial scales ranging from the CA to the region. These approaches have also been appropriately incorporated in the continuing education courses for middle and senior level forest managers and planners. Changes are also brought about in the training module for wildlife management at the IGNFA. A new course is being developed for forest working plan officers that will be built upon the learning from the project. The chapters on assessment of biodiversity, wildlife and habitat management planning in the draft National Working Plan Code, 1999, were largely based on the learning emerging from this project.
- **Study Tour for the Indian Delegation** - A 13-member Indian delegation visited USA on a study tour from July 24, 1999 to August 7,1999. The delegation included five faculty members from the Institute and eight field managers representing the four project sites across five Indian States. The program was jointly prepared and coordinated by Mr. Tom L. Darden and Dr. Hal Salwasser of the USFS, with support by Dr. James R. Stevenson, US Foreign Agricultural Service. The group visited two important regions – the Southern Appalachian Region on the east coast and the Sierra Nevada Region in the State of California and Nevada on the west coast. Visits to different National Forests, wilderness areas and conservation areas were organized. The counterpart US scientists also joined the visiting group during their field visits to different areas and participated in the workshop and project review. In addition to the field visits to different demonstration areas, workshops were also organized at Asheville, NC and the Institute of Forest Genetics (IFG), Placerville, CA. Several resource persons from the USFS, US National Park Service, and the University of California, Davis were invited during the workshops/field visits to provide their technical inputs. The delegates also visited the Department of Forestry Science in University of California, Davis.

Making large-scale ecological assessments on hierarchical scales to address management were central to the study tour. The experience gained in the process was ploughed into the presentations and field demonstrations. The entire experience was extremely relevant to the emerging situation of planning in India and addressed the vital areas of training, research, monitoring, planning and management. Apart from the field visits, the visiting group was paced through different approaches to integrated forest management using the concept of large landscape/conservation areas. Emphasis was laid on different tools and methods for forest and wildlife inventories, habitat assessment, timber management, endangered species management, management of forest insects epidemics, wildlife habitat relationships, fires, recreations, visitor management, ecological monitoring and some significant research especially on the spotted owls in the Pacific Northwest. Several opportunities were also provided for cultural exchange. The visiting delegations also made presentations based on their field/research works on respective Indian sites and related the experience to the element of the study tour conducted.

- **Management Guide -** The project has ultimately provided a new way of thinking about managing for biodiversity at the landscape scale, by taking into account all types of lands, across multiple spatial scales for multiple wildlife species and resource management needs. The project has provided an insight for the conceptual framework, the scientific basis, specific procedures for analysis and operations, and evaluation of select demonstration areas, about how to integrate resource assessment and management for biodiversity at the landscape level.

- **Information Dissemination** – Right from the beginning the project has yielded a substantial information in the form of technical annual reports or specific compilations. The project has significantly contributed in developing a spatial database. The field managers have extensively used the information generated in the preparation/ revision of management plans or planning other strategies/proposals. It is evident in the first management plan written for the Dudwa Tiger Reserve (De, 2001) and proposal for the establishment of an Elephant Reserve in the State of Meghalaya. Three Ph.D. dissertations are expected from the project. Researchers of the project have been making research presentations during the Annual Research Seminar organized by the Institute wherein a large number of field managers, scientists, decision-makers participate. The project plans to provide an electronic version of the report for its wider use by the scientific community as well as the field practitioners.

Organization of the Report

The final products of the project include a six volume management guide. The volumes have been produced in collaboration and intense interactions among four full time researchers, the US team of scientists, participating WII faculty, field managers of four project field sites and representative faculty from collaborating institution – IGNFA.

The Volume I addresses the conceptual and scientific basis of the approach, and would be of use to any manager or researcher entrusted with such an approach anywhere. Volume II is on wildlife habitat relationships and includes a framework for how to evaluate multiple wildlife species simultaneously, and narrative summaries of life histories of 184 wildlife species selected to represent various criteria of rarity, endemism, management focus, habitat associations and others. Volumes III to VI are intensive case studies of four "Conservation Areas" selected across India to represent a great diversity of ecological conditions, CA histories, cultural situations, and management challenges.

Lessons Learned

The four conservation areas studied in this project differed markedly in ecological conditions, socio-economic situation, and management issues. Equally diverse were the arrays of key stressors on the native flora and fauna, and in the management opportunities for improving conditions for native plant and animal diversity and human communities. Many useful lessons have been learnt from the project, principally the need to think broadly across major landscape areas when managing for native species and communities. This includes the need to coordinate data, analyses and management across different land ownerships and allocations. Cumulative effects in buffer areas or zones of influence outside existing protected areas, or even along international borders, are also to be taken into account when developing site-specific management plans. Also, an integrated resource management approach at all spatial scales is seen as the best way to avoid conflicts in resource use and to plan for appropriate ways to conserve biodiversity in managed forests.

Specifically, following is a gist of overall guiding principles and lessons learned from this project :

- *Think* broadly across major landscape areas
- *Integrate* management plans across administrative boundaries and between forest and wildlife resource areas
- *Consider* cumulative effects of all activities
- *Think* in hierarchical spatial scales
- *Use* local knowledge and needs in the conservation strategy
- *Consider* a fuller array of flora and fauna
- *Consider* ecosystem and anthropogenic processes and the ecological roles of organisms

The study categorised stressors into five main groups: (1) stressors associated with resource consumption, (2) stressors associated with use of non-consumptive resource amenities, (3) stressors associated with transportation and habitation infrastructures, (4) stressors associated with effluents, and (5) stressors associated with other human activities having impact on the resources.

Specific management opportunities related to reducing or eliminating the occurrence and adverse effects of the various stressors listed above can be summarized across the four conservation areas are follows:

- Management opportunities and recommendations in managed forests
- Management opportunities and recommendations for identifying natural conditions and native biodiversity
- Management opportunities and recommendations in riparian areas
- Management opportunities and recommendations for roads and transportation systems
- Management opportunities and recommendations for tourism
- Management opportunities and recommendations for protecting rare and locally-distributed species and ecological communities
- Management opportunities and recommendations for conservation of wide-ranging species
- Management opportunities and recommendations on collection and poaching of species
- Management opportunities and recommendations on participation by local people
- Management opportunities and recommendations on research and monitoring

Further, basic ecological understanding also is necessary to modernise silvicultural systems by moving them from a focus simply on the production of wood and other human goods and services, to the production of both human and ecological goods and services by restoring or maintaining diversity and viable forest ecosystems. The transition from old to "new forestry" will be critical for integrating PAs and MFs to meet ecological goals described for conservation areas. The transition likely will require a period of adjustment of attitudes and experimentation with new methods, such as use of adaptive management approaches.

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Chapter 1 Introduction

Satpura Conservation Area (SCA) represents the central Indian Highlands and is a heterogeneous mosaic of a large contiguous forest area that includes protected areas where resource use has been stopped or controlled for a long time. They are primarily managed for wild plants and animals. The second category, forests, are managed for goods and services. A large population of tribals, other forest and forest-side dwelling communities inhabiting the scattered villages across the SCA are dependent on a variety of forest products- timber, non-timber forest produce, fuel-wood and for grazing their cattle. This is a long-established forest dependent economy that operates through a number of concessions granted by the forest department to the people. These are regulated through prescriptions in working plans (forest plans). The details appear elsewhere. The managed forests have other categories of enclaved lands such as private lands and lands controlled by government agencies other than the forest department.

1.1 Statement of significance

i. **Economic**: The SCA extending over some 9000 sq km of forested country, represents the central Indian Highlands along the Satpura mountains trend and is one of the largest contiguous forested areas. The forests are economically amongst the most valuable of the dry deciduous types. Teak (*Tectona grandis*) also known as 'king of timbers' is the principal timber species. The largest size trees grow in the moister tracts of the Bori reserve in the north, no longer cut since the area is now included in the Satpura National Park and Bori Wildlife Sanctuary (M.P.). The finest grain is however developed in the drier Melghat forests in Maharashtra. There are several other less valuable timber species that grow along with teak. A small tract of sal (*Shorea robusta*) forests, another timber species among those most valuable that grow in India lies to the north-east, albeit on poor quality site, not harvested for a long time and now included in the PAs. The local forests and the forest dwelling tribal and non tribal communities, economically, are heavily dependent on these forests for their supply of small timber, fuelwood, bamboo, thatch grass, a variety of wild fruits, fibre, gum, seeds, medicinal forest produce, leaves, and fodder for grazing their cattle. The entire supply of water to a large number of scattered villages comes from the forest. Food items are derived from plant products with supplement of fish from streams. Other items useful for the construction are stone, gravel and sand. Leaves of the Tendu tree (*Diospyros melanoxylon*) a nationalized produce collected over a few weeks each year provides large-scale employment and significant monetory gain for those engaged in collection activity. Tendu leaves support a multi-million rupee industry.

ii. **Biological**: SCA represents one of the largest contiguous populations of the critically endangered tiger estimated between 120-140 individuals. The other endangered species include mammals, birds, reptiles, amphibians, fishes and insects. A number of endangered

plants are still being documented with at least four pteridophytes in that category. A survey conducted in the Melghat forests has put up a list of more than 200 plant species of cultural and medicinal importance. Several herbaceous species in the northern tract of SCA have affinities with those in the Western Ghats to the north and south-west and Himalayas in the north-east, which is under debate as the 'Satpura Hypothesis'. The two National Parks within SCA and portions of the four Wildlife sanctuaries which represent ecological bench marks as they are least disturbed. The dry deciduous mixed forests represented in the SCA are among the finest and most diverse within this type.

iii. **Ecological processes and functions**: There are 14 regionally important rivers in the SCA, those in the north drain into the Narmada and those in the south into the Tapi river, which are among the major rivers in the country. These with their tributaries sustain life - human, plant and wild animals within SCA. The local economy depends on these rivers in context of water regime and quality, catchment capabilities and soil conservation. The Tawa reservoir across the Denwa and Tawa rivers is the arbiter of regional economy in the Hoshangabad district within the command area. Some of the finest wheat and Soyabean crops are raised here that have changed the face of economy in this tract outside the SCA.

iv. **Recreational**: Outdoor recreation has its own place in the societal values. Pachmarhi to the north-east and Chikhaldara to the south attract a large number of visitors on account of the salubrious climate, verdant landscape and scenic sites. The tourism corporations in MP and Maharashtra respectively have made considerable investments to promote tourism. The unique advantage is the surrounding protected areas- The Satpura protected area complex (BSP) around and below Pachmarhi and Melghat Tiger Reserve below Chikhaldara. Although the tiger is the major attraction a wide range of animals, birds and plants constitute the recreational values.

v. **Scientific**: Since the protected areas are among the least disturbed tract, they are a repository of species richness and diversity; ecological processes and functions; diverse social systems, traditional lifestyles and wisdom. Opportunities for scientific research abound here.

vi. **Educational**: Conservation education and nature interpretation opportunities in SCA are wide-ranging and diverse which can serve an equally diverse target groups. The significant aspect is the likely emerging support for conservation of biological diversity.

vii. **Cultural**: The rich and diverse tribal societies, their traditions, customs and wisdom contribute to India's heritage. They are a repository of nature's wisdom. Most traditions and religious beliefs revolve around wild plants, animals, wilderness and living in harmony with nature. Several rock paintings believed to be more than 10000 years old hold the secrets of ancient civilizations. There are old forts and other historical sites, sites of religious pilgrimage that attract pilgrims from various parts of the country.

1.2 Historical background

1.2.1 History of settlement, hunting and designation of forests and parks

(a) **Betul Forests**

Betul district came formally under British territory in 1826, after the battle of Sitabaldi in 1818. When the area came under British territory in 1826, utility of forest was then not known, lines of communication were poor and shifting cultivation

in the name of *Dahiya* or *Bewar* was being practiced. It resulted in creation of large blanks and making the forest drier, by eliminating less hardy species and in parts by increasing the percentage of teak. These forests remained inaccessible upto 1856.

The demand for timber for construction of railways and for the Public Works Department was met from forests through contractors. Contracts were given by Civil authorities by issuing *parwanas*. In the absence of supervision, the contractors behaved as they wished. With the creation of Forest Department in 1862, and appointment of Lieutenant Doveton in 1864, areas were selected and demarcated in consultation with the settlement officer and declared Reserved in 1865 under the Forest Act. Forest areas of Nimar, Hoshangabad and Betul district formed the Western Division with headquarters at Hoshangabad. The unappropriated wastelands were classed as unreserved forests, under the management of the Deputy Commissioner, Betul Forest Division was separately constituted in 1873 and unreserved forests were to be managed by the forest officer of the district under directions from the Deputy Commissioner.

The former reserved forests were again declared reserved in 1879, after the passing of the Indian Forest Act of 1878. The responsibility of the Conservator was extended to all the Government forests of the district, while the Divisional Forest Officer was regarded as Assistant to the Deputy Commissioner, in so far as the interests of the population were concerned. Betul division comprised of five ranges namely Bhawargarh, Asir, Ranipur, Tapti and Dabka. Later Saonligarh range of Betul district was transferred from Hoshangabad division in to Betul division in July 1892, increasing the number of ranges to six.

The Dabka range was split into Dabka and Sawalmendha in 1904. In April 1921, Dabka and Sawalmendha ranges were transferred to Amravati forest division, and Tapti range was divided into North and South Tapti ranges. Betul and Amla ranges came into existence by splitting of Ranipur range into two in November 1926. Small re-adjustments in area distribution were done in 1927. With the abolition of Amravati (minor) division in 1938, Dabka and Sawalmendha ranges were transferred back to Betul. The North and South Tapti ranges were amalgamated in to one, excepting Chandu Circle of South Tapti range (area South of river Tapti), which was transferred to Salwalmendha range. With the increase in work for war supply, Bhawargarh range was temporarily splitted into North and South Bhawargarh ranges during 1942-43 to 1944-45.

Unregularised and unscientific exploitation of the *Malguzari* forest by the contractors and the public, led to their deterioration. In these forests the number of malformed stems and inferior species increased. With the abolition of *Malguzari pratha* (system) in 1950, these Protected Forests became Government property and were taken over by the Revenue Department. These forests, were transferred by the Revenue department to Forest department for its management in 1955-56.

In July 1961, Betul forest division was divided into North and South Betul forest divisions. North Betul division consisted of Betul, Amla, Sarni, Ghodadongri, Shahpur, Bhaura and Saoligarh ranges, while south Betul division comprised of Tapti, Chicholi, Mohda, Bhainsdehi, Athner and Multai ranges. With the reorganization of divisions in 1966, North, South and West Betul divisions were formed in the Betul district. With the nationalization of timber and timber trade in 1970, West Betul division was abolished, while a Lumber Division was created for the whole district, for the departmental working of coupes. All the divisions were under the administrative control of Conservator of Forests, Hoshngabad, upto 30-9-1976. With the reorganization on 1-10-1976 two circles namely, Betul territorial and Betul Sale Circle were formed. These Circles comprised of following divisions:

I) Betul Territorial Circle:-

(a) North Betul (T) Division.

(b) South Betul (T) Division.

(c) Lumber Division Betul.

(d) All Territorial divisions and Lumber Division of Chhindwada district.

II) Betul Sale Circle, Betul:-

(a) Sale Division Betul.

(b) Sale Division Hoshangabad.

(c) Sale Division Chhindwada.

(d) Sale Division Jabalpur.

(e) Sale Division Satna.

This Sale Circle was abolished on 15-10-1978 and converted into Betul Production Circle, which controlled all the Lumber Divisions of Betul, Khandwa, and Hoshangabad districts. Betul Territoral Circle was also abolished from the same date and Territorial divisions of Betul district came under the administrative jurisdiction of Conservator of Forests, Hoshangabad. A plantation division Betul was formed in the year 1980, which was abolished in the year 1982. In July 1980, Betul Production Circle was abolished, while only one circle referred to as Betul Circle, was formed for Betul District. On 8-10-1982, three Territorial divisions North, South and West, as well as four production divisions namely 1, 2, 3, and 4 were created, in Betul District. The newly created Production and Territorial Divisions came into existence from 21-12-1982.

Gawasen and Saoligarh ranges of North Betul Division were included in West (T) Division. Production Division No.4 was abolished on 19-9-1983. On 1-12-1983 Gawasen range of West (T) Division again was merged with North (T) Division of Betul Circle. The remaining three Production Divisions are now referred to as North, West and South Production Divisions, respectively. A Social Forestry division was created in the year 1987.

(b) Hoshangabad

These forests were declared reserved under Section 34 of Indian Forest Act VII, of 1878 by Central Province Gazette Notification No. 886 dated 20th February 1879 and No. 917 (f) and (h) dt. 24th February 1879. However, part of the sanctuary, which was erstwhile Bori reserve east of Sonbhadra has the distinction of being the first to be declared under the Reserve Forest Act of 1865.

The past history of game management in this area dates back to 1931 when it was declared as Bori sanctuary extending over an area of 1400 sq. kms surrounded by Denwa river on the East and North, Tawa River on the West and District boundary of Betul and Hoshangabad on the South. Shooting of animals was restricted in this area. Legislations to manage the sanctuary, prevailing since then were: -

1. The Wild Birds and Animal Protection Act (Act No. VIII) of 1912 passed by the Indian legislature as amended in its application to the central province by the Central Province Act XII of 1935 and such rules and modifications as have been made there under.

2. The shooting rules made by the Govt. under section 26(1) and 76(a) of the Indian Forest Act (Act XVI of 1927).

3. The Central Province Game Act (Act XV of 1935) was passed by the Central province legislature council. From 1st October 1963 a complete ban on shooting for two years was imposed in entire Hoshangabed district. In 1972 (Act XXX of 1972) was promulgated and M.P. Wildlife Protection Rules, 1974 became applicable to the entire area. The sanctuary was notified under Wildlife (Protection) Act 1972 for the first time in 1975, vide Govt. of M.P. Notification No. 1313/ 608 (2)/ 75 dated 22-

3-1975. Later on for the purpose of intensive management, it was decided to make two sanctuaries out of it.

The area was therefore renotified vide Notification No. 15/22/76-10(8) dated 1-6-1977 which designated Pachmarhi sanctuary separately. The sanctuary so constituted was spread over Bori range and part of Sukhtawa, Bagra and Sohagpur ranges, the total area being 802.89 sq. kms.

In 1981, Satpura National Park was notified out of Bori and Pachmarhi Sanctuary vide Govt. of M.P. Notification No.15/12/80/x-(2)/8, dated 23-10-1981, extending over an area of 524.37 sq. kms. Thus present Bori Sanctuary after 1981 is left with an area of 485.77 sq. kms., which extends over Bori and Sukhtawa ranges in a compact block. A part from it also extends over the Sohagpur range as an isolated pocket of 42.32 sq. kms. consisting of 5 Reserved Forests compartments (394, 395, 396, 404 and 405) and 3 Protected Forests compartments (124, 125 and 126). These isolated compartments are adjacent to Pachmarhi Sanctuary, hence for administrative convenience it is being managed by Superintendent Pachmarhi sanctuary. Legally there should be a revised notification separating this area from Bori sanctuary and including this with Pachmarhi sanctuary.

Legal Position (1887-88 to 2001-02) Hoshangabad Division

The Reserved Forests of the division were declared reserved under section 34 of Indian Forest Act VII of 1878 by Central Province Gazette Notification numbers 884 and 888 dated 20 February 1879. The Protected Forests were declared under the provision of section 29, Chapter IV of the Indian Forest Act 1927. Notification under section 4 of the Indian Forest Act 1927 for constituting them as Reserved Forests was issued vide Govt. of Madhya Pradesh Forest Department Notification numbers listed below:-

Notification	No. Date	M.P. Gazette Date
13320-11820-65	25-11-65	4-9-1966
4614-1839-67	20-5-67	19-1-1968
8740-4706-68	19-10-68	27-12-1968

In olden days the Forests of this division like other forests in the country were considered as worthless overgrowth and were subjected to ruthless clearance by needy inhabitants who practiced shifting cultivation. The East India Company ruthlessly exploited teak in this tract for supplying to Britain for building Naval Ships. It continued for almost sixty four years i.e. from 1796 to 1860. The two, above mentioned factors, alongwith annual fires led to the destruction of forests. The situation worsened due to agriculture which included cash crops like indigo which was encouraged because it greatly added to the revenue earned by the new rulers. For this, large tracts of forests were transferred to land owners for cultivation.

In the years 1862 the forests were differentiated into two distinct classes i.e. Reserved and Unreserved. The Reserved Forests were directly under the control of the Forest Department while the Unreserved Forests were managed by the Revenue Authorities. The first Conservator was appointed in Central Provinces in 1860 and the Waste Land Rules were introduced in 1862.

Reservation under the Waste Land Rules

This was the first step from disorder to order. Although the rules were meant to preserve Teak, *Saja*, *Shisham* and *Bija* and not the forests as a whole it was a step in the right direction. Under these rules free access was permitted to the people and species other than the four reserved species were allowed to be cut and removed from any part of the forest against an Annual Commutation Fee. Many blocks were leased out for a nominal sum. Since there was no control on fellings, other than the four reserved species, ruthless exploitation continued resulting into considerable degradation of forests.

License system

In 1872, all commutations, except those of the aboriginal tribe, were abrogated. To exercise better control license system was introduced. Under this system all produce removed had to be paid for, separately, and the information like forest from which the produce was removed and the route by which it could be transported was noted down on the license at the time of issue. However, there was still no binding on exploitation of other species, except for the four reserved species. The license system was applicable to the Reserved Forests only i.e. those being managed by the Forest Department. In the unreserved forests the commutation system prevailed. In 1878, however the Unreserved Forests were also handed over to the Forest Department and were amalgamated with the Reserved Forests and the entire Reserved Forests of the district were placed under the charge of a Divisional Forest Officer. It must be noted that *malguzari* forests continued to be under private ownership till 1961.

The earliest step towards the preservation of game dates back to the year of the reservation of the forest under the Government of the India's legislation -The Wild Birds Protection Act of 1897, which was repealed in 1912 and was replaced by the Wild Birds and Animals Protection Act (Act No. VIII) of 1912. So far as the Reserved Forests were concerned, shooting and hunting were controlled by the Central Provinces Shooting Rules contained in Appendix VII of C.P. Forest Manual Vol. II. Later on the Provincial Government secured the ad hoc legislation of the new Act called the Central Provinces Game Act. 1935.

Prior to the abolition of proprietory rights of *Rajas, Jagirdars,* and *Malgujars*, these forests were the preserves of the proprietors. These forests came under the management of the Forest Department in 1955-56 after the abolition of *Zamindari* rights.

The hunting and shooting of the game in the forests were governed by the following Game Laws and Rules prior to 1972.

a) The Wild Birds and Animal Protection Act. 1912.

b) The Indian Forest Act 1927 (XVI of 1927).

c) The Central Provinces Game Act. 1935.

d) The Indian Forest Act, 1927 read with M.P. amendments Act 1965 (IX of 1965).

e) The M.P. Game Rules, 1965 framed under M.P. Game Act 1935 (XII of 1935), vide State Forest Department Notification No. 1433-X/62, dated 19-2-1962.

f) The Madhya Pradesh Forests (Hunting, shooting, fishing, poisoning waters and setting traps in the Reserve or Protected Forests) Rule 1968, framed under Indian Forest Act. 1927 (XVI of 1927), vide State Govt., Forest Deptt, Notification 1133/X/63 dt. 31-2-1965.

g) The Arms Rule 1962 under Indian Arms Act, 1959 (XIV of 1959).

The forest was divided into a number of shooting blocks. The Divisional Forest Officer, used to issue shooting permits for open block on application and payment of a prescribed fee. The Collector notified the destruction of man eaters and cattle lifters under Rule 35 of M.P. Shooting Rules, 1963 and necessary free shooting permits for this were issued by the D.F.O. The Conservator of Forests was empowered to limit the number of each species to be shot in a year in each shooting block and the D.F.O. fixed the number of animals allowed to be shot on one permit, subject to the maximum limit fixed under Rule 10 of M.P. Shooting Rules 1963. No permit holder was allowed to shoot more than two tigers or one tiger and one leopard or two leopards only in one year. Shooting was banned in notified Sanctuaries and National Parks.

With the object of providing effective protection to wildlife, the State Government banned tiger shooting, throughout the state in 1970. The protection was also extended to gaur, wild buffaloes, crocodiles and peafowls. Provision was also made

so that shooting permits for any class of game were issued only under directions of the State Government.

Results: -

Game shooting was a craze for trigger happy sportsmen. Increasing price of trophies, skin, horns, flesh and other article of wild animal product gave birth to herds of hidden hunters and poachers, and modern equipments such as Jeep, rifle and searchlights made poaching a lucrative business.

Game rules and shooting ethics remained diametrically opposite to each other. *Shikars* became non sportive and ruthless destruction of wild animals continued. The guns would never wait even for the mother animals to deliver the litter. Water holes were never respected. Shooting blocks were delimited only on the paper not in the field. Bag limit was fixed only for reporting that number, but field execution was far beyond the truth. Closed seasons were recognized only in the books. Shooting permits gave coverage to killing of even prohibited game animals under the garb of the permitted ones. As a result of uncontrolled shooting of wildlife, its population dwindled down to a rock bottom level in the onset of seventies threatening near extinction of many species.

Apart from indiscriminate shooting, destruction of forests as a result of its non forestry uses and extreme biotic interference, disturbed and destroyed the habitat of many wildlife species.

The Wildlife (Protection) Act 1972 was passed by the parliament under clause (i) of Article 252 of the Indian Constitution, it covers wildlife conservation, and protection of endangered species both inside and outside the forest area. For the purpose of controlling hunting the most significant step taken under the Act was to classify wild animals, birds, amphibians and reptiles into five different schedules. Schedule I lists the rare and endangered species, which are totally protected throughout the nation. Schedule II lists special game species which require more stringent protection and for which licenses may be given only under special circumstance. Schedule III and IV comprise big and small game while schedule V lists vermines. In 1974 M.P. Wildlife (Protection) Rules were framed under the provisions of this Act.

The trade in wildlife and possession of trophies and other articles of wildlife origin has also been brought under the control of this Act. In order to control global trade, legal and illegal, in endangered species, India is a signatory to the Convention on International Trade in Endangered species of Wild Fauna and Flora in 1976, commonly known as "CITES".

(c) Pachmari Sanctuary

The forests were declared Reserved under Section 34 of Indian Forest Act VII of 1878 by Central Provinces Gazette notification No. 886 dated 20th February 1879 and No. 917(g) and (h) dated 24th February 1879. The Protected Forest blocks of this sanctuary were declared so, under the provision of Section 29 of Indian Forest Act 1927. Notifications under section 4 of Indian Forest Act 1927 for constituting them as Reserved Forests, have been issued vide Govt. of M.P. Forest Department notification No. listed below:-

No.13320-11820 dated 25-11-65 in M.P. Gazette dt. 4-9-1966.

No.4614-1839-67 dated 30-5-67 in M.P. Gazette dt.19-1-68.

No. 8740-4706-68 dated 19-10-68 in M.P. Gazette dt. 27-12-68.

The past history of game management in this area dates back to 1931 when Pachmarhi as a part of Bori sanctuary was declared as a sanctuary extending over an area of 1400 sq. kms.surrounded by Denwa river on the East and North, Tawa river on the west and district boundary of Betul and

Hoshangbad on the South. But restricted shooting was permitted inside the sanctuary as late as 1971, with a brief ban for two years in 1963. Legislations prevailing since then to manage the sanctuary were as follows:

1. The Wild Birds and Animal Protection Act (Act No.VIII of 1912 passed by the Indian legislature as amended in its application to the Central provinces by the Central Province Act XII of 1935 and such rules and modifications as have been made there under.

2. The Shooting Rules made by the Govt. under section 26(1) and 76(a) of the Indian Forest Act (Act XVI of 1927).

3. The Central Province Game Act (Act XV of 1935) passed by the Central Provinces legislative council form Ist October 1963 a complete ban on shooting was imposed in entire Hoshangabad district, which was probably the first district to impose such restriction in M.P. In 1972 Wildlife (Protection) Act (Act XXX of 1972) was promulgated and M.P. Wildlife Protection rules 1974 became applicable to the entire area. The sanctuary was notified under Wldlife (Protection Act) as Bori sanctuary for the first in 1975 vide Govt. of M.P. Notification No.1313/608-(2)/75 dt. 22-3-1975.

The area was notified vide Govt. of M.P. Notification No. 15/22/76-X(8) dt 1-6-1977, and for the first time Pachmarhi sanctuary was created separately out of Bori Sanctuary extending over an area of 654.40 sq. kms. In 1981 with the creation of Satpura National Park vide Govt. of M.P. Notification No. 15/12/80/X-2(8) dt. 13-10-1981, extending over an area of 524.37 sq. kms.

Legal settlement-

The sanctuary boundary includes 36 revenue villages within the sanctuary area. During settlement it was proposed to exclude all such village and non-forest areas as enclaves, instead of acquiring them. The action of settlement started after the final notification of Satpura National Park.

The subject matter of Forests and Wild life protection has been brought under concurrent list by the Parliament in the Constitution of India through the 42nd Amendment in 1976. It has not only enabled the Government of India to exercise direct control and make uniform preservation and conservational policies but also empoweres it to acquire certain forests of national importance.

To emphasise the importance of rules of forest and forest lands as proper habitats, the Government of India have also legislated Forest (Conservation) Act 1980, which stops diversion of forest land for non forestry purposes without the permission of the Central Government. This Act is applicable to privately owned forest lands also.

Thus enough legal measures have been attempted in the recent past for the conservation and preservation of wildlife which is paying dividends in the form of increase in population of wildlife.

(d) Melghat Forests

Traditionally local tribals mainly korkus used to carryout irregular exploitation for trade in forest produce in Berar plains. There was no concept of title over a piece of land except few recorded rights of Melghat *Rajas* to own some land and to tax forest produce being carried out. The Melghat Forests are situated in the Gawilgarh Hills, which form the southern offshoot of the Satpura Range, Melghat. These Forests have a long history of scientific forest management. These Reserved Forests date back to 1860s soon after the administration of Berar came under the British Administration in 1853.In the year 1965 Assistant Conservator of Forests, Berar was appointed. The year 1866 marked the beginning of forest administration and the process of reserving of forests started.Till the year 1872 heavy fellings continued in unreserved forests. Berar Forests Laws and Rules were published in 1886 and 1872

respectively. Bairagarh Reserve was declared demarcated State Forests in 1889. Seventeen forest villages situationed inside were included in this reserve and the rest of the forest was declared as State Forests in 1892. Bairagarh Reserve was declared as Class A forests. Application of Indian Forest Act, 1878 in 1911 and therby repeal of Berar Forest Law, designated all forests as Reseve Forests. In the year 1938 Amravati Division with head quarters at Amravati was created by merging Melghat Division with Amravati and Morsi Ranges. In 1964 east and west Melghat divisions and Amravati sub division was carved out from the erstwhile Amravati Division. In the year 1969 forest villages were converted into revenue villages. The Dhakna – Kolkaz Wildlife Sanctuary came into being in 1969. Poject Tiger, Melghat was designated in the year 1972. Subsequently in 1983 reorganisation led to creation of three divisions viz. East, West and South Melghat.

Forest Villages- In order to harvest forest produce on the basis of sustainable utilization a need for organized labour force was felt. The human resource available was aboriginal and were nomadic in nature and used to till wherever they went. Hence, the need was felt for having forest villages to ensure dependable labour. In fact these were labour colonies mainly responsible for the protection of forests and execution of harvesting and conservancy works, which used to be sanctioned by the Conservator of Forests. A forest villager used to be granted a piece of forestland upto a maximum of 15 acres for a nominal rent of Rs. 1.00. A *'Jamabandi Register'* was maintained, which gave only sketchy details of–

(i) The land holders in the forest village,

(ii) The record of the recovery of rent.

Legal Aspects

In 1967 Government of Maharashtra decided to convert these forest villages into regular revenue villages, vide a G.R., by disforesting the cultivable area and *gaothan* and to grant class II tenancy rights to the holders of the land. The forest officers of the Forest Department were vested with the powers of the Revenue Code, 1966 for Revenue Administration of these villages. It was decided by the Government that the encroachers would not be included for the rights.

The Government decided to grant tenancy rights on the basis of the *Jamabandi* record maintained by the Forest Department and directed the Chief Conservator of Forests, Maharashtra to submit proposals for the disforestation for lands to be given to the villagers. As these records were not up-to-date, the matter was brought to the notice of the Government and a request was made for the survey of the lands occupied by the forest villagers. The Government of Maharashtra, therefore, directed the Settlement Commissioner to take up the survey, demarcation of village boundary and also the individual fields of the villagers. The Officers of the Settlement and Land Records Department raised the legal point that such survey is not permissible unless the land to be surveyed is disforested formally. Thus, there was a sort of deadlock as the survey required disforestation notification and disforestation notification required exact extent of area for which detailed survey is necessary. Therefore, a formal decision, to denotify approximate areas of Reserved Forests under Section 27 of IFA, was taken in a meeting on 6-8-1969. It was also decided that, modified notification would be issued by indicating the actual area under cultivation and *gaothan* after the completion of survey.

It was decided by the Government of Maharashtra that each forest villager was to be entitled to get tenure right on a maximum of 16 acres of land. Anybody found occupying land in excess of this limit would be treated as an encroacher and evicted. In the record of DILR all lands except *gaothan* and lands occupied by legitimate holders were to be shown as land belonging to Forest Department. The DILR survey was completed by 1971.

***Patta* Distribution**

The Government of Maharashtra decided to grant *'pattas'* (piece of land) to the forest villagers by 31-12-1971. It was also decided vide the same letter that-

i. The encroachments in the forest village area limits be regularized.

ii. Even if the area under possession of the forest villager exceeds the area allotted to him as per *'Jamabandi'* (settlement), it should not be treated as an encroachment but be granted to him as per the survey records prepared by the DILR.

With the issue of these orders, some of the discrepancies of the survey also got automatically regularized.

Wildlife Management in the Past:

Prior to reorganisation of States, wild life conservation was through the implementation of the provisions of the Indian Forest Act and the Shooting Rules framed by the Madhya Pradesh Government, as given in Appendix of M.P. Forest Mannual, Volume II combined with the Wild Birds and Animals Protection Act, 1912 as amended by the Central Provinces Amendment Act of 1935.

By 1927, shooting blocks system was started. The Conservator of Forests in consultation with the Divisional Forest Officer and the District Magistrate, declared certain blocks of Reserved Forests with abundant game, as open for shooting. Subsequently, a sliding scale of animals to be shot annually in each block was introduced.

The Indian Board of Wildlife was constituted in 1952 with the main object of devising ways and means for conservation of wild life through co-ordinated legislative and practical measures and sponsoring setting up of National parks and Wildlife Sanctuaries.

The Bombay Wild Animals and Wild Birds Protection Act, 1951 which was considered as the most comprehensive legislation of its kind, was made applicable to the Vidarbha Region in 1961. Though this Act did not propose a significant change in the management of game in Reserved Forests, it was important, as it operated even in areas outside Reserved Forests. Under the provisions of this Act, arms lincence holders for sports were required to register themselves with the Wildlife Preservation Office. Hunting licences were categorised into four kinds (1) Small game, (2) Big game, (3) Special big game and (4) Pet animals; and no person was allowed to carry on trade in trophies without a separate Trophy Dealer's Licence. The shooting rules as contained in the Bombay Wild Animals and Wild Birds Protection Rules were made applicable throughout the State of Maharashtra.

The Wildlife Management Plan for Melghat Tiger Reserve drafted by Shri Shaikh and Sawarkar provides interesting information on number of permits issued and game shot in the shooting blocks in Melghats prior to 1968. It is seen that Melghat was a much sought after game reserve; as many as 53 permits were issued in the year 1955-56. Almost every year a number of animals were shot, with figure being as high as 11 tigers in 1955-56, 18 leopards in 1958-59, 8 bears in 1956-57 etc.

1.2.2 History of Management of Forests

(a) Betul Forests:

The Betul district came formally under the control of the British territory in 1826 after the battle of Sitabuldi. Upto 1862, the wasteland rules (1862) were being followed under which: ***a)*** Cutting of teak (*Tectona grandis)*, Saja (*Terminalia tomentosa),* Shisham (*Dalbergia sissoo)* and Bija (*Pterocarpus marsupium)* was forbidden without the sanction of the Deputy Commissioner. These four species could be removed on permits but there was no restriction on cutting and removal of any kind of other forest produce and ***b)*** Long- term leases

for the removal of all other species were given out for nominal sums. As a result of these activities there was a rapid decline of other species except the four reserved ones.

As a result of the enactment of the first Forest Act in 1856, the forests were differentiated into reserved and unreserved and management of the unreserved forests remained under the control of the Deputy Commissioner while the reserved forests were under the control of the Forest Department. In 1864, Lieutenant Doveton was appointed the first Deputy Conservator, who in consultation with the Settlements Officer, selected and demarcated areas which were declared reserved in 1865. The Betul forests were becoming drier due to elimination of many of the less hardy species as a result of shifting cultivation and there was an increase in the percentage of teak.

In 1878, the Betul division was carved out from the Hoshangabad division. In 1872, the license system was introduced for forest produce and in 1883, the system was extended to unreserved forests also. However, irregular exploitation continued. In order to stop this, 32 felling series were formed for 57 sq. km. and the size of annual coupe was kept limited to 15 acres.

It was in 1896, when the first attempt to prepare a working plan was made. The first working plan for Betul was prepared by E.E.Fernandez (1897-1926) Forests were divided into regular and *Nistar* (open to a range of concessions) fellings series. Each range formed a working circle with 35 felling series under varying rotation periods (20 & 30 years). The rotation period was fixed according to the quality of the forest. The silvicultural system adopted was coppice improvement felling. Cultural operations were practiced in areas containing teak and *tinsa*. A coupe of regular felling series was closed to grazing for ten years immediately after fellings. No closure to livestock grazing was prescribed in *Nistar* series. During the period of this working plan, the greater part of the forest received systematic treatment. The coppice improvement system helped greatly in improving the growing stock. Forests became better stocked with younger trees.

C.I. English wrote the plan for the period 1927-1934. The forests were divided into compartments which were to remain permanent units of management. All the workable areas were then stock mapped. However, the stock mapping was not on the standard lines of the present time. There were three working circles *viz.* High Forest WC, Low Forest WC and Bamboo overlapping WC with a total of 43 felling series. The plan suffered several setbacks due to faulty allotment of areas to working circles and defective arrangement of sequence of coupes. Teak and Bamboo forests on the hill slopes were not properly worked and insufficient attention was paid to control of bamboo that was suppressing teak. The system of felling prescribed for Low Forest WC was found to be too rigid. Areas which were found well stocked were to be clear felled without any consideration. Clear-felling of climber-infested forest, forest on the steep and exposed hill slopes having dense grass produced undesirable results.

The period 1934 to 1947 was of Gurdyal Singh Lambas' Plan**.** In this, the entire area was stock-mapped on standard lines. This accurate stock mapping helped in correct allotment of the areas to various working blocks to a great extent and in picking up compartments for the regeneration block of the conversion working circle. There were five working circles *viz.* Conversion, Improvement, Coppice, Bamboo overlapping and Miscellaneous. The conversion WC included all the good quality teak areas capable of producing large-sized timber and fit to be worked on long rotation. Object of management was to convert into a normal series of age gradations. The conversion period of 60 years was divided into three blocks of 20 years each. The presence of dense climbers, remoteness and low demand were the reasons that led to allotment of certain areas to the Improvement WC. This included both teak and mixed forests. The silvicultural system was selection-cum-improvement fellings with a cycle

of 40 years, yield being regulated by area. The poor quality teak and mixed forests regulated by area with good demand for timber and charcoal were placed in Coppice WC. These were to be worked under CWR systems on a felling cycle of 20 years. Clearing and thinning in the 12th year and 25th year after main fellings were prescribed. Compartments with bamboo in exploitable quantity were placed in the bamboo overlapping WC Standard prescriptions for working of bamboo were followed. Improvement fellings combined with thinnings were prescribed for forest village areas. Compartments considered unworkable owing to inaccessibility or paucity of growing stock were placed in the miscellaneous working circle and left untouched. Due to the World War II, the plan could not be revised and hence the plan period of G.S. Lambas' plan was extended upto 1951-52. Thereafter, the plan remained in force for 18 years. In general, the plan was a successful one.

The period 1951-1967 was the period of N.K. Sharmas' Plan with amendments by Y.K. Sahu. This Plan covered the entire Betul Forest Division (Area 1164.16 sq. miles or 3015.25 sq. kms.). The working plan for North and West Betul Divisions was taken up for revision. The seven working circles, were Teak Conversion WC, Selection-cum-Improvement, Coppice with Reserve, Protection, Softwoods (overlapping), bamboo (overlapping), and miscellaneous. Special works of improvement like fire protection creation of road network, climber cutting, cultural operations and plantations and nurseries were undertaken. This plan was sanctioned for the period 1952-67 but continued up to 1970 *i.e.* 18 years. The results obtained during the plan period were quite prominent and are given as a) Conversion by successive improvements was satisfactory, b) natural regeneration from seeds was found to be inadequate and mostly regeneration was of coppice origin, c) the felling cycle of 40 years was reduced to 30. The prescriptions for Protection WC yielded desired results and so did sincere implementation of the prescriptions in CWR WC, d) No fellings in softwoods WC was done, and e) Bamboo WC through NEPA mills was found to be satisfactory. Coupes sold to contractors in the open auctions led to heavy working causing damage to bamboo growth.

The period 1972-85 was that of Y.K. Sahus' plan for North and South Betul Divisions. He divided the area into Conversion, Selection-cum-improvement, Improvement, Coppice with reserves, Plantation and bamboo (overlapping) circle. The rotation was maintained at 100 years with five periodic blocks of 20 years each. A felling cycle of 30 years and 20 years was fixed for areas allotted to Selection-cum-improvement and Improvement WC. Rotation of areas to be worked under coppice with reserve was maintained at 50 years. Bamboo was to be exploited based on Standard Felling Rules prevalent in Madhya Pradesh.

A regular working scheme for the protected forests was prepared in 1970 by R.P.Verma who divided the area into CWR, Ad-hoc and Bamboo working circles to be worked under a felling cycle of 20 years, 20 years and 4 years respectively.

Current Management System

i. North Betul Managed Forest Division

The plan period for the current working plan for North Betul is ten years from the period 1992-93 to 2001-02. It has been prepared by Ravi Srivastava. The allotment to different working circles according to this plan is as follows:

1. **Teak working circle**: It includes the best teak areas in the division. The main objective of this working circle is to regenerate the area naturally and maximum utilization of site potential in view of environmental stability. The rotation has been kept as 100 years with 5 periodic blocks of 20 years each. Periodic Block 1 is divided into 3 treatment types: a) areas excluded from felling, b) areas to be converted to even-aged stands naturally by existing advance growth or pole crop and c) areas to be converted to even-aged stands artificially through plantations. Seed dibbling and *Lantana* eradication has been

proposed along with induced natural regeneration in Periodic Block II. The usual improvement fellings and thinnings have been proposed in Periodic Block III. Periodic Block IV has been subjected to thinings only. Cleaning-cum-thinnings are proposed for Periodic Block V. Cleanings have been proposed in the 5th year and thinnings in the 10th, 20th, 30th and 45th year. The allotted area as per departmental records is 46,224 ha.

2. **Selection-cum-improvement fellings working circle**: It includes teak forests and the area allotted is 21,900.9 ha. The main aim is to remove the over-wood over adequate regeneration, thinning of young pole crop and general improvement of the crop. Selection girth for different species is fixed and the felling cycle fixed at 20 years. Yield is to be regulated by area. Type-A will include area protected from fellings; type-B existing plantations; type-C group of pole crops and type-D remaining areas. Fruit trees and rare trees are to be protected from fellings and soil conservation works to be done in erosion prone areas.

3. **Improvement working circle**: It consists of less accessible, poor quality forests mainly of miscellaneous species. The area allotted is 15,748.5 ha. The main objective is improvement of the existing crop. The felling cycle is fixed at 20 years. The different treatment types include areas: a) areas reserved against fellings, b) plantable areas, c) existing plantations, d) areas having pole crop and e) remaining areas. Fruit trees and rare trees will be protected from fellings and fellings will be done for improvement of the existing crop.

4. **Coppice-with Reserve working circle**: It consists of poorly stocked forests on account of being close to habitations. It will be worked to fulfill the local demands. The area allotted is 15228.0 ha. The rotation is fixed as 50 years. The various treatment types includes 1. Protection areas, 2. Existing plantations, 3. Plantable areas and 4. Remaining areas. The areas will be planted with suitable species of fodder grasses and legumes, and soil conservation measures will be undertaken. Thinnings will be done in the 11th and 25th year.

5. **Rehabilitation of degraded forests working circle**: It mainly includes blanks and under-stocked areas. The area allotted is 8,766.8 ha. The objective is to rehabilitate the existing growth and supplement it by plantations. A felling cycle of 20 years is adopted. No yield is expected from this working circle.

6. **Bamboo overlapping working circle**: It includes all bamboo forests of the division extending over an area of 44,111.6 ha. A felling cycle of 4 years is adopted and yield will be regulated by area. The area shall be worked under standard bamboo cutting rules as prevalent in the state of Madhya Pradesh.

7. **Forest extension and social forestry**: The plan provides for planting up the areas outside forest, increasing the use of non-conventional sources of energy, reducing energy consumption and its wastage.

ii. South Betul Managed Forest Division

The plan currently being followed in South Betul is by Dr. Ram Pratap Singh and is for 10 years for the period 1993-94 to 2003-04. The plan consists of three working circles and its prescriptions may be summarized as:

1. **Selection-cum-Improvement-Working Circle:** Good and medium quality teak and mixed forests have been allotted to this working circle. The total area is 78,228.13 ha. The main object of management is to develop, conserve and build up the growing stock. Along with teak, the mixed species have been equally given due weightage. Felling cycle is 20 years. 41 felling series are formed. Yield is regulated by

area. A-type is the protection area which includes areas with slope over 25 deg, 20m strip along streams, frost affected, rocky and eroded areas. No green felling will be done here and appropriate soil and water conservation measures will be adopted. B-type includes successful plantations where treatment will be according to age and condition of the crop. C-type includes workable areas where thinning will be done in congested pole crop. In the rest of the areas, leaving aside fruit bearing trees, 50% of silviculturally available trees above selection girth will be marked for felling. To improve regeneration conditions improvement fellings will be carried out. In suitable areas bamboo plantations will be done. D-type includes blank and under-stocked areas where rehabilitation of degraded forests, plantations, seed sowing and pasture development works will be taken up. Subsidiary silvicultural operation and 10th year thinnings have been prescribed. Plantation and soil conservation areas will be looked after as per standard practices.

2. **Protection-cum-rehabilitation Working Circle:** In this working circle, 200m strip on both sides of the Tapti River, steep slopes, inaccessible areas and low and medium density forests with more open areas have been allotted. The total area is 36,217.67 ha. Main objects of management are to protect unguarded soil cover and through rehabilitation, conserve and improve the crop conditions. Felling cycle is 20 years. 21 felling series are formed. A-type includes areas with slope over 25 deg, 20m strip along streams, frost affected, rocky and eroded areas. No green felling will be done here and appropriate soil and water conservation measures will be adopted. B-type includes 200m strip on both sides of the Tapti river where felling is prohibited. Fellings will be limited as per government orders. Plantations, seed sowing, bamboo under-planting and soil and moisture conservation works will be taken up. C-type includes blank and under-stocked areas where rehabilitation of degraded forests, plantations and pasture development activity will be taken up. D-type includes successful plantations which will be treated as per their age and condition. E-type contains workable areas where thinning will be done in congested pole crop and improvement fellings in the rest of the areas have also been prescribed. Bamboo under-planting at suitable sites will be also taken up. Subsidiary silvicultural operations and 5th year cleaning have also been prescribed. Plantations, soil conservation works and pasture development areas will be looked after as per standard practice.

3. **Bamboo (overlapping) working circle:** Bamboo forests are limited to Amla range. The total area is 9216 ha and bamboo bearing area is 5847 ha. Cutting cycle will be 4 years. 4 felling series are formed. Yield is regulated by area. Standard bamboo felling rules are prescribed. Felling of *Karla* and *Mohila* bamboo is prohibited. Minimum number of culms per clump retained in quality I, II and III will be 20, 15 and 10 respectively. Rhizome will not be dug and felling will start after 15th October.

4. **Forest extension and social forestry:** To inculcate active peoples' participation in forest development and plantation programmes, appropriate extension programmes are outlined. It includes individual and community programmes, developing the use of non-conventional sources of energy and alternatives of wood. Training of the concerned staff is emphasized.

iii. West Betul Managed Forest Division

In the year 1865 these forests were categorized into two – Reserved Forests and Un-reserved Forests. In the year 1865-66 two Forest Officers from Scotland were entrusted with the job of carrying out teak plantation. In the year 1872 a system of licensing for procuring forest produce was started. In the year 1883 the categorization of forests as Reserved and Un-reserved was abolished. The west

Betul Division was managed under the following Working Plans:

- E.E. Fernandezes's Plan (1897-1926)
- C.I. English's Plan (1927-1934)
- Gurdyal Singh Lamba's Plan (1934-1951)
- N.K. Sharma's Plan (1952-1973)
- Y.K. Sahu's Plan (1973-1994-95) (Mohda, Tavdi and Swaligarh Ranges) (**Plate 44**)
- R.S. Mishra's Plan (1973-1994-95) (Chicholi Range) (**Plate 44**)

Current Management

The current Working Plan has been written by Shri Y. Satyam, Deputy Conservator of Forests, Working Plan, Betul. The Plan period is 1995-96 to 2004-05. With the objective of management in mind the forests were divided into following categories

1. Good quality Teak and Miscellaneous forests
2. Medium quality Teak and Miscellaneous forests
3. Forest within 200 m radius of Tapti River
4. Blank, degraded and malformed forests

The following Working Circles were proposed

1. **Selection-cum-Improvement** – The rotation was fixed at 100 years and the selection girths were as follows:

Species	Selection girth	Pre-selection girth
Tectona grandis (Sagvan)	120 cm	91-120 cm
Terminalia tomentosa (Saja)	120 cm	91-120 cm
Gmelina arborea (Shewan)	105 cm	61-90 cm
Anogeissus latifolia (dhaura), *Lagerstroemia parviflora* (lendia) etc	90 cm	61-90 cm

2. **Rehabilitation of Degraded Forests Working Circle** – The objective is to rehabilitate degraded forest area by restocking them through plantations and soil conservation measures.

3. **Bamboo Overlapping Working Circle** – This system aimed at management of bamboos so as to cater to the needs of local people and forest based industries.

For all the Working Circles the operations proposed to be carried out are more or less similar to those already explained elsewhere in the Chapter.

(b) Hoshangabad Forests*:*

This area was under the ownership of a Korku chief, Bhupat Singh till the year 1859, when the British Government confiscated it. Shifting cultivation (slash and burn) was a common practice then and trees were charred and girdled. No silvicultural work was done during 1859 to 1862. From 1862 to 1865 the charred and girdled trees were extracted but there were no fresh fellings. Fellings were not done for another 24 years *i.e.* up to 1889 except that in the year 1869 Davidson created two small teak plantations (*Tectona grandis)*. The period from 1889 to 1895 saw fellings of mature teak and *tinsa* (*Ougenia oogeinensis)* trees beyond 40 c.m. d.b.h. every year over a definite area resulting in very heavy fellings and so this was stopped for the next two years *i.e.* up to 1897.

From the year 1897 to 1908 improvement fellings were prescribed by the then Working Plan officer (WPO) Fernandez, in his working plan. These fellings were again found to be heavy and were stopped after five years till the new working plan. Dunbar Brander wrote the Working Plan

of the period 1909 to 1919. During this period, an accurate stock mapping was done for the first time. No healthy trees were to be cut until and unless required for silvicultural operations till the sixth year and climber cutting and cutting of less valuable (timber) species was also prescribed. Since the improvement after this was insufficient, another cycle of ten years (improvement fellings) was prescribed (1919 to 1927). As a result of all this, the forests were good enough for intensive management.

In Sodhi's Plan (1929 to 1938) Conversion to uniform system was introduced at eighty years rotation and with four Periodic Blocks. Three working circles were constituted *viz.* Bori special teak, Low forest and High forest. It was presumed that in absence of advance growth, regeneration could be introduced by judicious opening of canopy in stages. As a result, the areas that were opened for inducing teak regeneration failed to do so and were covered with grass, weeds and bamboos.

In the Macdonalds Plan (1938 to 1947), the same system of conversion to uniform continued with a rotation of eighty years and four Periodic Blocks. Half of the Periodic Block I was worked under the previous plan and the remaining half was divided into ten annual coupes and felled. The successive regeneration felling was replaced by concentrated regeneration felling. However, due to the intervention of the IInd world war, heavy fellings had to be done. As a result of these treatments, a good amount of young growth was sacrificed.

The period 1948 to 1963 was the period of D.H. Kulkarni's Plan. During this, the conversion to uniform system was continued, however the rotation and conversion period was changed to 120 years on the basis of stem analysis data. There were six Periodic Blocks and exploitable girth was fixed to 180 cm. Bori teak was managed under special teak working circle. Yield was regulated by area with overall volume check. The Periodic Block I was divided into three parts based on treatment. The result was problem in the reproduction of teak, bamboo as a menace and teak forests were moist or semi-moist and hence complete conversion could not be achieved.

The Jangley's Plan was operative for the period 1965-66 to 1979-80. The Working Circles constituted were –

- Bori Special Teak Working Circle
- General Teak Working Circle
- Coppice with Reserve Working Circle
- Improvement felling Working Circle
- Miscellaneous Working Circle
- Bamboo Overlapping Working Circle
- Tendu Leaves Overlapping Working Circle

Current Management

The Working Plan currently in operation is written by A.A. Ansari, Deputy Conservator of Forests. The Plan period is 1987-88 to 2001-02. The Working Circles constituted according to this Plan are as follows:

- General Teak Conversion Working Circle
- Coppice with Reserve Working Circle
- Fuel and Fodder Plantation Working Circle
- Protection cum Improvement Working Circle
- Miscellanous Working Circle
- Bamboo Rehabilitation (Overlapping) Working Circle

The overall objective was conversion of miscellanous areas into teak that means having a spefic focused management of teak, catering to the needs of local population, and protection and improvement of vulnerable areas.

Satpura National Park

Satpura National Park is well protected on either sides by Bori Wildlife Sanctuary and

Pachmarhi Wildlife Sanctuary (**Plate 3**). Satpura National Park has some patches of old growth stands, which have not been worked for around 70-80 years. The appearance of these stands gives an insight into how the forest would really look like if not worked for so long. These areas are like living museums and need to be preserved as controls. Part of this Park is like open savannah country with unique landforms in the form of rocky mountain ranges and hillocks. At the junction of the boundaries of Satpura National Park and Pachmarhi Wildlife Sanctuary teak and sal co-exists which is a unique phenomenon. There is negligible biotic disturbance. Sites of some of the evacuated villages have developed into pastures, which are favourite sites for herbivores.

The management in Satpura National Park is basically focused on the following issues

(i) Protection from poaching of wild animals and timber

(ii) Consolidation of ownership and control especially related to Tawa reservoir

(iii) Habitat maintenance, restoration and development

(iv) Water resource management

(v) Fire protection and management of fire sensitive areas

(vi) Management of bamboo areas and wildlife habitats

(vii) Organisation and management of census operations

(viii) Research and monitoring

Bori Wildlife Sanctuary

The Bori Wildlife Sanctuary is situated in the south west of the Satpura National Park (**Plate 3**). Prior to 1985 there was no zonation in the sanctuary. The whole sanctuary is very well protected geographically, hence it is as good as a core area. The north western corner of the sanctuary covering an area of 3,006.39 ha. was identified as core area in the Working Plan by P.B. Gangopadhyay, 1985. The rest of the sanctuary is being managed as a buffer. This area has a very good density of herbivores mainly sambar and chital. During the summers gaurs usually come down into the plain areas in search of water and fodder. However, they recede to the higher hills and plateau areas during rainy seasons and winters. There is a sizeable population of gaur in this area. There are lots of plantations of teak and bamboo in this area, which serve as good habitat for herbivores.

Extensions buffering-regulations of forestry practice – In the adjoining areas of the sanctuary Minor Forest Produce collection has been permitted in a regulatory manner.

Zonation and regulation of tourism – Being near to Bhopal this sanctuary has a great potential from tourism point of view. There are three forest guest houses located at Churna, Bori and Dhain. Over the years tourism is gradually picking in the area.

The Working Circles proposed in the P.B. Gangopadhyay Woking Plan, 1985-86 to 1994-95 were

- **Bori Special Teak Working Circle**
- **General Teak Conversion Working Circle**
- **Selection-cum-Improvement Working Circle**
- **Coppice with Reserve Working Circle**
- **Protection-cum-Preservation Working Circle**
- **Bamboo Overlapping Working Circle**
- **Miscellaneous Working Circle**
- **Wildlife Core – Habitat improvement and restoration**

The management of the sanctuary currently is focused on the same issues as described in case of Satpura National Park.

Pachmarhi Wildlife Sanctuary

This sanctuary is heavily disturbed on account of the presence of the huge Pachmarhi township and presence of religious worship places like Chauragarh and Mahadev. The sanctuary is also sprinkled with many habitations. The sanctuary did not have any zonation prior to 1985. Two Core Zones were proposed in the Working Plan by P.B. Gangopadhayay, 1985. One was identified around the Anjandhana forest village adjoining to Satpura Naitonl Park covering an area of 2375.07 hectares; the other Core Zone was identified near Singanama, engulfed between Denwa and Dhudhed Rivers covering an area 3149.61 ha. Richness in wildlife and minimal disturbance was the criteria for selection of these areas. Departmental fellings of timber and bamboo were proposed to continue upto 31st of March every year.

The rest of the sanctuary was proposed to be treated as Buffer Zone. The steep slopes of Pachmarhi hills and Pachmarhi plateau being fragile and prone to soil erosion were set free from all sorts of forest working. For the rest of the sanctuary, forestry operations continued with suitable modifications to accommodate wildlife management. The northern boundary of this sanctuary has an interface with thickly populated Narmada plains.

Socio buffering-regualtions of user privileges – In the areas adjoining to the sanctuary collection of the Minor Forest Produce was allowed in a regulated manner and to be finally withdrawn, provided alternative employment for livelihood of villagers is available.

Zonation and regulation of tourism – Pachmarhi itself is a big tourist attraction it being one of the only two hill stations in central India. The other being Chikaldara adjoining to Melghat Tiger Reserve. Some of the other tourist attractions are Dhupgad and the trek from Jhiria, Pachmarhi to Mahadev.

The Working Circles proposed in the P.B. Gangopadhyay Working Plan, 1985-86 to 1994-95 were

- **General Teak Working Circle**
- **Coppice with Reserve Working Circle**
- **Protection-cum-Preservation Working Circle**
- **Bamboo Overlapping Working Circle**
- **Miscellaneous Working Circle**
- **Wildlife Core – Habitat improvement and restoration**

The management of the sanctuary currently is focused on the same issues as described in case of Satpura National Park.

(c) **Melghat Forests**

Past Forest Management

There was no forest administration in the tract before Melghat Tahasil came under British administration in 1953. Korkus irregularly exploited the forests for trade in forest produce on plains. Large areas were under shifting cultivation. Reservation of forests gradually brought the indiscriminate fellings under control by 1913, by which time the reservation was complete. The reserved forests were worked under improvement fellings upto 1935. From 1936 to 1955, the forests were worked under Stein's Plan which prescribed uniform system in the better quality teak forests and Coppice-with-Reserve in comparatively poorer quality forests. Remote and understocked areas were not subjected to any type of regular working. Sharma's Plan came into force in 1956 covering a period of 15 years upto 1970, which prescribed selection-cum-improvement fellings in the better quality teak forests. Coppice-with-Reserve system was prescribed in relatively poorer quality forests and no regular working was prescribed in remote and understocked areas. Sharma's Plan has been revised by Joshi.

Following are the working plans/schemes that were in force in Melghat in the past.

(a) Bagshaw's Plan 1893-1915 for Bairagarh and Gugamal Reserves.

(b) Gugamal Reserve Working Scheme 1910-1915.

(c) Tapti Reserve Working Scheme 1912-1915.

(d) Dunbar Brander's Working Plan 1915-1916 to 1935-1936.

(e) Stein's Working Plan 1935-1955.

(f) Sharma's Working Plan 1956-1970.

(g) Bhathena's Working Scheme 1961-1971 for Debida, Dhulghat, Wan and part of Rupagarh Reserve.

(h) Joshi's Working Plan 1975-1985.

Noteworthy feature of Joshi's working plan is constitution of a separate working circle for wildlife. The objectives spelt out for this working circle are

(a) to ensure maintenance of viable population of wildlife and

(b) to preserve for all times areas of such biological importance as national heritage for the benefit, education and enjoyment of the people.

To achieve the above said objectives, certain prescriptions are made which inter-alia prohibit felling in radius of 100 metres around perennial water holes and felling of fruit trees. Operations to be carried out in the main coupes either in main felling or in subsidiary cultural operations, were – development of salt licks, erection of wildlife watch towers and creation of shelters and hiding places in the areas where such structures do not exist naturally. Due to shortage of water during summers, the prescriptions state that the water holes should be kept under constant vigilance.

Current Management

Over the last ten years following activities have been undertaken/ proposed to be undertaken in the Melghat Tiger Reserve as per the Management Plan for the MTR 1988-98 by M.G. Gogate:

(a) Habitat restoration and development works

- Study related to food base, floral and faunal associations.
- Biomass studies.
- Identifying threatened plant species in the area.
- Tiger population estimations.
- Population estimation of other mammals.
- Waterhole counts.

(b) Development of approaches for habitat improvement and resource mobilisation

- Generation of database.
- Inventory of plant and animal species.

(c) Optimal resource utilization and resource mobilization

- Fire protection.
- Grazing.
- Prevention and control of diseases being transmitted from domestic cattle.

(d) Augmentation of surface water

- Adopting the approach of 'Kolhapur type *bandharas*' or '*Vasant bandharas*'.
- Building of wiremesh check dams.
- Construction of inverted *bandharas*.
- Soil and moisture conservation measures.

(e) Veterinary care and orphanage

(f) Rehabilitation of Cheetal, Sambhar and Nilgai

(g) Captive breeding of endangered species to ensure perpeptuity for animals like Caracal, Rattel, Giant squirrel, Turtles, Tortoises, Smooth coated otter, Lesser florican etc.

(h) Monitoring

- Changes in buffer area.
- Bench Marked Studies to cover important parameters for monitoring.
- Monitoring silvicultural operations as prescribed in the Working Plan.

(i) Rational use of Wildlife resources and better appreciation

- Encouraging tourism.
- Development of infrastructure for tourism.

(j) Development of interpretive and educational facilities

(k) Review of organizational setup

Management practices prescribed in the Management Plan were as follows:

(a) Distribution of areas into preservation, buffer and tourism zones

The distribution of area into preservation, buffer and tourism zones were detailed as below.

Preservation zone	Total No. of compartment	Area in sq. km.s
(a) Gugamal National Park	154	359.31
(b) Raipur satellite core	25	54.58
(c) Rangubeli satellite core	13	34.09
	Total 192	447.98
Buffer zone	504	1170.95
Total		1618.93
Tourism zone	20	60.00 (overlapping)

(b) Management of Preservation Zone

- Network of checkposts for effective protection.
- Development and maintenance of external and internal firelines.
- Fire observation towers at strategic sites.
- Firewatch tower along the firelines at a distance of not more than 2 km apart.
- Establishing fire fighting squads with adequate equipments.
- Augmenting drinking water.
- Soil and moisture conservation measures.
- Management of roads and cross drains.
- Effective wireless communication.

(c) Management of Multiple Use Areas

- Grazing control.
- Control of migratory cattle.
- Meadow development.
- Shifting of villages.
- Soil and moisture conservation measures.
- Wildlife restoration.
- Habitat amelioration.
- Captive breeding of endangered species.

(d) Mobilisation of forest dwellers support

- Elevation of status of tribals.
- Concessions of grazing vis-à-vis conflict of wild herbivores.
- Timely payment of compensation of cattle killed by wild animals.

- Genetic improvement of livestock and removal of poor quality cattle.
- Food cultivation on private land.
- Formation of Nature Societies involving local people.

(e) Ways and means to enhance tourism

(f) Research and monitoring

- Habitat evaluation and preparation of cover maps.
- Identification of habitat qualifiers and delineation of important habitats.
- Developing inventories for plant species, lower animal forms, fishes, amphibians, reptiles, avifauna and mammals.
- Ecological studies.
- Special exploration to confirm occurence of species of importance.
- Controlling factors inimical to habitats like fire, grazing, water resources.
- Monitoring of management interventions.
- Conducting census on regular/ periodical basis.

(g) Miscellaneous Regulations

- Maintenance of record of saltlicks, wallow sites and water holes.
- Non Timber Forest Produce (NTFP).
- Lopping of fodder trees as per prescriptions.
- Maintenance of boundaries.
- Record of fires.
- Census – Tiger Census, total animal count, census estimates by random sampling.
- Maintenance of control record namely control book, compartment history and compartment description, vegetation monitoring plots, maintenance of record of rainfall and temperature.
- Other miscellaneous regulations regarding entry into the park, restrictions and prohibitions.

East Melght Forest Division

Past Management

The area was worked under following Working Plans

(1) Bagshawe's Plan 1893-1903 extended to 1905: Introduced four felling series and 20 annual coupes and prescribed selective fellings for local needs on two year cycle for bamboo cutting. He proposed complete fire protection and eradication of Lantana.

(2) Dunbar-Brander Working Plan 1915-16 to 1935-36: The plan was written for Bairagarh and Kohana Reserves. The Working Circles proposed were – High Forest Working Circle, Coppice with Standard Working Circle, Un-regulated Working Circle and Bamboo Overlapping Working Circle.

(3) Stein's Working Plan 1935-55: The Working Circles prescribed were – Teak High Forest Working Circle, Copice Working Circle, Miscellaneous Working Circle and Bamboo Overlapping Working Circle.

(4) Sharma's Working Plan 1956-74: The Working Circles proposed were – Selection Working Circle, Coppice with Reserve Working Circle, Protection Working Circle, Bamboo Working Circle and Rusa Grass Working Circle. The overall assessment was that, the safeguards were difficult to implement. Growing stock improved but regeneration suffered.

(5) **Joshi's Working Plan 1975-76 to 1984-85 extended till 1988**: The Working Circles proposed were – Selection Working Circle, Coppice with Reserve Working Circle, Protection Working Circle, Bamboo Overlapping Working Circle, Rusa Grass Working Circle and Wildlife Working Circle. During this plan period growing stock increased in almost all girth classes. During this period plantations were taken up in large scale, though not prescribed in the Plan.

Current Management

The current Working Plan is by Shri Vinay Kumar Sinha and Shri B.S. Thengadi. The plan period is 1993-94 to 2002-03. The Working Circles proposed are as follows:

Selection-cum-Improvement Working Circle: Emphasis is on obtaining regeneration through selective fellings so that nutrients and space are available for recruitment of tree speices. Removal of the one third of the trees above g.b.h. of 135 cm in well stocked areas without disturbing special habitats and ensuring maintenance of bio-diversity.

Protection Working Circle: Includes areas of steep slopes and open crop and intends to offer complete protection to steep slopes by bush sowing, stump planting and planting of seedlings.

Bamboo (Overlapping) Working Circle: Aimed at restoration of health and rehabilitation of bamboo crop on suitable sites.

Wildlife Overlapping Working Circle: High priority has been assigned to water and soil conservation measures.

West Melghat

Past Mangement

The Past Management of West Melghat Managed Forest Division was almost the same as East Melghat Forest Division upto Stein's Plan except that Gugamal Reserve Working Scheme was introduced in the year 1910-15. The Gugamal Reserve was divided into six felling series each with six annual coupes and the first five coupes in each felling series were worked under improvement felling series between 1910-11 and 1914-15. Another exception is the Tapi Reserve Working Scheme implemented between 1912-1915. As a result of visit of Mr. Hart, the then Chief Conservator of Forests, in 1912-1913, fellings under the Coppice with Standard system commenced in the newly created Tapti Reserve.

Sharma's Working Plan 1956-1974: The Working Circles proposed were almost same except for an additional Miscellaneous Working Circle. The Plan covered the area of Dul Ghat, Dahiba, Wan and parts of Rupgarh Reserve, apart from covering the entire Melghat Forests.

Bhathena's Working Scheme 1961-1968: With a view to start systematic management in areas of Miscellaneous Working Circle of Sharma's Plan, this Working Scheme was prepared and introduced in 1961. It covered a large part of what we now call south Melghat Division. The Working Scheme contained only two Working Circles namely Coppice with Reserve and Miscellaneous Working Circle.

Joshi's Plan 1975-76 to 1984-85: The Working Circles proposed are the same as those in case of East Melghat Forest Division except for two additional Working Circles namely Improvement and Miscellaneous Working Circles.

Oaks Scheme for erstwhile Protected Forests: This scheme covered only the then Protected Forests in West Melght Division, now distributed over both West and South Melghat Divisions. The Working Circles proposed were Improvement and Pasture Working Circle.

Current Management

The current Plan which is operational is by Shailendra Bhadur and B.S. Thengdi, Deputy Conservator of Forests, Working Plan Amravati. The

plan period is 1993-94 to 2002-03. The Working Circles proposed are as follows:

- **Selection-cum-Improvement Working Circle**
- **Protection Working Circle**
- **Bamboo Overlapping Working Circle**
- **Miscellaneous Working Circle**
- **Wildlife Overlapping Working Circle**

The management objectives and prescriptions proposed are almost the same as proposed for East Melghat Forest Division except for the Miscellaneous Working Circle which has been proposed in addition for the unclassed forests transferred to West Melghat Division as compensatory land under Forest Conservation Act, 1980. These were the E class grazing lands with Revenue Department meant for *Nistar* suppy to *Raiyatwari* villages. The forests were classified as Protection Forests, Tree Forests, Minor Forests, Pasture Lands and Grass Reserves.

Area Constitution

The area constitution is as under:

Land-use	Particulars	Extent of area (sq. kms.)
Protected Area	Satpura N.P.	524.00
	Bori W.L.S.	486.00
	Pachmarhi W.L.S.	417.00
	Gugamal N.P.	359.57
	Melghat W.L.S.	1200.00
Managed Forests	Hoshangabad	82.86
	Rampur Bhatori proposed sanc.	392.68
	North Betul	2397.45
	South Betul	5566.98
	West Betul	1693.68
	East Melghat	309.37
	West Melghat	387.99
	South Melghat	46.79

Location

The study area is located partly in the state of Madhya Pradesh covering the forest division of (1) Hoshangabad, major part of which is incorporated in a cluster of three protected areas *viz.* Satpura National Park, Bori Wildlife sanctuary and Pachmarhi Wildlife sanctuary, more popularly known as Satpura Protected Area Complex, and a small part as Managed Forests of Hoshangabad, (2) the three Forest Divisions of Betul *viz.* North, South and West Betul Forest Divisions and partly in the state of Mahasrashtra covering the Melghat forests comprising of (1) Gugamal National Park, (2) Melghat Wildlife Sanctuary and portions of the three Managed Forest Divisions of Melghat *viz.* East, West and South Melghat Forest Divisions which together constitute the Melghat Tiger Reserve (MTR).

The entire study area is shown in Plate 1. The map in Plate 2 shows the area proposed to be included in the Pachmarhi Biosphere Reserve. The map in Plate 3 shows the Bori, Satpura National Park and Pachmarhi Wildlife Sanctuary (BSP) Protected Area Complex. The Plate 4 shows the Managed Forest Divisions of Betul District. Management Units of Melghat Tiger Reserve are shown in Plate 5.

Components of Maps

For the convenience of the data handling, analysis and depiction of maps in GIS domain and in Plates, the study area has been divided into three components

(a) BSP Protected Area Complex

(b) Betul District consisting of three Managed Forest Divisions

(c) Melghat Tiger Reserve and Managed Forests

Hence for each theme there are three sets of Maps for each component. The map of the entire Satpura Conservation Area has been shown for some of the themes wherever possible

Current administration

The Satpura Conservation area comprises a broad spectrum of areas under different sets of administration and management extending over one of the largest and compact forest areas of the central Indian highlands. It is a unique mosaic of protected areas and managed forests harbouring diverse habitat types and utilization patterns. The Hoshangabad forest division is under the administrative control of the Divisional Forest Officer while the Satpura Protected Area Complex is under the control of the Director Satpura National Park. Both of these fall in the Hoshangabad Conservancy under the administration of the Conservator of Forests. The Additional Principal Chief Conservator of Forests, Wildlife, M.P. who is also the Chief Wildlife Warden is the final authority exercising control over management of PAs and all wildlife matters in M.P. There are two Sanctuary Superintendents of the rank of Assistant Conservator for the Bori and Pachmarhi Wildlife Sanctuaries who are responsible to the Director, Satpura National Park.

The Conservator of Forest, Betul exercises control over the three Betul divisions each of them headed by a Divisional Forest Officer. In Maharashtra, the Gugamal National Park is under the control of the Field Director (MTR). The administrative jurisdiction over the entire Project Tiger area including Gugamal National Park, Melghat Sanctuary and surrounding small Protected Areas and Managed Forests is under unified control of the Field Director, Melghat Tiger Reserve. The managed forests comprising the MTR and those outside are managed by these officers as well. Management of PAs, MTR, and wildlife is under the control of the Principal Chief Conservator of Forests, Wildlife and Chief Wildlife Warden at the highest level in Maharashtra. Apart from this there is one Research Officer of the rank of Assistant Conservator of forests.

Physiography

Geology and soil: The tract is mainly covered by Gondwana sandstone, with a basal bed of Deccan trap formation made up of coarse grained basalt. The 'Gondwanas' comprise of the Talchirs, Barakars, Moturs, Bijori beds and Jabalpur formations. The crystallines found in the tract comprise both of the Archaean and Proterozoic group, while the Alluvium is found along river and nala banks. The forest soil varies from loose sand or reddish murrum to dark stiff clayey loam or black cotton soil, inclusive of all intermediate gradations. The soil is generally sandy loam turning to clayey loam or alluvium along stream beds(Plate 14 and Plate 14a). In the Maharashtra part, the only geological formation represented in the Melghat Tiger Reserve is the Deccan trap. Lava flows are usually found in a horizontal position but along the southern edge of Gawilgarh hill. They present a usual feature of a low but constant dip to North.

The underlying rock is basalt in one form or the other, the several forms chiefly being due to the successive lava flows. The most common form is the hard dark-coloured rock, compact or fine grained, but is occasionally with numerous phenocrysts. This rock usually occurs in thin layers and outcrops of it gives rise to the conspicuous scarps on the hill side. Prismatic jointing is well developed and at many places fine examples of columnar structure can be seen, particularly in the rivers and streams. When the hard scarp undergoes weathering, it is converted into soft earthy brown rock with rows representing the original columns of roughly spherical bodies exfoliating into successive concentric shells. A second form occurring in the lower hills is grey vesicular or amygdaloidal basalt, the cavities being lined with crystals of quartz and other minerals. Then there are

the thin layers of basalt tuff, a soft, grey, dull, fine-grained rock that occurs occasionally, representing the intervals of time that elapsed between the successive lava flows.

Climate : This area receives rainfall from the south west monsoon. The rainy season starts from mid-June and extends upto early October and winter season from November to March. The summer season is from April to early-June. The mean daily temperature varies between 18.1 °C to 32.2°C. The mean annual rain fall locally varies from 1200 to 3200 mm. The climate is not excessively humid and in fact fairly dry for at least 2-3 months. The prevailing conditions are conducive to good growth of dry and moist deciduous vegetation.

Forests: According to the classification of Champion and Seth (1965) the following types of forests are represented in the SCA -

Type 3B – South Indian Tropical Moist Deciduous Forests

Type 3B/C1 – South Indian Tropical Moist Deciduous Slightly Moist Teak Forests

Type 3B/C2 – South Indian Tropical Moist Deciduous Mixed Forests

Type 4F/R 5 – Riparian Fringing Forests

Type 5A – Southern Tropical Dry deciduous Forests

5A/C1 – Dry Teak -bearing Forests

5A/C1b – Dry Teak Forests

5A/C3 – Southern Dry Mixed deciduous Forests

5B/C1(c) – Dry peninsular sal Forests

5A/E2 – *Boswellia* Forests

Type 8A/C3 – Central Indian Subtropical Hill forests

Drainage: *The* Melghat Tiger Reserve is drained by Khandu, Khapra, Sipna, Garga, and Dolar rivers into the Tapti river. The Madhya Pradesh part is drained by the Tapti, Tawa, Denwa, Machna, and Sonabhadra.

Different themes related to physiography, soil and drainage have been depicted in the maps prepared in GIS domain as follows

Table 1. Thematic maps related to physiography, soil and drainage of the study area

Plate No	Title
6.	Digital Elevation Model of Satpura NP, Bori and Pachmarhi WLS
7.	Slope Map of Satpura NP, Bori and Pachmarhi WLS
8.	Aspect Map Satpura NP, Bori and Pachmarhi WLS
9.	Hill shade Map of Satpura NP, Bori and Pachmarhi WLS
10.	Digital Elevation Model Map of Betul
11.	Slope Map of Managed Division of Betul District, Madhya Pradesh
12.	Aspect Map of Managed Forest Divisions of Betul District, Madhya Pradesh
13.	Hill shade Map of Managed Forest Division of Betul District, Madhya Pradesh
14.	Map showing Soil types of Betul District
14a.	Soil Map of BSP Protected Area Complex
15.	Digital Elevation Model Map of Melghat Tiger Reserve

Plate No	Title
16.	Slope Map of Melghat Tiger Reserve
17.	Aspect Map of Melghat Tiger Reserve
18.	Hillshade map of Melghat Tiger Reserve
19.	Hydrogeomorphological Map of Hoshangabad
20.	Satpura Conservation Area-Digital Elevation Model
21.	Satpura Conservation Area-Slope Map
22.	Satpura Conservation Area-Hill shade Map
23.	Drainage Map of Satpura National Park, Bori and Pachmarhi WLS
24.	Drainage Map of North, South and West Betul Forest Division in SCA
25.	Drainage Map of Melghat Tiger Reserve

Plate 1 - Satpura Conservation Area (SCA), Central India

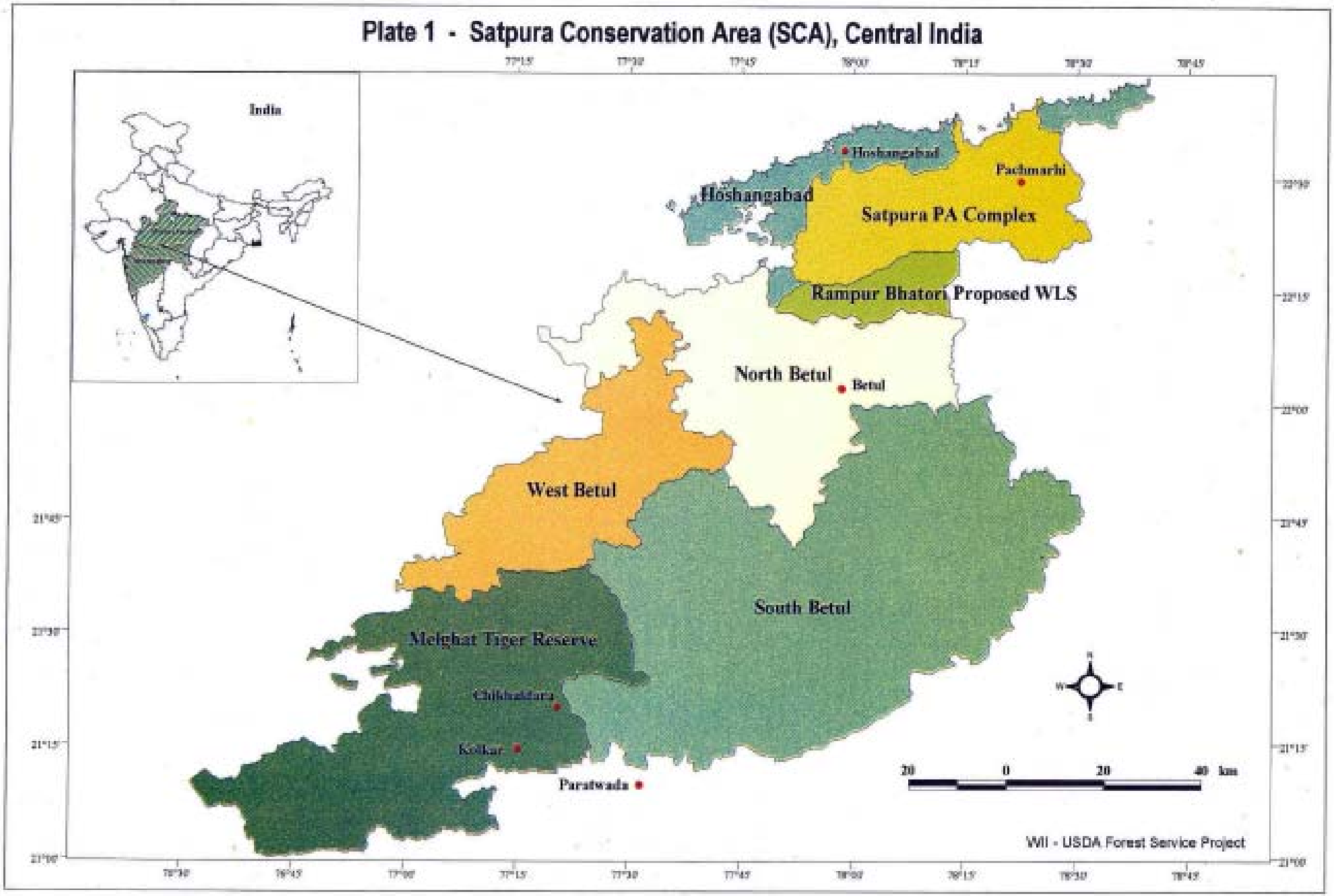


Plate 2 Map of Pachmarhi Biosphere Reserve

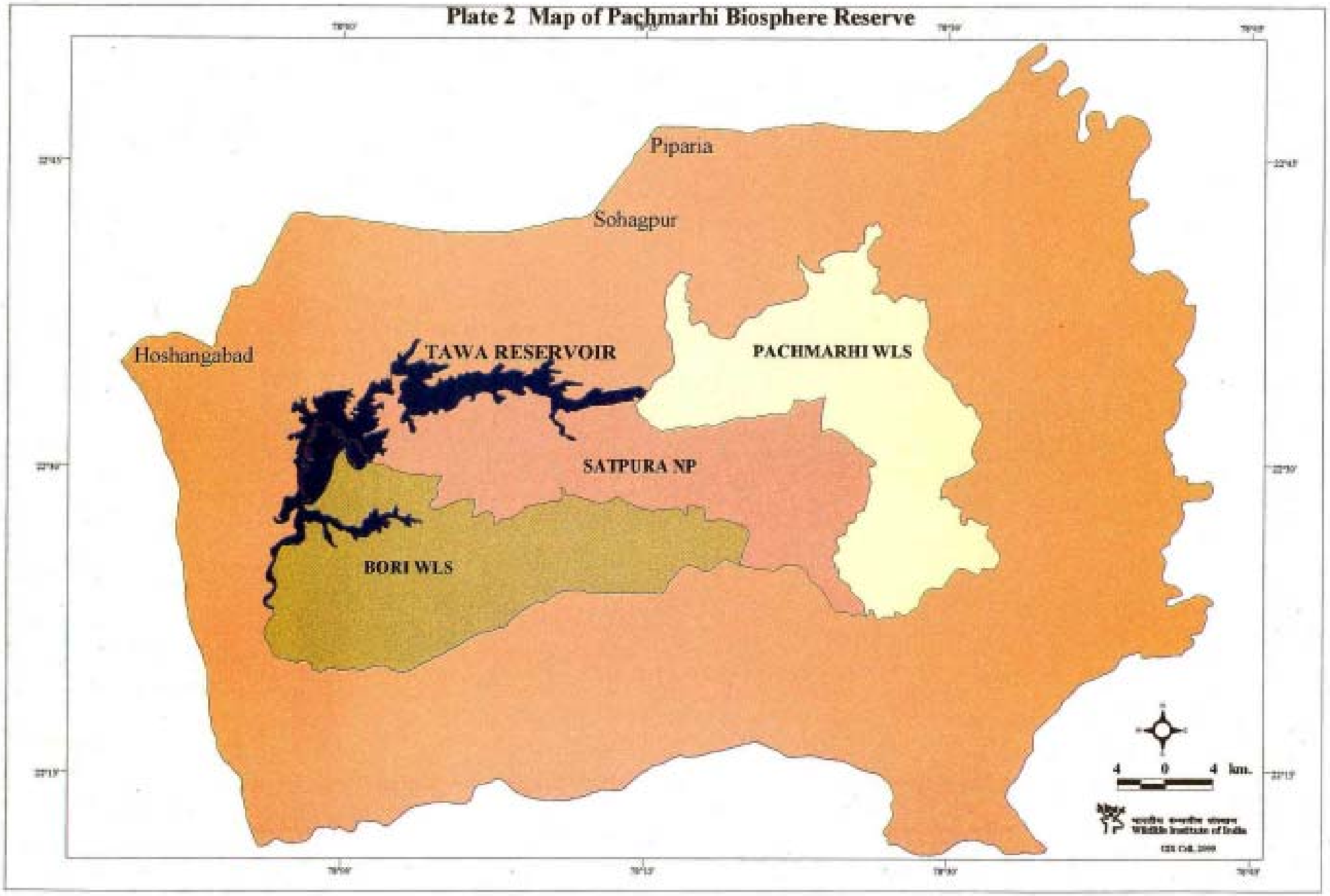


Plate 3 Satpura Protected Area Complex

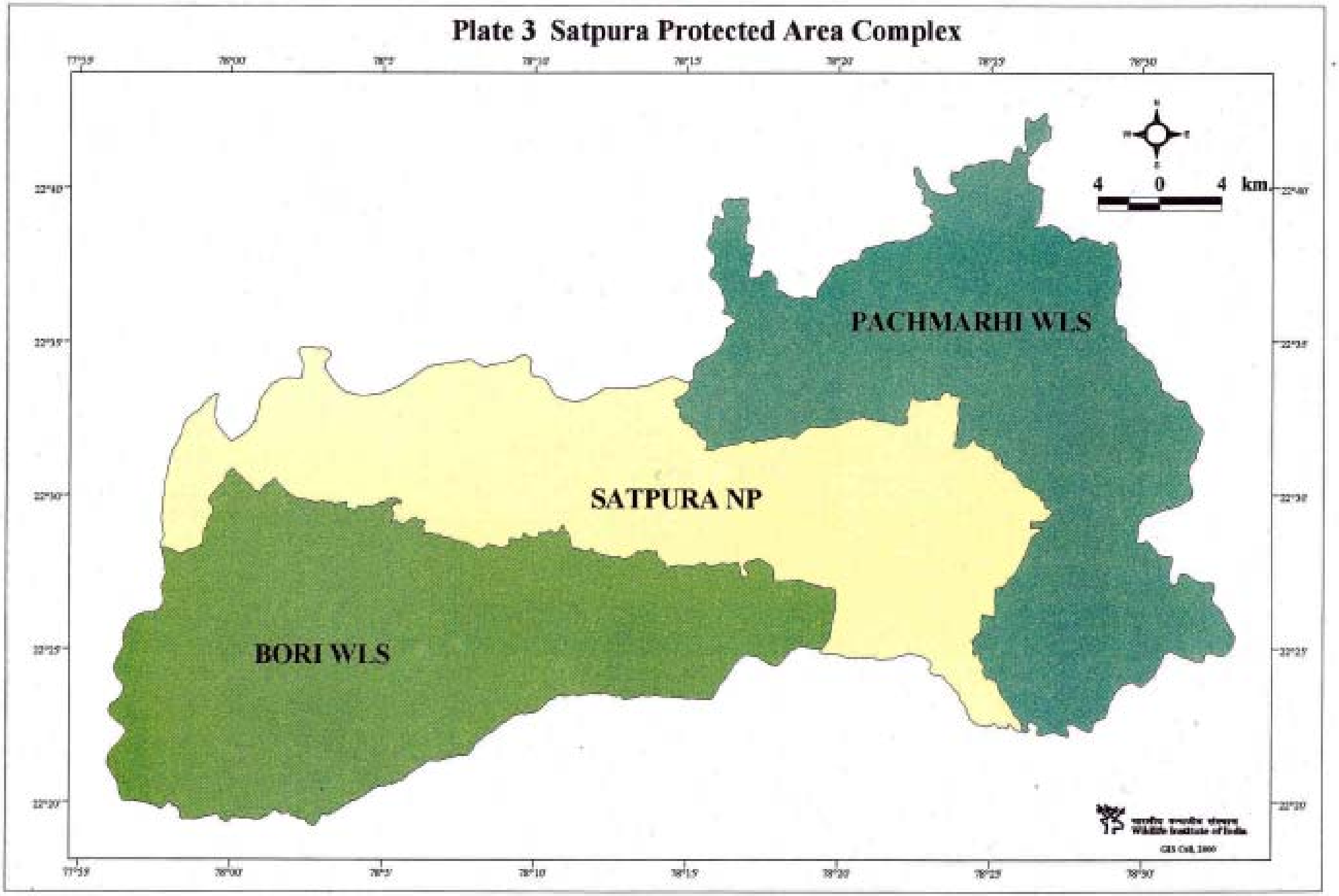
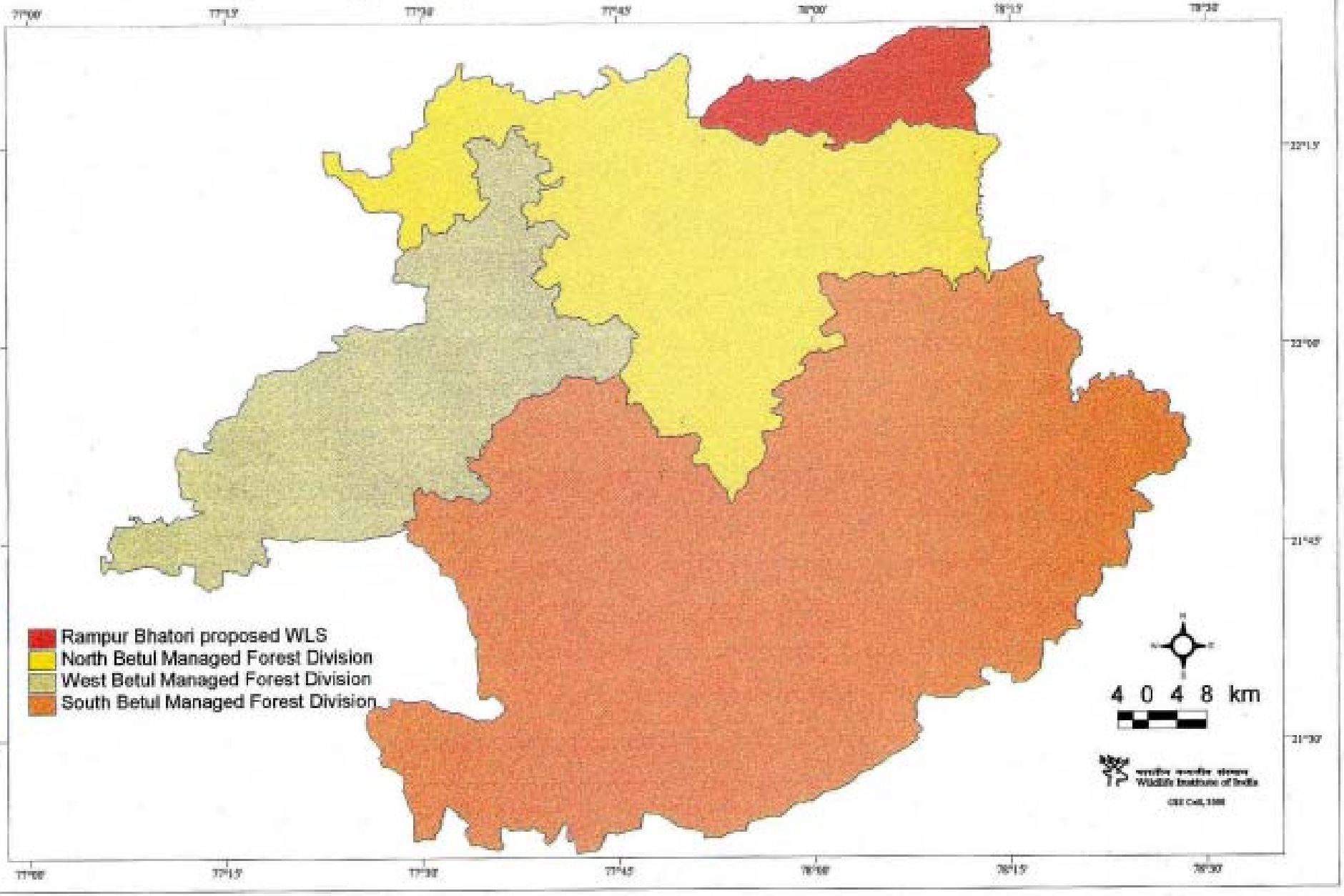


Plate 4 Map showing Managed Forest Divisions of Betul District , Madhya Pradesh



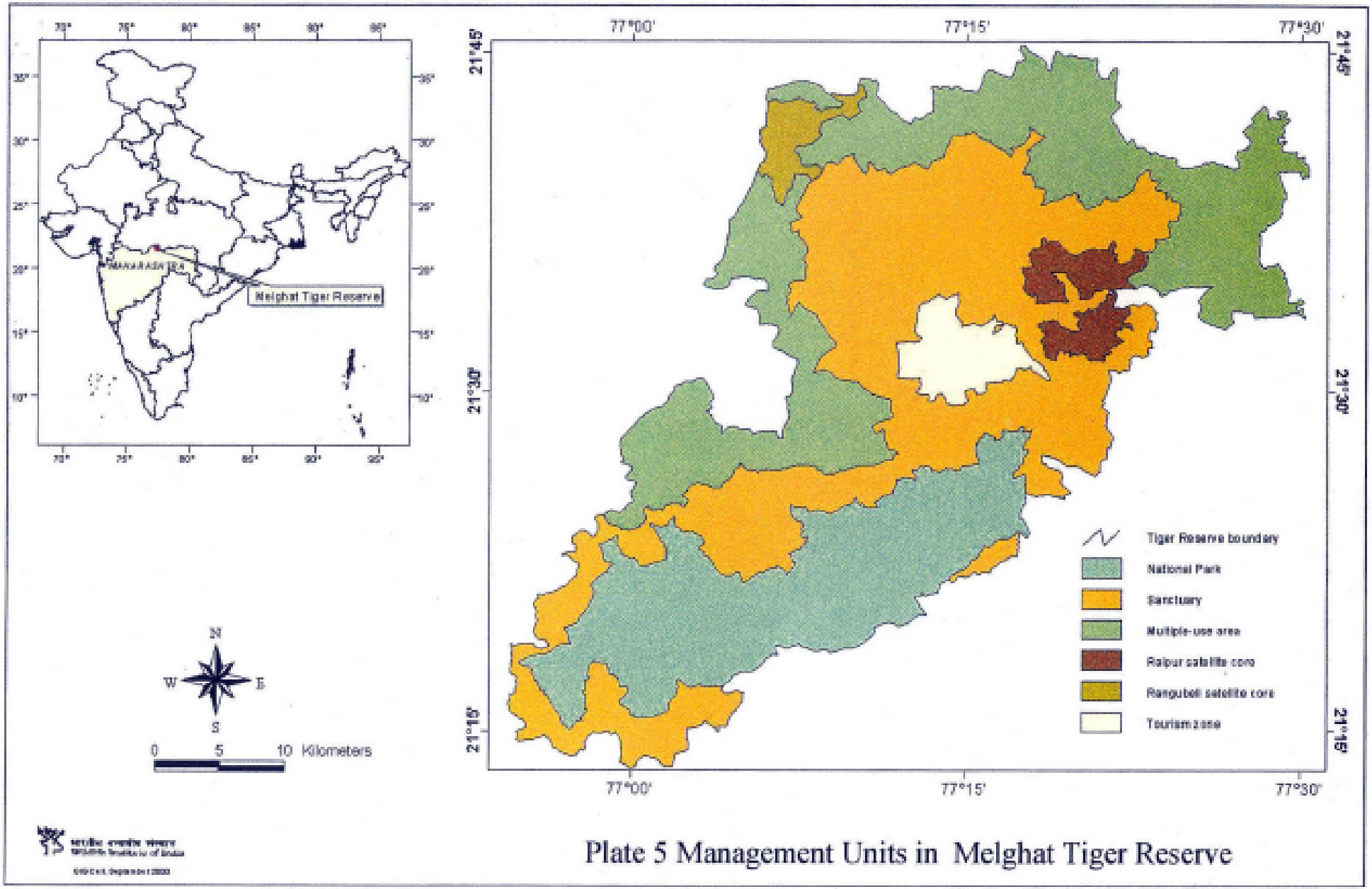


Plate 5 Management Units in Melghat Tiger Reserve

Plate 6 Digital Elevation Model of Satpura NP, Bori and Pachmarhi WLS

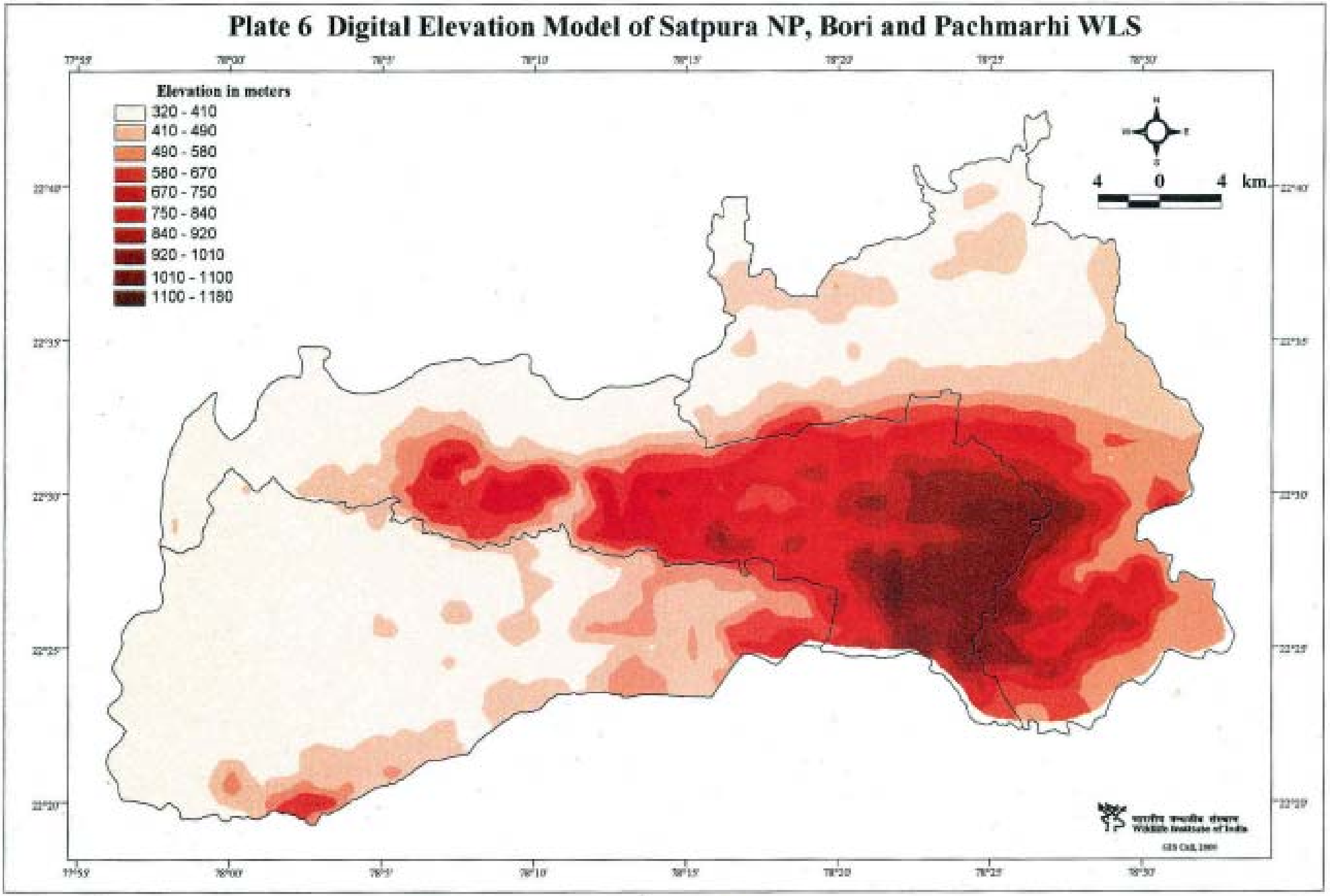


Plate 7 Slope Map of Satpura NP, Bori and Pachmarhi WLS

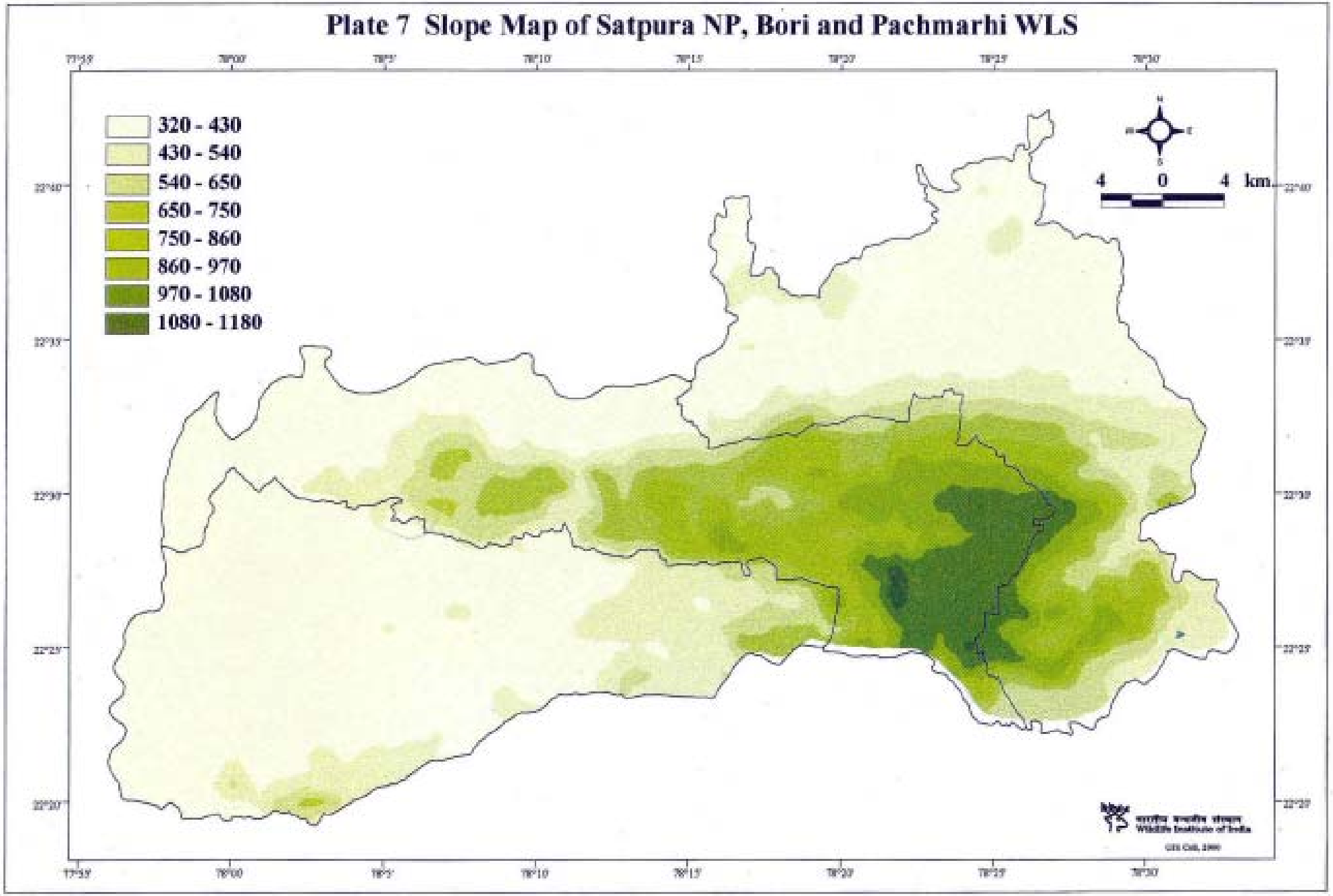


Plate 8 Aspect Map of Satpura NP, Bori and Pachmarhi WLS

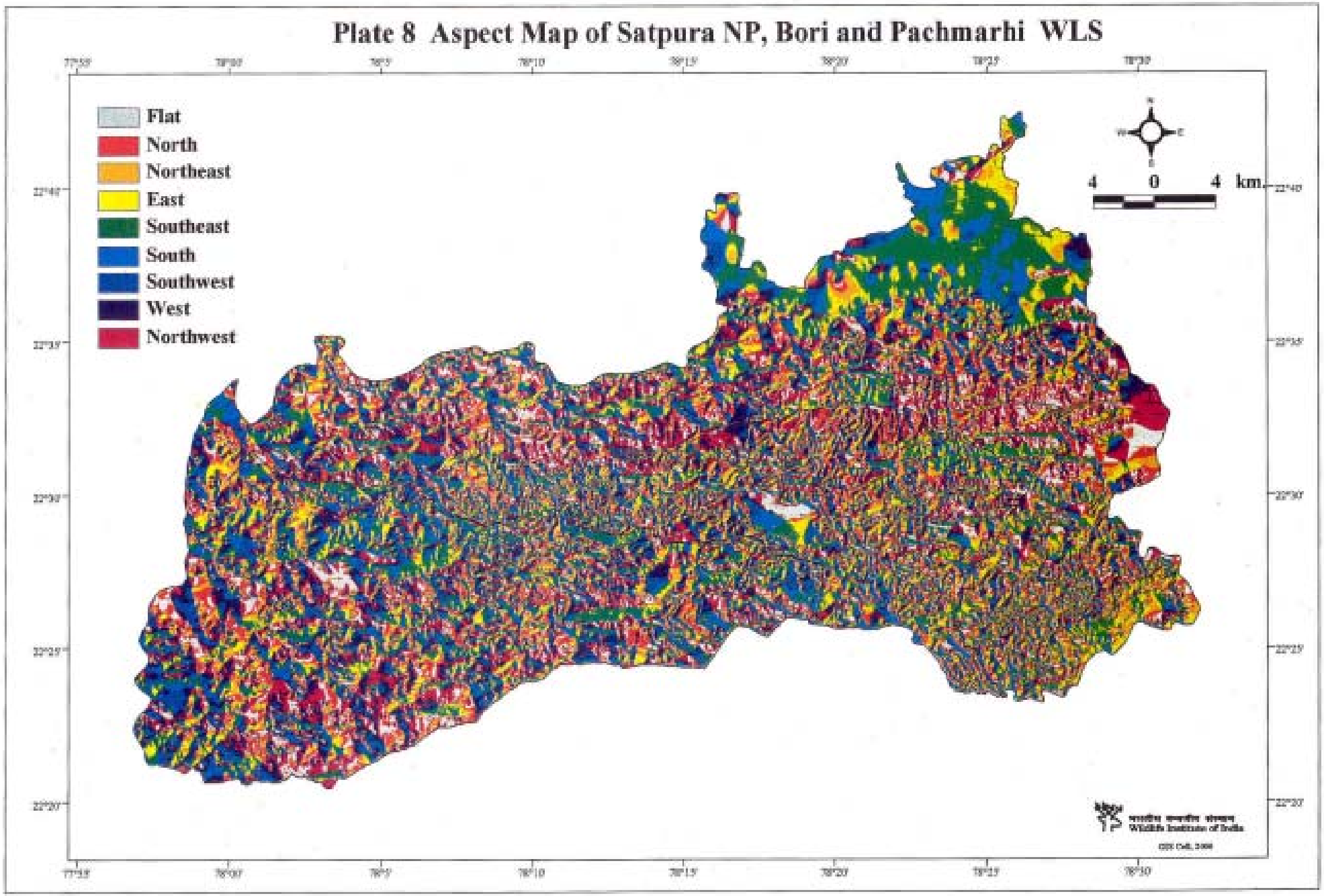


Plate 9 Hill Shade Map of Satpura NP, Bori and Pachmarhi WLS

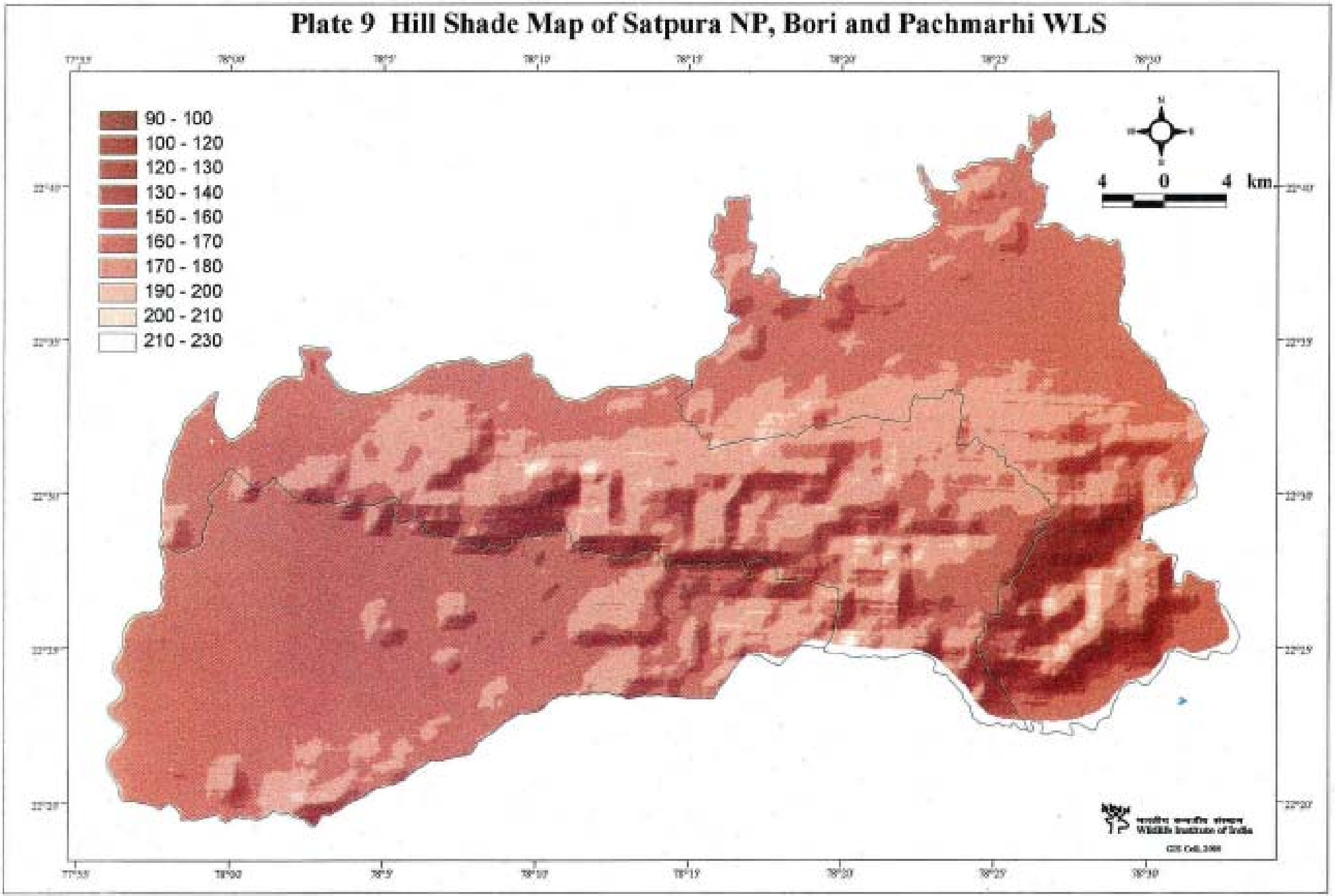


Plate 10 Digital Elevation Model Map of Betul

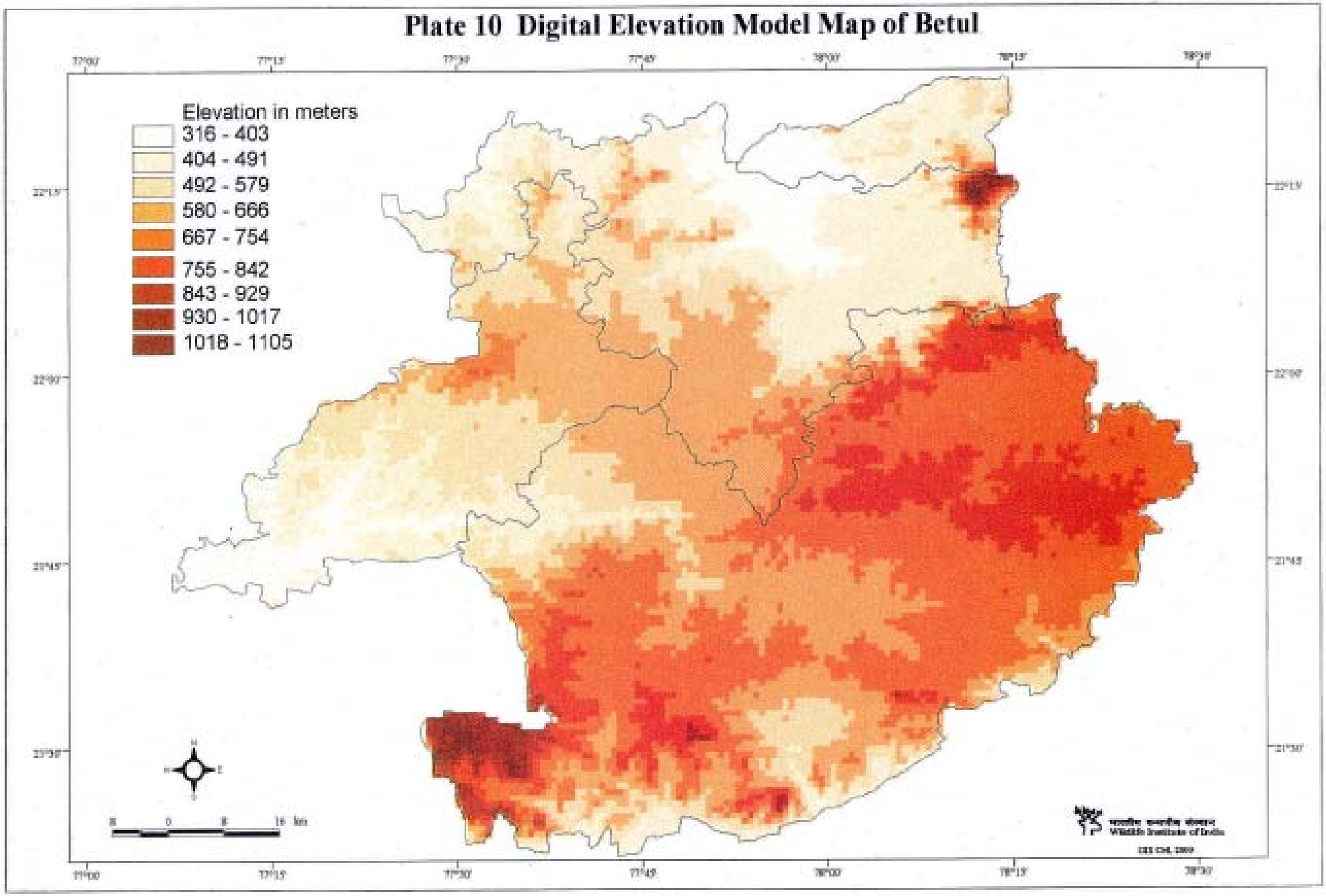


Plate 11 Slope Map of Managed Forest Divisions of Betul District,Madhya Pradesh

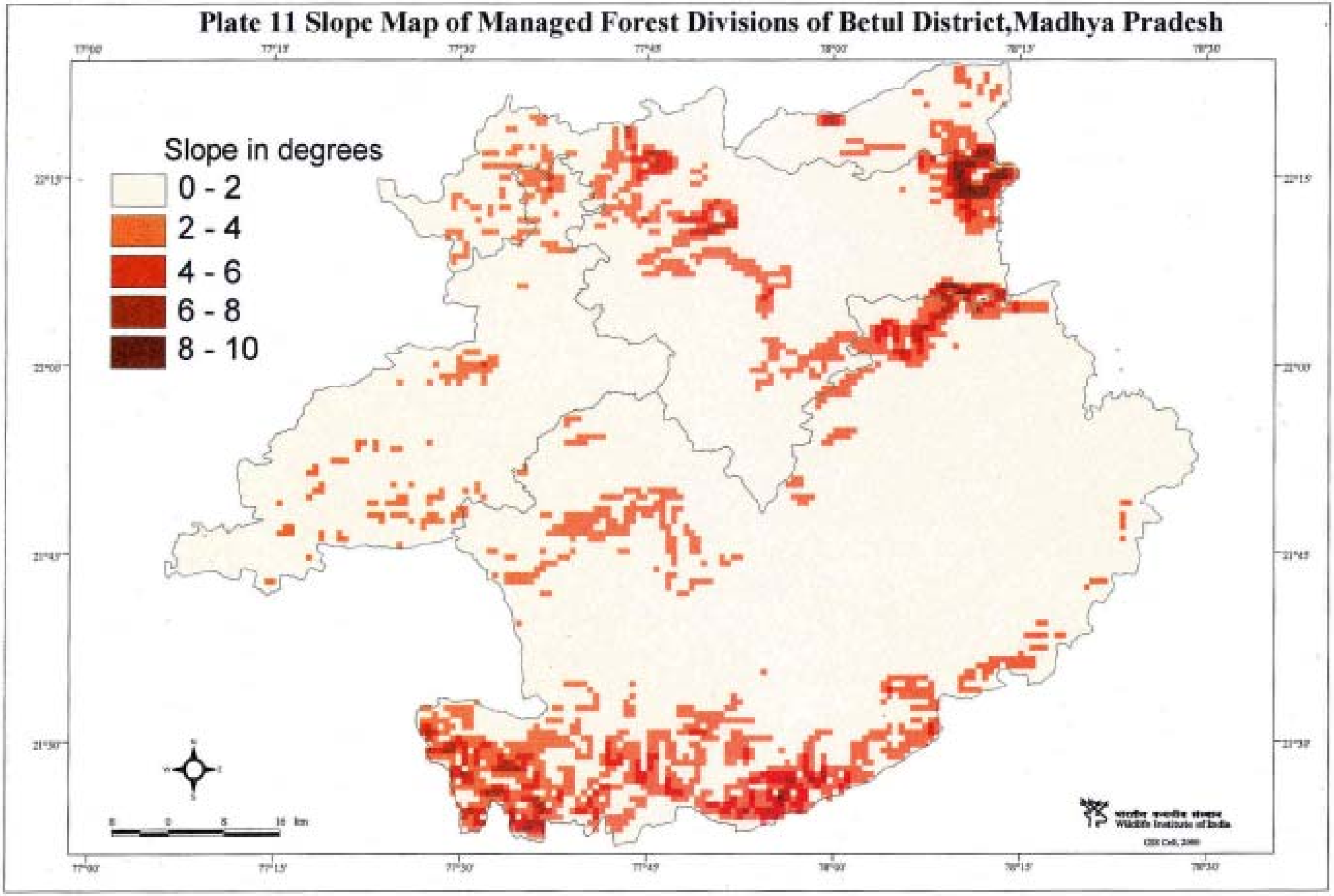


Plate 12 Aspect Map of Managed Forest Divisions of Betul District,Madhya Pradesh

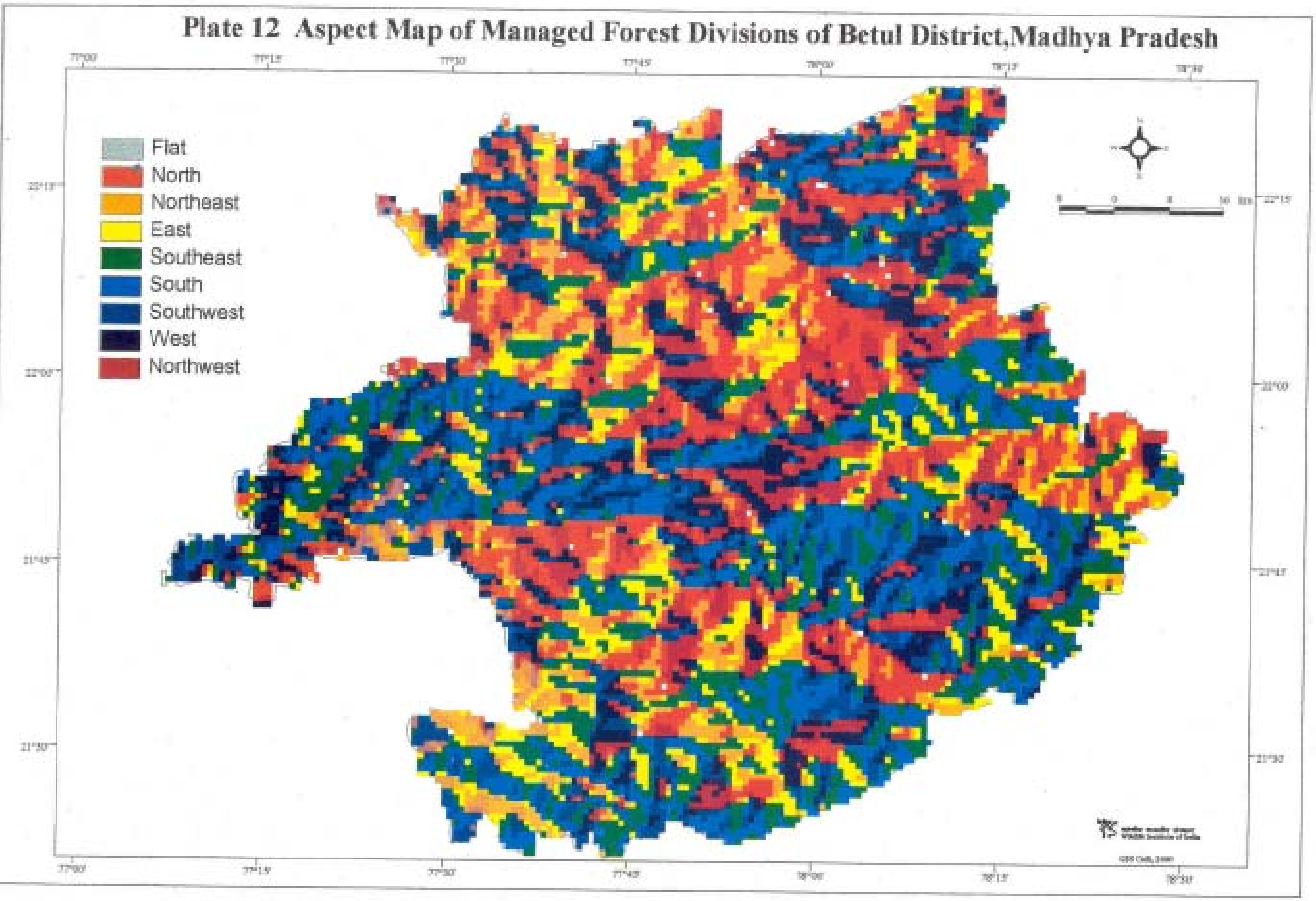


Plate 13 Hill shade Map of Managed Forest Divisions of Betul District,Madhya Pradesh

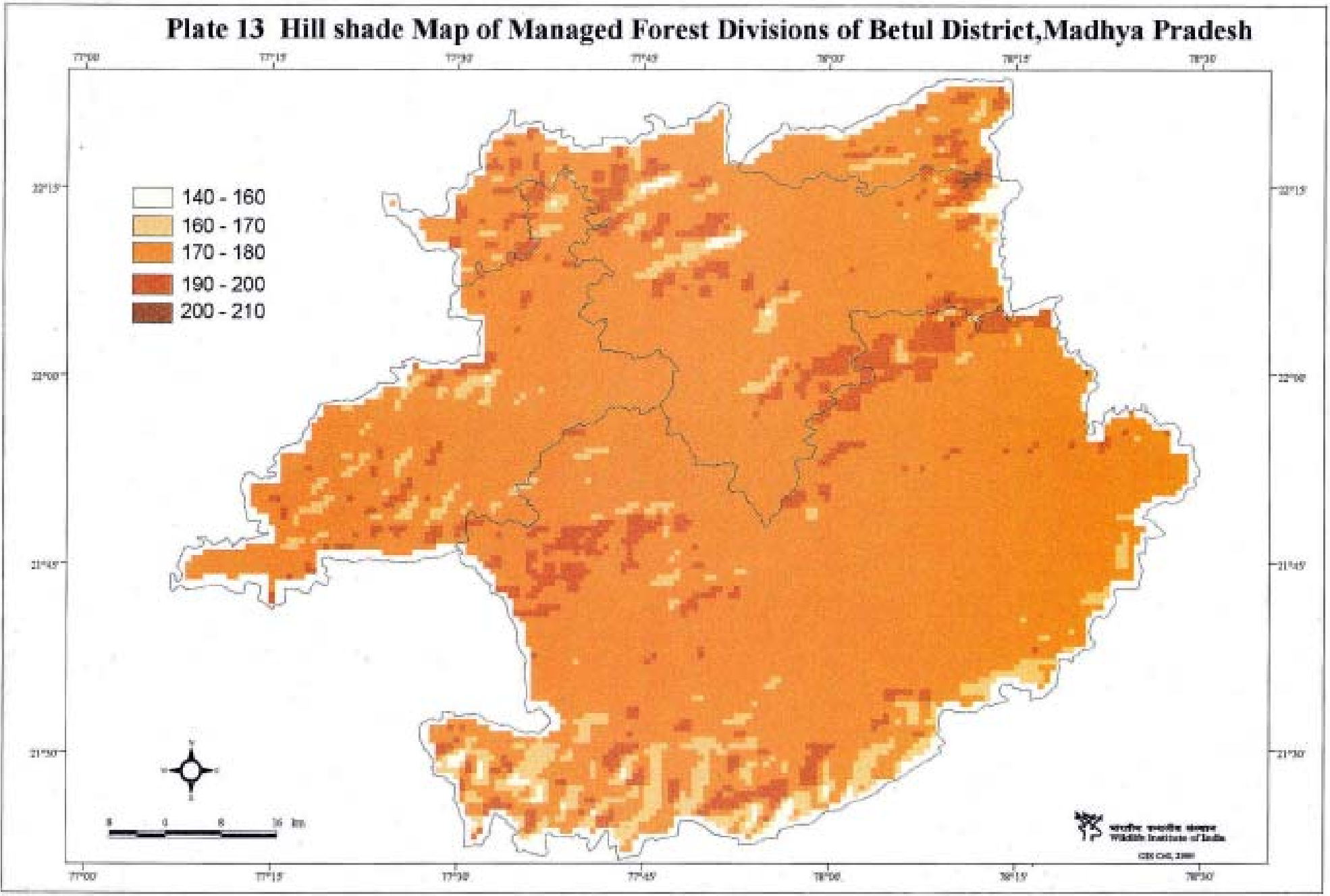
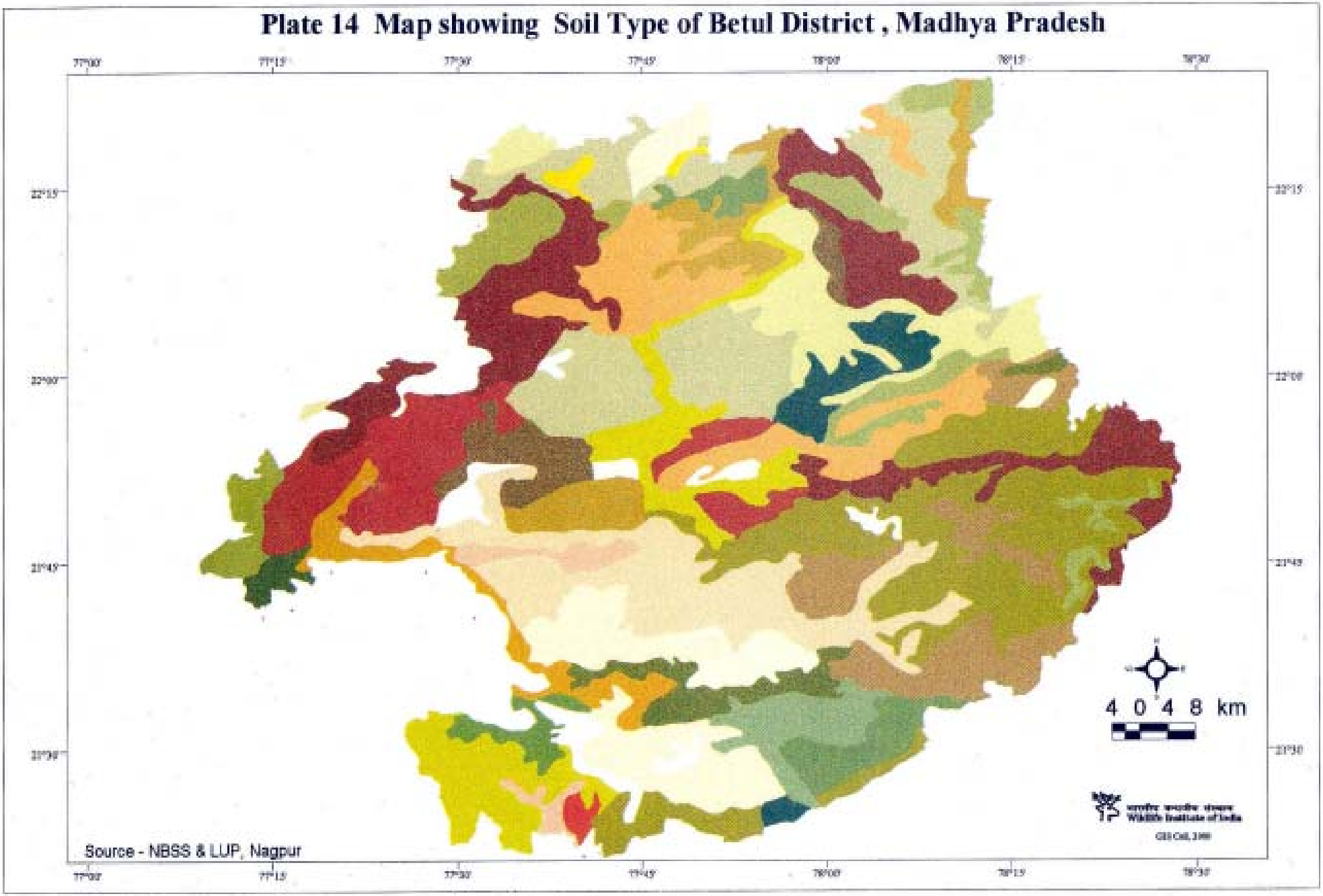


Plate 14 Map showing Soil Type of Betul District , Madhya Pradesh



Legend Of Soil Map

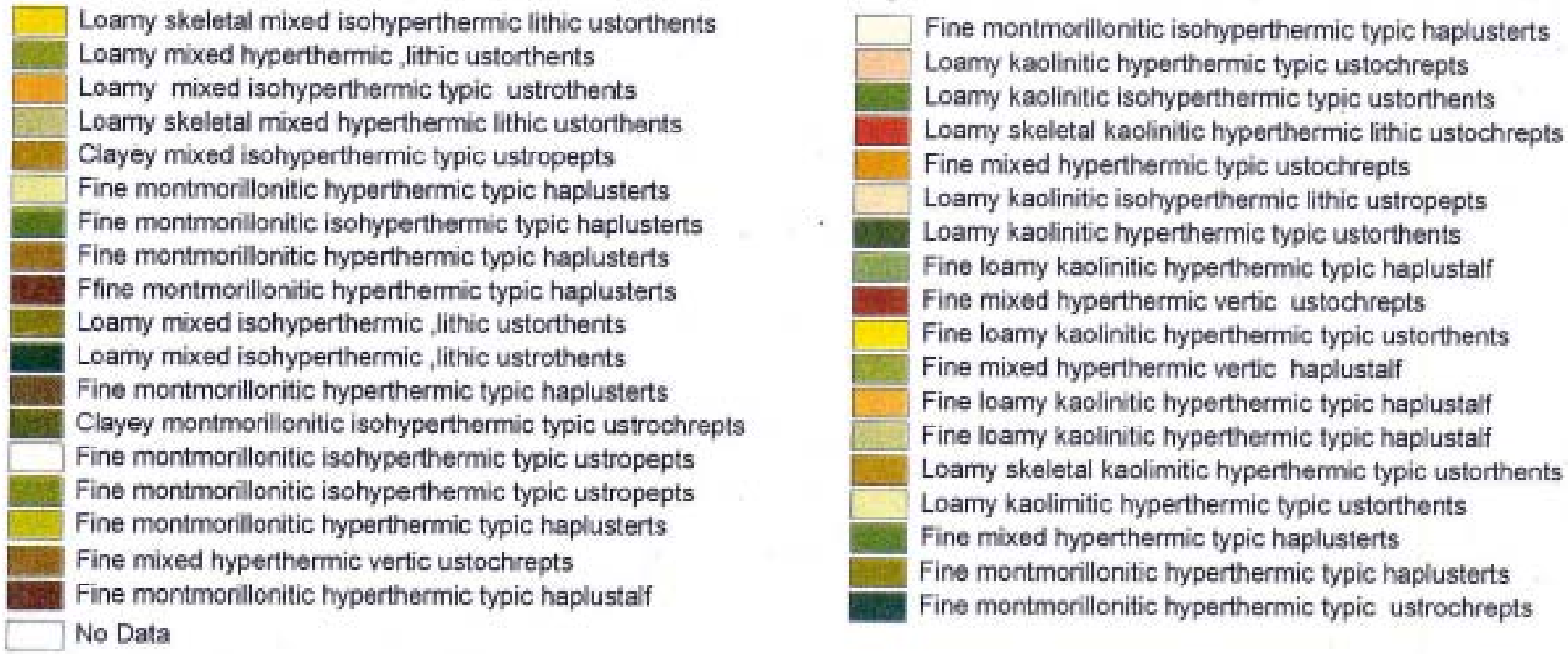
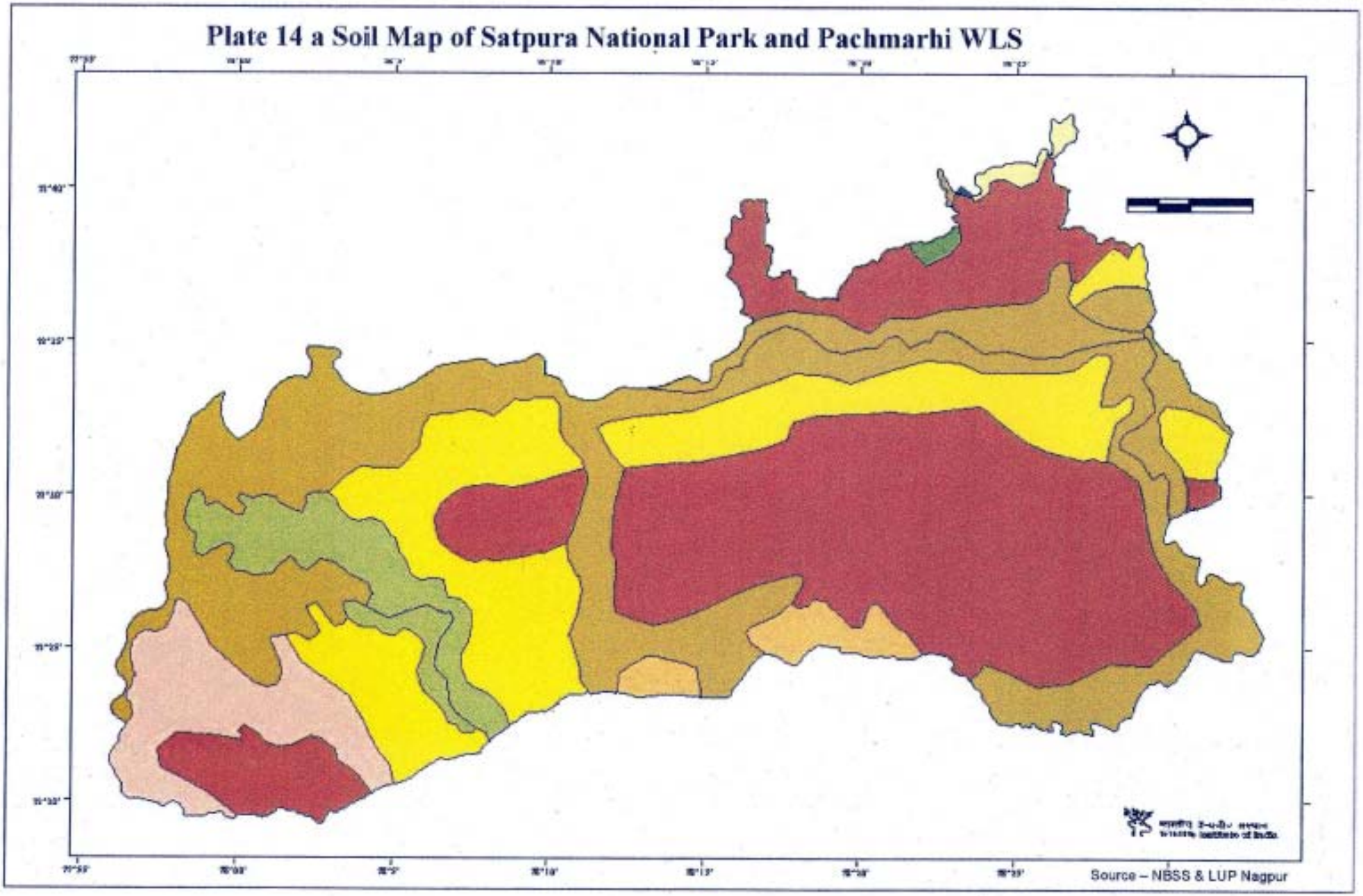


Plate 14 a Soil Map of Satpura National Park and Pachmarhi WLS



Source – NBSS & LUP Nagpur

Legend


Loamy, Kaolinitic, Hyperthermic, Lithic Ustorthents
Loamy, Kaolinitic, Hyperthermic, Typic Ustorthents
Very shallow, somewhat excessively drained, loamy soils on moderately steep sloping hills and ridges with scarps with severe
stony, associated with :shallow, somewhat excessively drained loamy soils on moderately steep sloping with severe erosion a


Fine Loamy,Kaolinitic,Hyperthermic,Typic Haplustalfs
Clayey ,mixed ,Hyperthermic,Typic Ustochrepts
Deep well drained ,loamy soils on gently sloping pediments with moderate erosion ,associated with :
shallow,well drained clayey soils on gently sloping with severe erosion and slightly stony


Loamy, Kaolinitic, Hyperthermic, Typic Ustochrepts
Loamy, Kaolinitic, Hyperthermic, Lithic Ustorthents
Shallow, well drained loamy soils on gently sloping undulating land with severe erosion associated with :very shallow ,
somewhat excessively drained clayey-skeletal soils on gently sloping with severe erosion


Fine Mixed,Hyperthermic,Vertic Ustochrepts
Clayey-skeletal, Kaolinitic,Hyperthermic, Typic Ustorthents
Moderately deep well drained clayey soils on gently sloping undulating land with moderate
erosion associated with : Very shallow , somewhat excessively drained clayey-skeletal soils on gently sloping with severe eros


Fine-Loamy, Kaolinitic, Hyperthermic, Typic Haplustalfs
Fine-Loamy, Kaolinitic, Hyperthermic,Typic Ustochrepts
Deep well drained loamy soils on very gently sloping undulating land with narrow valleys
with moderate erosion associated with : Deep, well drained loamy soils on very gently sloping with moderate erosion


Coarse-Loamy, Kaolinitic, Hyperthermic, Typic Ustorthents
Fine-Loamy, Kaolinitic, Hyperthermic, Typic Haplustalfs
Deep well drained loamy soils on moderately sloping undulating land with isolated hillocks, with moderate
erosion associated with :Deep, well drained , coarse loamy soils on moderately sloping with severe erosion


Fine, Montmorillonitic, Hyperthermic,Vertic Ustochrepts
Fine-Loamy,mixed , Hyperthermic,Typic Haplustalfs
Deep moderately well drained clayey soils on gently sloping residual hills, with moderate erosion and strongly stony associate
Deep, well drained, loamy soils on very gently sloping with moderate erosion and slightly stony


Fine, Montmorillonitic,Hyperthermic,Chromic Haplusterts
Fine, Montmorillonitic,Hyperthermic,Vertic Usotchrepts
Deep ,well drained clayey soils on gently sloping undulating plains with moderate erosion and slightly stony associated with :
Deep ,moderately well drained, clayey soils on very gently sloping with slight erosion


Fine, Montmorillonitic,Hyperthermic,Typic Haplusterts and Vertic Ustochrepts
Deep ,moderately well drained, clayey soils on very gently sloping plain land with moderate erosion associated with :
Deep ,moderately drained, clayey soils on gently sloping with moderate erosion


Fine, Montmorillonitic,Hyperthermic,Typic Haplusterts and Vertic Ustochrepts
Deep ,well drained loamy soils on gently sloping plain land (slightly dissected) with moderate erosion and slightly stony ass
Deep ,moderately well drained, clayey soils on very gently sloping with slight erosion

Plate 15 Digital Elevation Model Map of Melghat Tiger Reserve

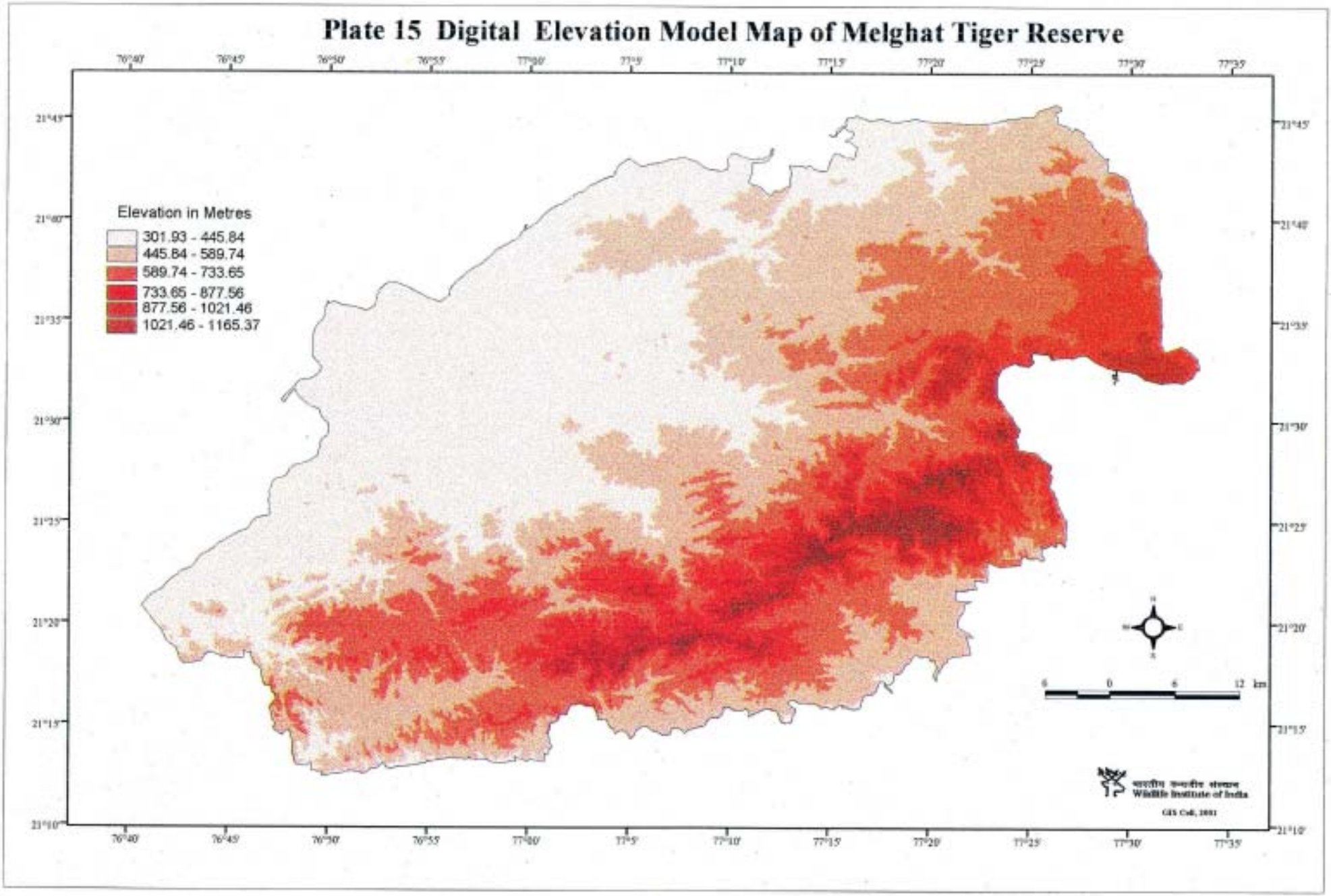


Plate 16 Slope Map of Melghat Tiger Reserve

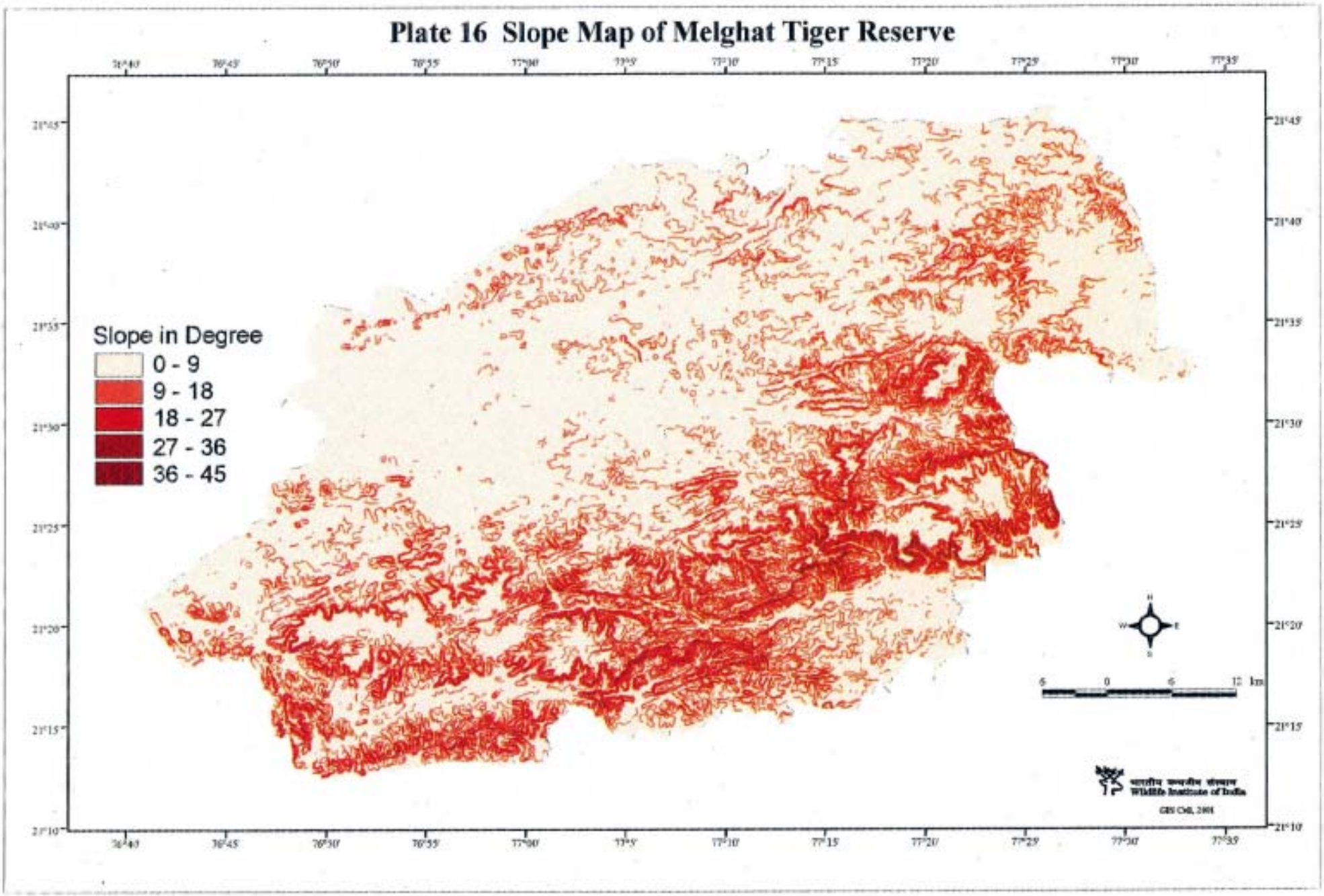


Plate 17 Aspect Map of Melghat Tiger Reserve

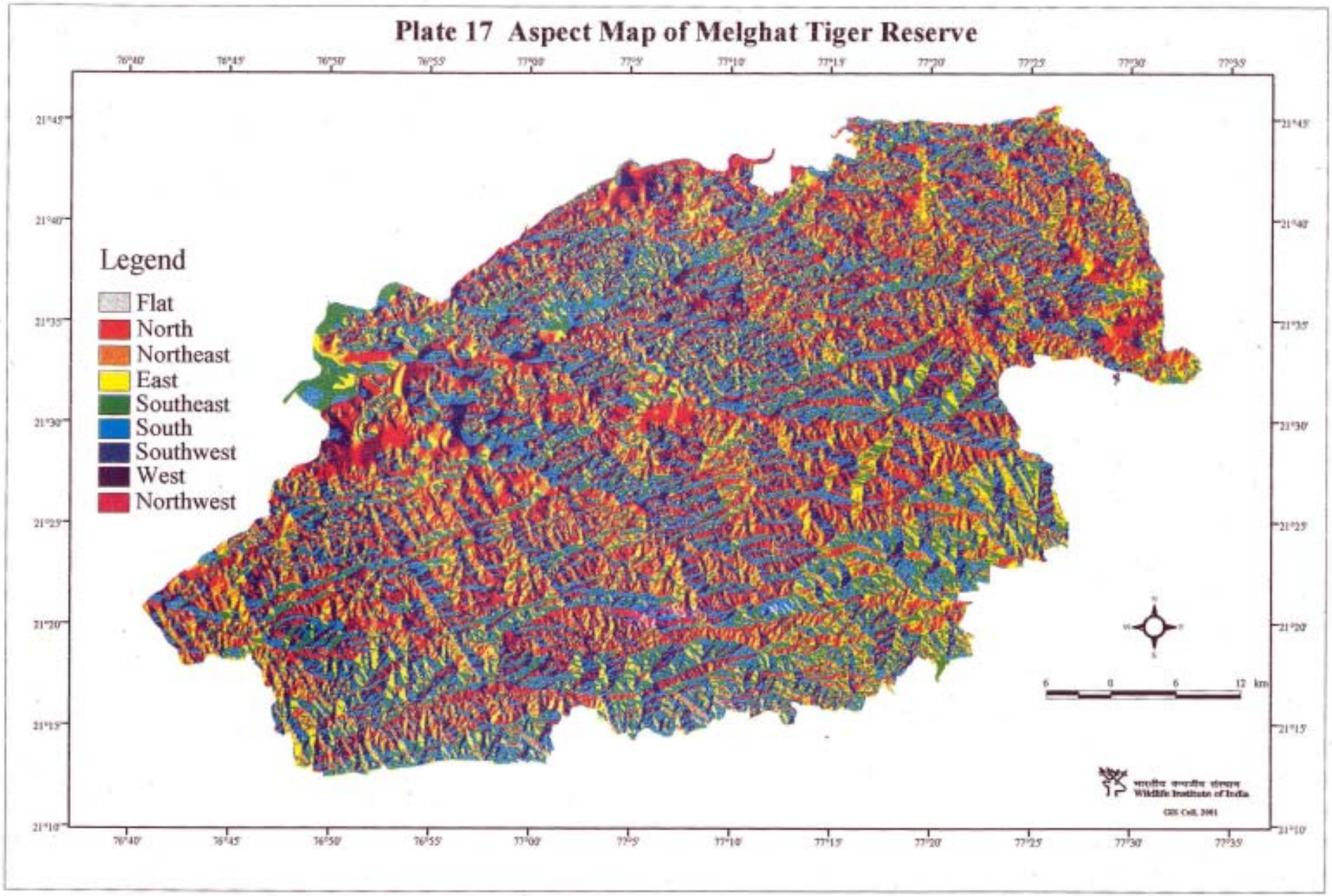


Plate 18 Hillshade Map of Melghat Tiger Reserve

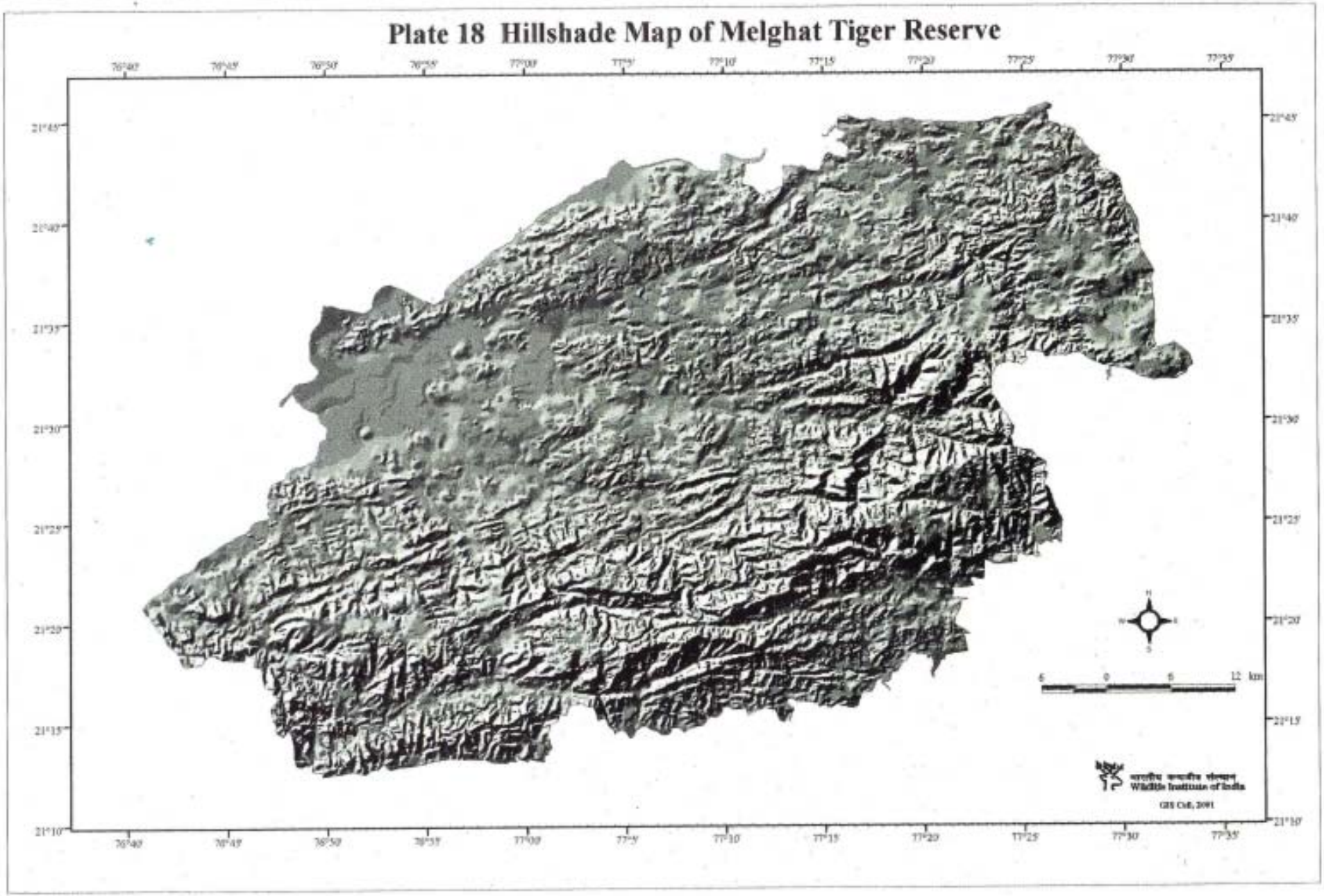


Plate 19 Hydrogeomorphological Map of Hoshangabad

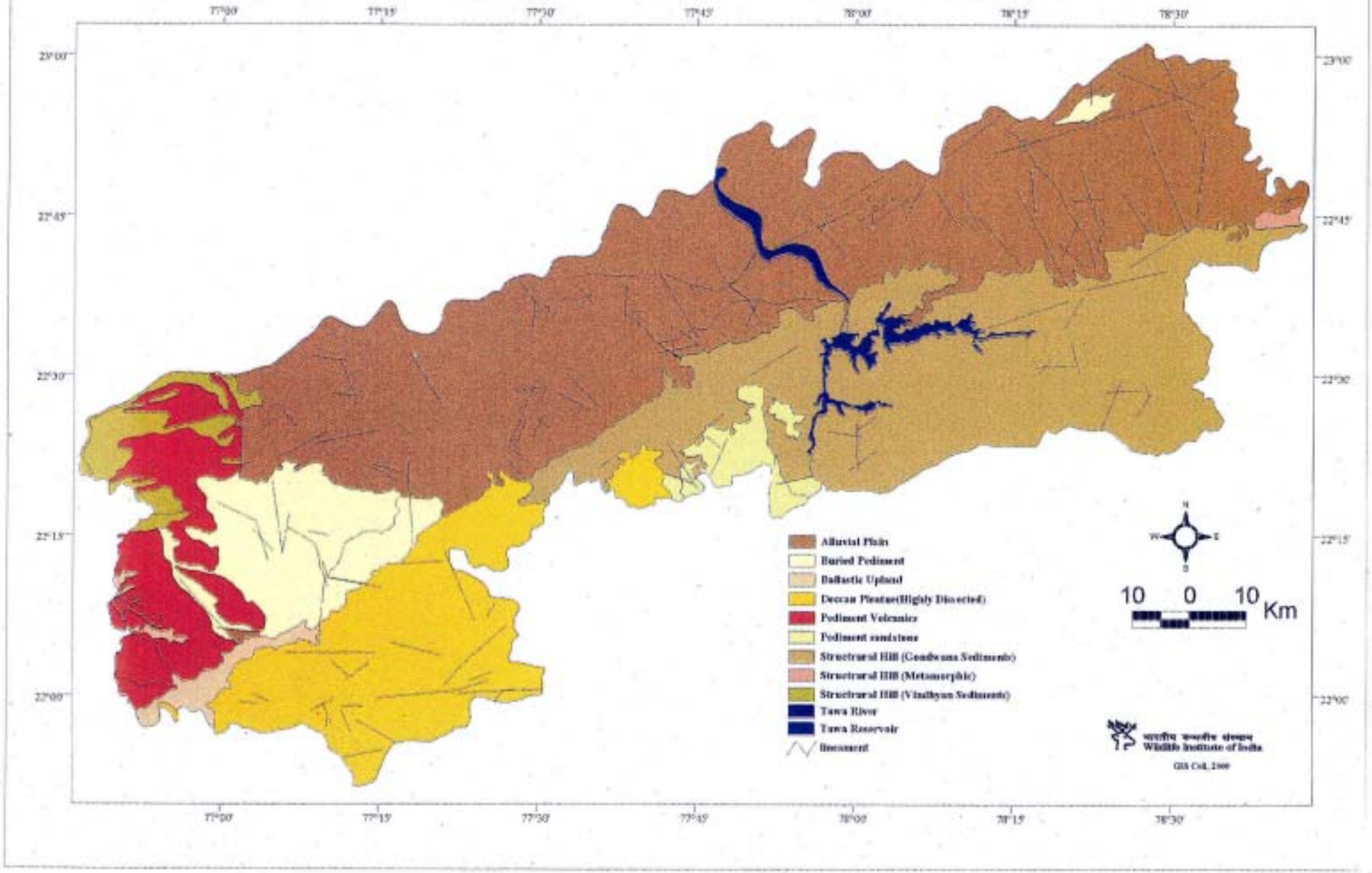


Plate 20 Satpura Conservation Area - Digital Elevation Model

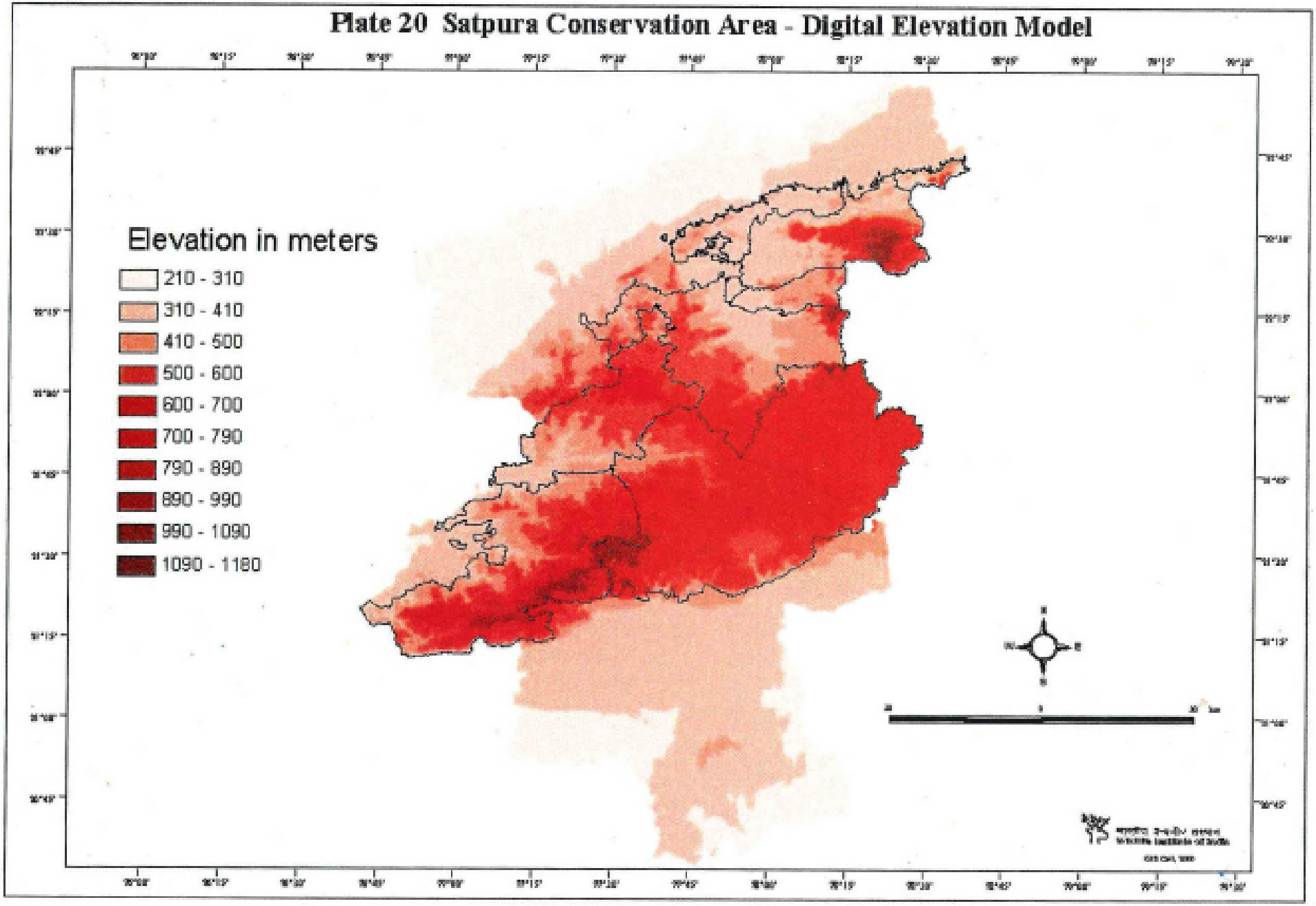


Plate 21 Satpura Conservation Area - Slope Map

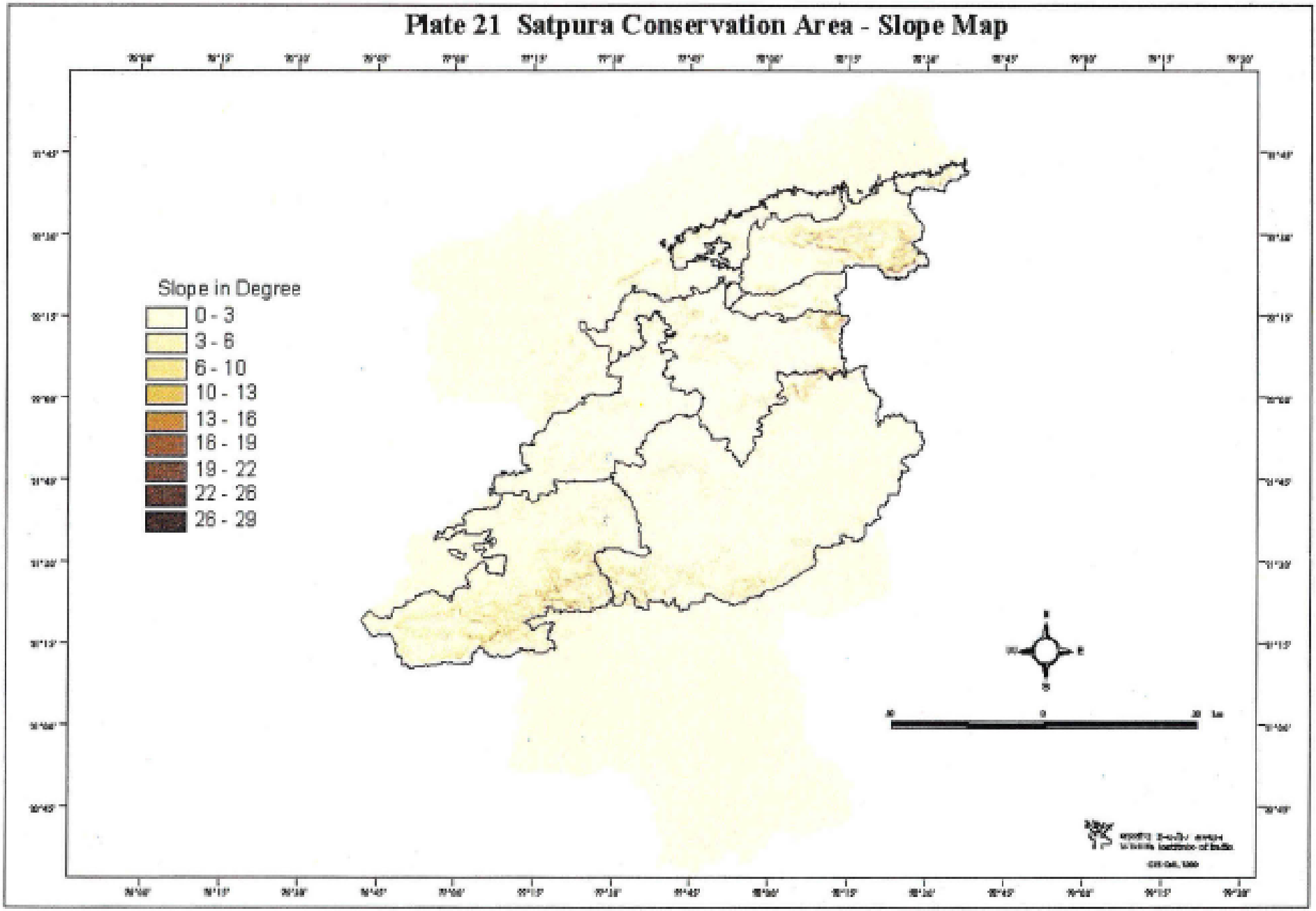


Plate 22 Satpura Conservation Area - Hill shade Map

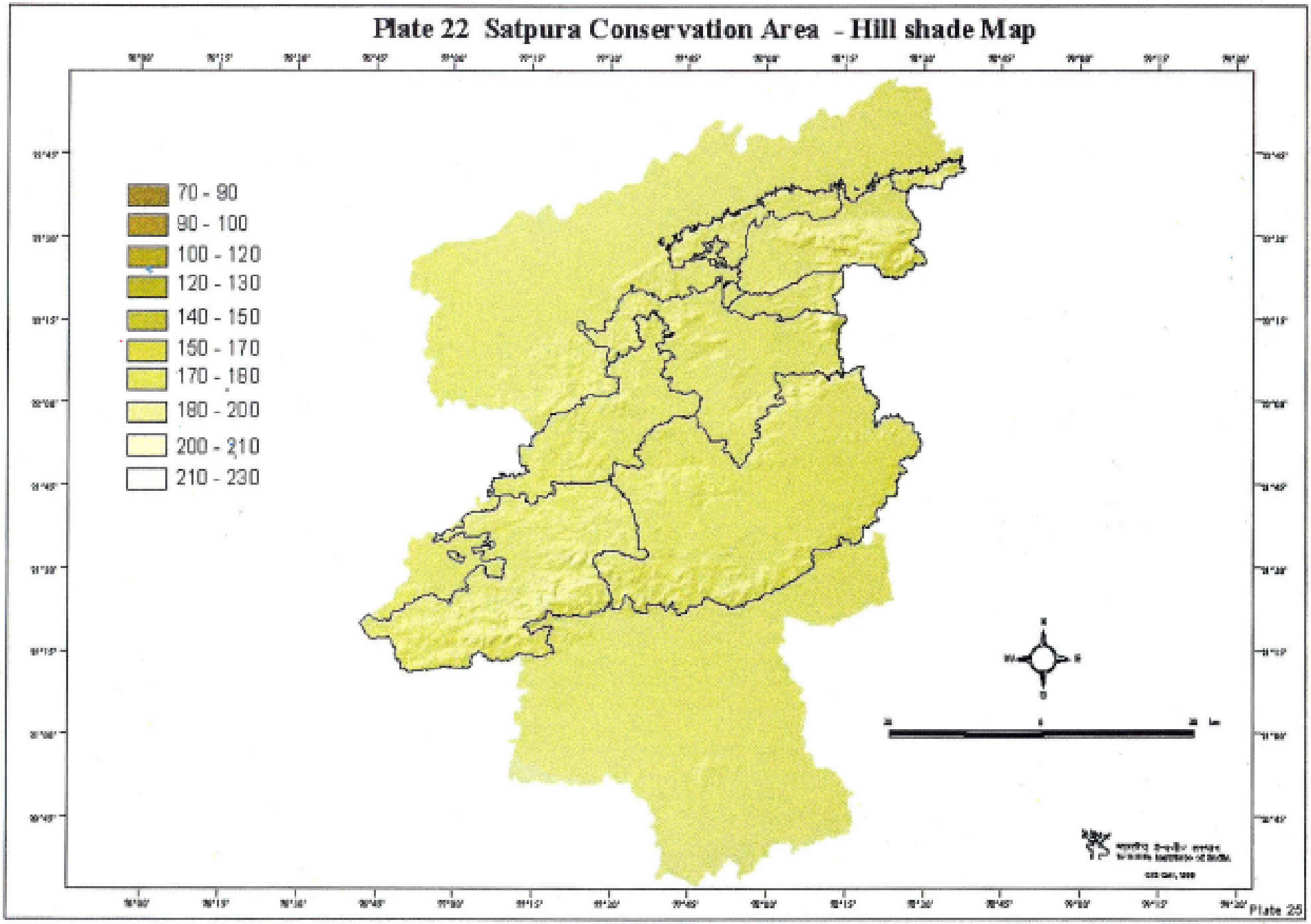


Plate 23 Darinage Map of Satpura national Park, Bori and Pachmarhi WLS

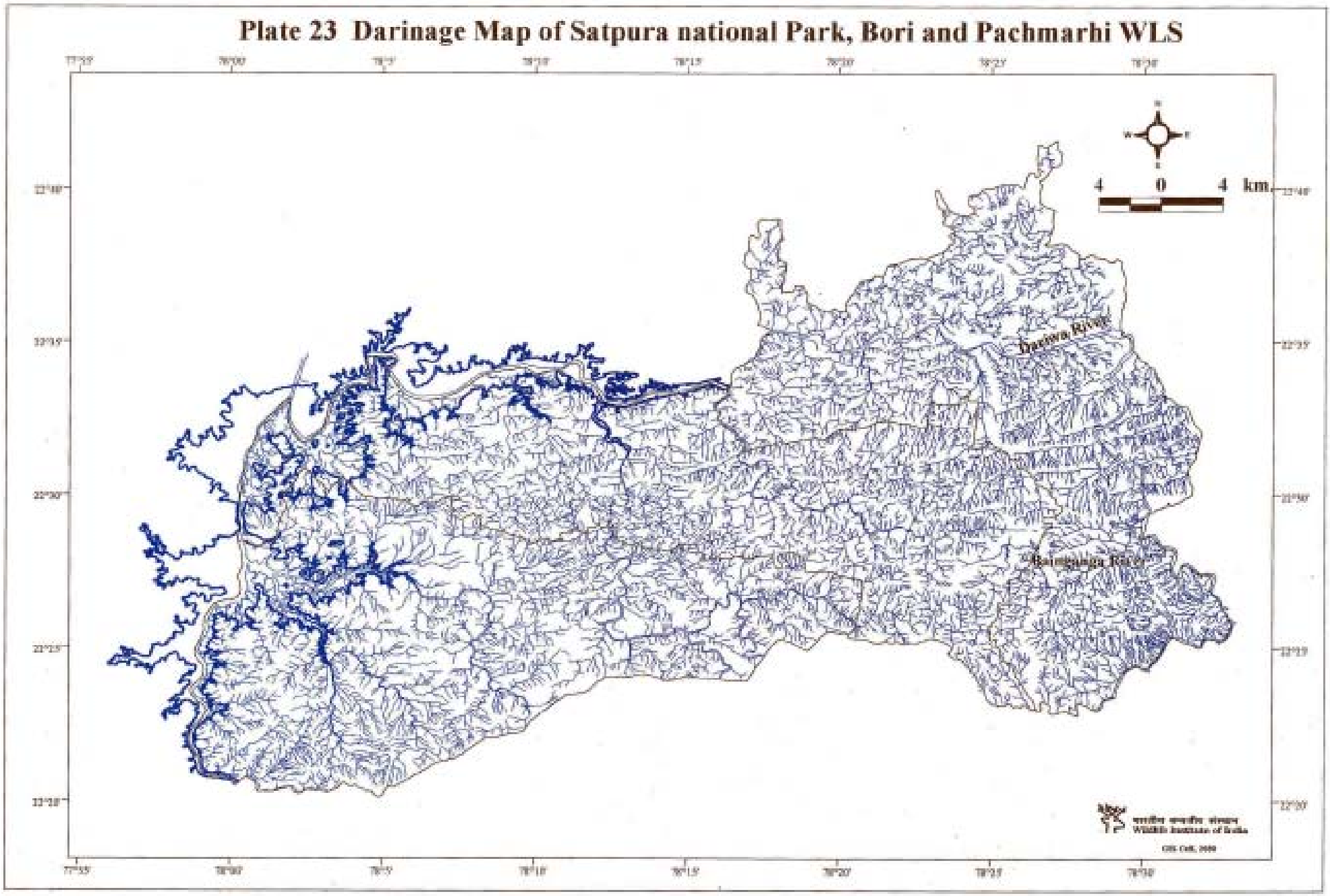


Plate 24 Drainage Map of North,South and West Betul Forest Division in SCA

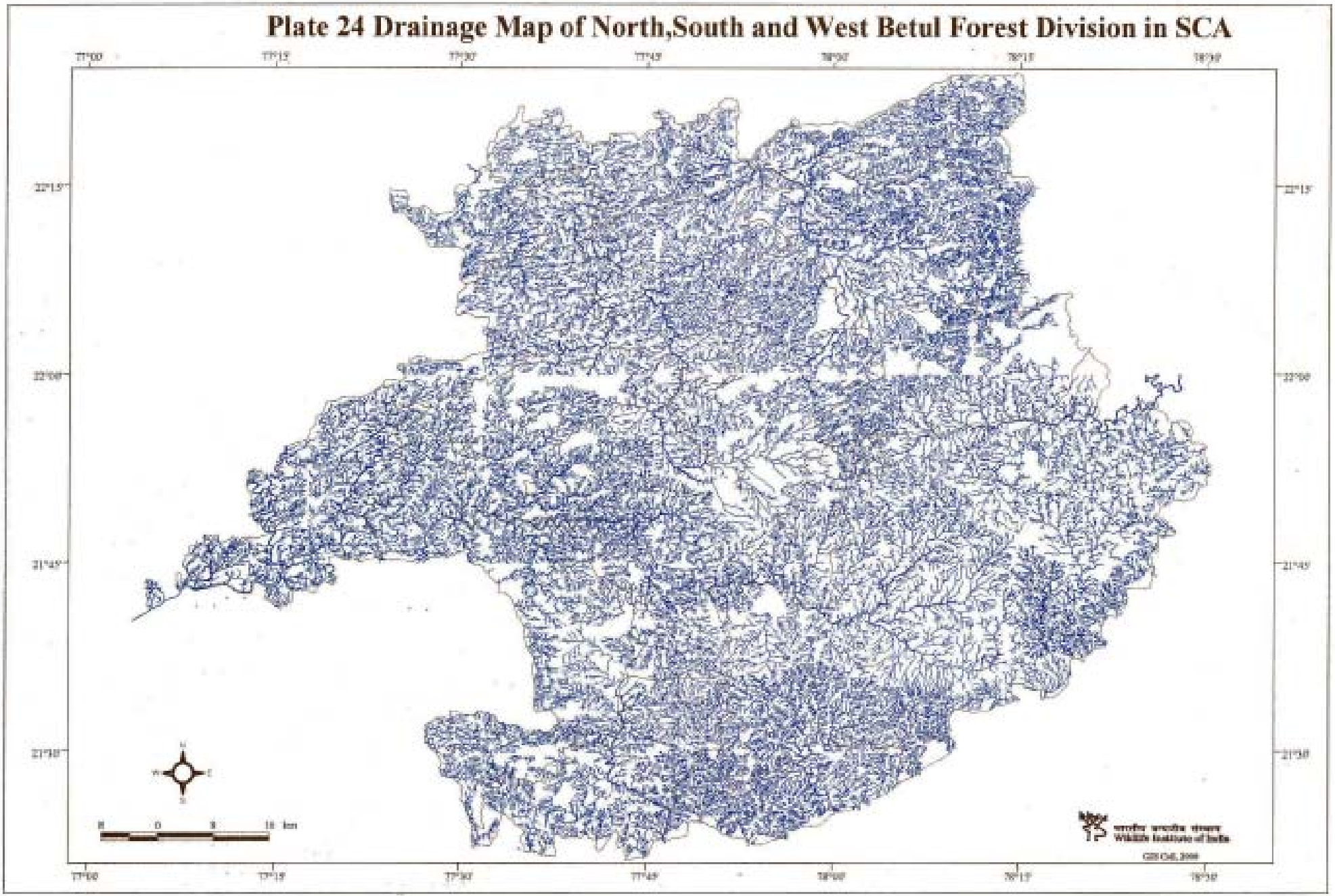
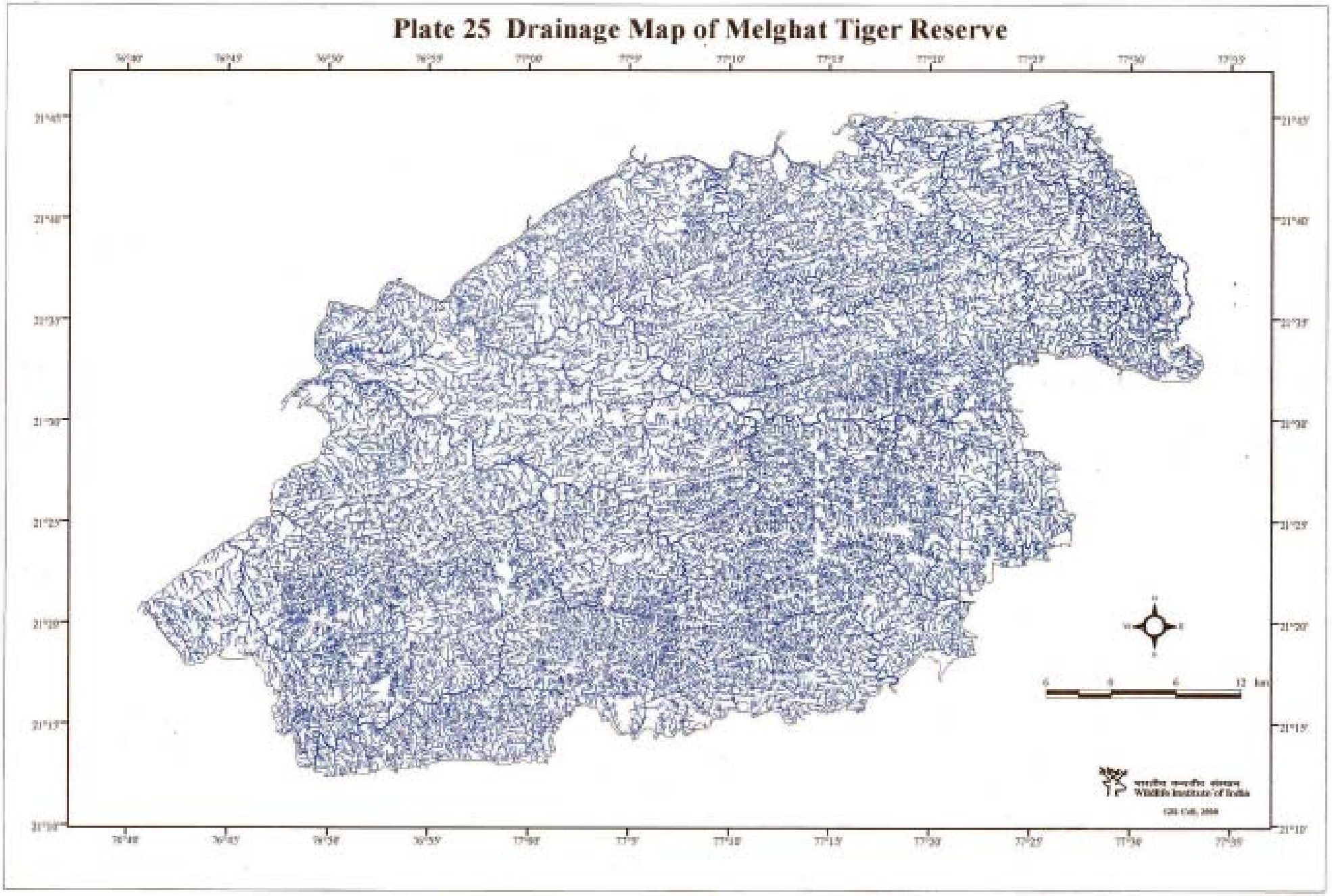


Plate 25 Drainage Map of Melghat Tiger Reserve



Chapter 2 Vegetation

2.1 Champion and Seth's classes:

According to Champion and Seth's' classification the Satpura Conservation Area consists of the following classes:

Group 3B - South Indian Tropical Moist Deciduous Forests -

Subgroup 3B/c1 -South Indian Tropical Moist Deciduous Teak–bearing forests

Subgroup 3B/c2- Southern Moist Mixed Deciduous Forests

Group 4E - Tropical Riparian Fringing Forests

Subgroup 4E/R 5- Riparian Fringing Forests

Group 5A - Southern Tropical Dry Deciduous Forests

Subgroup 5A/c1- Dry Teak -bearing Forests

5A/C1b- Dry Teak Forests

Subgroup 5A/c3- Southern Dry Mixed Deciduous Forests

Subgroup 5B/c1(c)- Dry peninsular sal Forests

5A/E2- *Boswellia* Forests

Group 6 - Southern Tropical Thorn Forests

Subgroup 6A/c1 – Desert Thorn Forests

Group 8A - Central Indian Subtropical Hill forests

Subgroup 8A/c3 – Central Indian Subtropical Hill Forests

2.2 Data and Methodology:

2.2.1 Spatial Database

The spatial database for the entire study site was developed in three phases based on the availability of satellite data and convenience of handling a large database for an area of the magnitude of around 15500 sq.km. The three phases were as follows:

1. BSP PA Complex, Hoshangabad District, MP
2. Betul District., MP
3. Melghat Tiger Reserve, Amaravti District, Maharashtra

2.2.1.1 Remotely Sensed Data

The IRS 1-B LISS II December 1995 satellite data was use for the mapping of the BSP Complex and November/ December, 1996 data was used for the mapping of Betul district. Due to financial constraints data could not be procured for the Melghat Tiger Reserve. The satellite data indented consisted of around 40 Geocoded sheets at the scale of 1:50,000.

a. Initially the Survey of India topsheets of 1: 50,000 scale were procured for the entire study area.

b. A reconnaissance survey was carried out in both the areas which were stratified based on variables like topography, vegetation, disturbance and moisture. Based on this an 'Interpretation Key' was prepared.

c. Base Maps was prepared on tracing films and study sites were delineated along with important features.

d. Based on the interpretation key the Vegetation/ Landuse maps for BSP PA Complex and Betul District were prepared using the technique of 'visual interpretation' of Satellite Images.

e. The BSP PA Complex was considered for intensive study site hence a detailed classification scheme was adopted based on available maps and extensive ground validation. For Betul District a broad level classification scheme was adopted.

f. Midcourse corrections were done as result of ground validations which continued at the field level.

g. The stock maps of the forest department and the field staff served as ground truth for detailed classification apart from the ground work of the field team.

h. Implanting of details based on field observations was done where satellite data did not show distinct tone.

i. Plots were laid in different strata to assist ground validation and for studying the composition of the forests.

j. Final map preparation.

k. Accuracy checks were done before entry into GIS domain.

2.2.1.2 Other Spatial database

a. Map preparation based on forest department stock maps

b. Preparation of Map layers for different themes from the Survey of India toposheets.

c. Preparation of Soil and land use planning maps from the maps of National Bureau of Soil Survey and Land use Planning for Betul and Hoshangabad district.

d. Preparation of Hydro geological map for Hoshangabad District

2.2.2 Geographical Information System

a. The ARC INFO and Arcview softwares were used for the purpose of generating a digital database.

b. The data entry of spatial layers was done by manual digitization.

c. Final map preparation and analysis for area estimates was done.

d. The spatial layers developed were tested for its potential use in development of WHR on spatial scales.

e. Demonstration of database for future utility by field managers.

2.2.3 Field Data

a. Stratified Random Sampling was done and the transect design was prepared which ensured optimum coverage of area.

b. Using the toposheet the feasibility for walking the transects was checked.

c. The transects were marked on the maps in hard copies as well as in the GIS.

d. In all 200 plots were laid and sampled in the Protected Area complex and 400 plots in Managed Forest Divisions (North Betul - 185; South Betul 50 and West Betul - 165 plots). It was ensured through the process of stratification that the plots were established in the areas being managed under different silvicultural systems.

e. The transect length consisted of one km. with 20 mtrs diameter circular plots at a distance of 250 mts consisting of concentric plots of 10 mts and 4 mts diameters for recording different parameter **(Diagram 1,2,3 and 4).**

f. Data recorded in 20 m radius plot

- Tree species along with girth at breast height
- Height of trees (ocular estimates)
- Canopy density

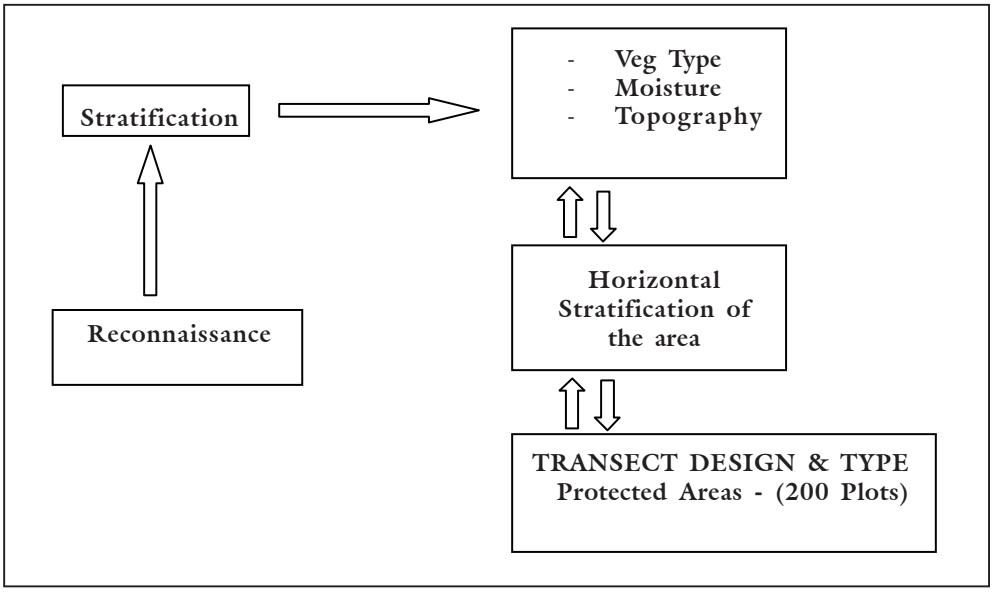


Diagram 1

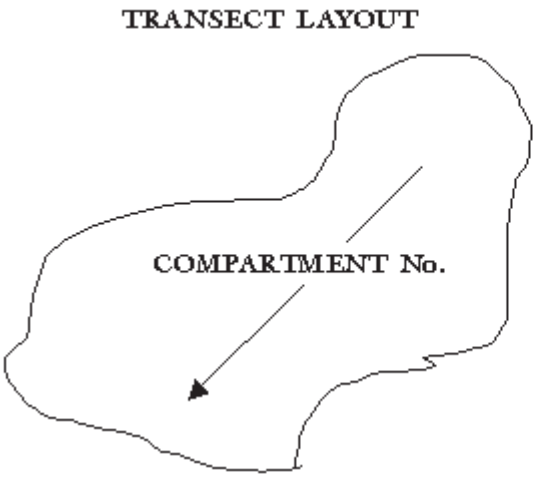


Diagram 2

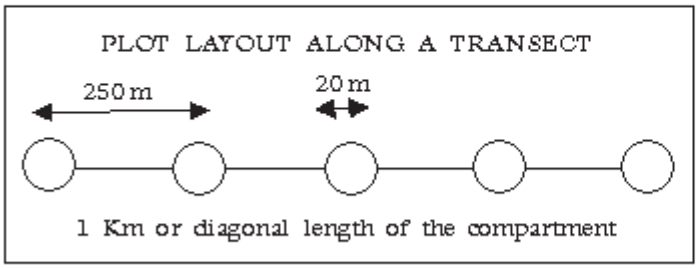


Diagram 3

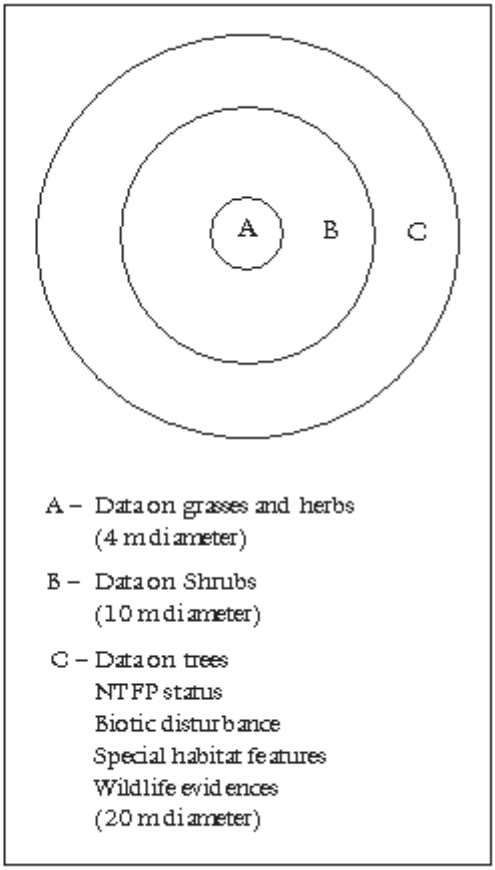


Diagram 4

- Wildlife evidences (indirect)
- Livestock evidences

g. Data recorded in 10m diameter plots
   - Shrub species
   - Shrub cover
   - Regeneration of major tree species

h. Data recorded in 4 m diameter plots
   - Herbs/Herbs cover
   - Grass species
   - Grass cover
   - Regeneration of important species

i. The other parameters recorded were
   - Vicinity to habitations and roads
   - Vicinity to perennial and non-perennial water sources
   - Past system of management
   - Direct human impacts
   - Unique and special habitats

Note- A sample of transect layout in case of Bori Sanctuary has been depicted as an example at Plate 41a.

The data collected on various parameters was with the objective of studying the following:

1. Study the structure and composition of the forests in different strata.
2. Study the impact of various silvicultural treatments on selected timber and NTFP species in order to compare situations in Protected Area and Managed Forests.
3. Assistance in ground validation of the satellite data.
4. Study wildlife distribution in protected areas vis-a-vis Managed Forests.
5. Assessment of the ground cover from the point of view of its availability for wild animal.

2.2.4 Methodology for quantification of fruit production in order to study impact of human activities

Fruit production per tree was estimated by weighing the fruits collected during extraction and adding the estimated weight of fruits left on a tree. To calculate weight of fruits left on the tree after extraction, the number of fruits left on a tree were counted, and the number of fruits in 1kg were also counted. Then the weight of one fruit was deduced from it. Methods of collection were also ascertained by direct observation. Collection took place in a large area. The area being very large and manpower being limited, only some data could be collected by direct observation. To overcome the problem of low sample size, the houses of collectors were visited during the collection season and their collection weighed. The collected products were then traced back to the trees from where they were collected and the amount left on the tree too was estimated. Data for many gbh classes was still not covered, so a third method was employed. Intensive search of un-extracted, missing gbh class trees was carried out and professional collectors including the field assistants were asked to harvest some of these trees. A market survey was also done to ascertain how much of the produce had reached the market in the current as well as previous years. Some of the products were being sold through Forest Protection Committees (FPCs) and hence their registers were also consulted.

For estimating fruit production per tree, of "*Achar*" (*Buchanania lanzan*) data was collected by direct observations at the time of extraction. Trees of desired gbh were selected before the harvesting season started and during the collection period, fruits collected from these trees were weighed on the site.

Similarly, for *mahua* (*Madhuca indica)* too, production data was collected for both flowers and fruits (*gulli*). In case of *harra* (*Terminalia chebula*) and *bahera* (*T. belerica*), no data could be collected

as trees were isolated and rare except for Kukru in Bhainsdehi range of South Betul division. However, the information of the NTFP was collected from office records of the Managed Forest Divisions.

Damage done to the individual trees during collection i.e lopping and felling was also recorded. Data regarding the methods of processing of collected NTFP was obtained by visiting and interviewing the collectors at their residence.

For non-timber forest products, 50 additional plots (10 m diameter) were sampled around the tree being sampled for getting information on seed bank, regeneration, weeds, predation, fires etc. Trees sampled included major NTFP species (different girth classes) of each. Information on fruit/flower production by tree, fruits extracted, percentage lopping and cutting was also collected.

2.2.5 NTFP (production and extraction data)

The following facts were assumed in quantifying production of fruits and flowers

1. Production per tree excludes the produce (fruits and flowers) that might have been consumed by wild and domestic animals prior to harvest.
2. It also excludes the produce that might have fallen on the ground before harvest.
3. Production for similar g.b.h. class in all strata will be more or less same.

2.3 Mapping of the Study Area

2.3.1 Vegetation Maps

A detailed classification scheme was adopted while interpreting the satellite data using forest department stock maps and collection of fiield data for ground truthing. It is possible to group the detail classes and correlate them with the Champion and Seth's Forest Types.

The Vegetation map of the BSP Complex and the three Managed Forests Divisions of Betul has been prepared using remotely sensed data IRS IB LISS II December 1995 and Novembe/ December 1996 respectively at a scale of 1: 50,000 (**Plate 26** and **Plate 40**). Satellite data could not be procured for the remnant division of Hoshangabad and Melghat Tiger Reserve for want of funds.

The Satpura Protected Area Complex (BSP Complex) is a cluster of three protected areas covering an area of 1427 sq km (**Plate 3**). This area was considered as an intensive study site for mapping hence a detailed classification scheme was adopted which was supported by a strong ground data component, forest stock maps (4" = 1 mile scale) and knowledge of frontline staff. Wherever certain categories were not possible to be delineated from the satellite data, information was implanted. Of the forty three landuse/landcover classes delineated from IRS-1B LISS II FCCs, Mixed Miscellaneous was the most dominant (30.57 %) and consisted of five sub-classes which were: (Type 5A/c1 Dry Teak bearing Forest and Type 5A/c3 Southern Dry Mixed Deciduous Forests). In the following Vegetation/ Landcover Classes, there are three density classes namely >60%, 30 to 60 % and < 30%. The figures in the bracket indicate percent geographical area under that category.

1. Mixed miscellaneous with density more than 60% (14.03),
2. Mixed miscellaneous with density between 30 and 60% (5.53%),
3. Mixed miscellaneous with density less than 30% (3.68 %),
4. Mixed miscellaneous interspersed with bamboo more than 50% (5.75%), and
5. Mixed miscellaneous interspersed with bamboo less than 50% (1.58 %).

The next dominant class was found to be Teak (22.37%) consisting of ten subclasses: (Type 3B/c1 Moist teak bearing forest andType 3B/c2 Southern moist mixed deciduous forests – C&S).

1. Teak mixed more than 60% (1.73%),
2. Teak mixed between 30 and 60% (3.2%),
3. Teak mixed less than 30% (0.62 %),
4. Mixed teak more than 60% (6.47%),
5. Mixed teak between 30 and 60% (7.71%),
6. Mixed teak less than 30% (1.5%),
7. Teak mixed with bamboo more than 50% (0.11%),
8. Teak mixed with bamboo less than 50% (0.05%)
9. Mixed teak with bamboo more than 50% (0.8%),
10. Mixed teak with bamboo less than 50% (0.18%).

Sal (Type 5B/c1c Dry peninsular sal forests) was a category restricted to a patch near Pachmarhi (6.64 %) and had 12 sub-classes:

1. Sal more than 60% (0.33 %),
2. Sal between 30 and 60% (0.29 %),
3. Sal- less than 30% (0.36 %),
4. Sal-mixed more than 60 %(1.29%),
5. Sal Mixed between 30 and 60 % (1.03 %)
6. Sal-mixed less than 30%,(0.18 %)
7. Mixed-sal more than 60% (0.63 %),
8. Mixed-Sal between 30 and 60% (1.1 %),
9. Mixed-Sal less than 30 % (0.3%)
10. Sal mixed with bamboo more than 50% (0.53%),
11. Mixed Sal with bamboo more than 50% (0.34%),
12. Sal Mixed with bamboo less than 50% (0.14%), and
13. Mixed sal with bamboo less than 50% (0.12%).

Scrub/Savanah and Riparian (Type 5 DS2 Dry Deciduous Scrub and Subgroup 4E Tropical Riparian Fringing Forests).

1. Scrub/savannah (9.92 %)
2. Riparian (0.55 %)

Besides these major categories constituting 28 out of 43 categories, there were other categories (Non Champion and Seth) that were lesser in extent, but are equally important as wildlife habitat components.

These are:

1. Grasslands- dry (5.05 %)
2. Grassands moist (0.77 %),
3. Bamboo more than 50% (0.32%),
4. Bamboo less than 50% (0.22%),
5. River course (1.03 %),
6. River sand with grasses (1.53%),
7. Water bodies (11.33 %),
8. Rocky outcrop with grasses (0.66 %),
9. Rocky outcrops with scrub (3.12 %),
10. Bare rocky outcrops (1.22 %),
11. Village/habitation (4.05 %),
12. *Lantana* infested areas (0.07%) and
13. Plantations (0.58%).

The stock map has two site qualities mapped *viz.* Teak and Mixed miscellaneous (**Plate 28**). The site quality categorization follows as SQI, SQII, SQIII, SQIVa, SQIVb, SQVa and SQVb. Site quality I signifies the best site and IVb as the poorest. Maximum area is occupied by site quality IVb (44.54%) followed by IVa (25,48%) Site quality I and II have low representations. Varying age classes are represented in the mapped area. The maximum area falls under middle-aged forest (48.43%) followed by young-aged forest (23.36%) and old-aged forest (18.19%)(**Plate 29**) All the unclassed categories constitute 10% of the area *viz* Clear-felled areas, poorly stocked areas, non-forest areas *etc.* The Coppice with Reserve was found to be the most extensive of the working circles which had an objective to meet the small timber demand

of the local people as per the lastest Working plan (32.70%) followed by Protection-cum-Preservation Working Circle to prevent soil erosion mostly on hilly and fragile areas (19.45%) and General teak (9.43%) and Special Teak Working Circles (8.41%), these being high forest areas (**Plate 30**). The compartment map of the BSP Complex and Betul and Melghat TR have been used as management units since they have well defined and marked boundaries (**Plate 31, 32 and 33**). The allotment to different working circles of Betul Managed Forest Divisions can be referred to at **Plate 34.**

Habitations class basically consists of revenue villages, forest villages, abandoned villages and townships. As regards occurrence of bamboo, about 79% of the area is non-bamboo and of the remaining 21%, 2% is covered by site quality III, followed by site quality II covering an area of 11% and unclassed bamboo covers 8% of the area (**Plate 35**). Plantations are mainly restricted to the Bori sanctuary occupying an area of 9.10 sq km. Almost all the plantations consist of Teak, barring a few which consist of bamboo (**Plate 36**). *Lantana camara* occurs in some of the open areas subjected to biotic disturbance.

- *Lantana* infested areas (0.07%) and
- Plantations (0.58%).

The map with detailed vegetation classification (**Plate 26**) was later on clubbed up into 16 broad level classes and a map was generated in GIS (**Plate 27**) The objective of the clubbed map was to see how the associated classes are spaced out on spatial scales and to have a broad level idea of forest connectivities.

The Betul District (10,043 Sq Kms as per Revenue Records), which was taken up for mapping was considered as an extensive study site hence a broad level classification scheme, was adopted since the area was large. The visual interpretation of Betul district has been done on 1: 50,000 scale. As regards Vegetation/ Land use Map prepared by visual interpretation of IRS 1B LISS II (November-December-1996) for Betul District (**Plate 40**) two vegetation classes emerged to be dominant with a marginal difference. They were Teak Forest with Teak more than 50% covering an estimated area of 13.21 % and the Mixed Forests 13.85 %. The detailed classification of these two classes is as follows

a. **Teak Forests** (Type 3B/c1 Moist teak bearing forest and Type 5A/c1 Dry Teak bearing Forest)

Teak Forest	**%**
Teak Mixed Open Forest (Densitty <50%)	5.85
Teak Mixed Closed Forest (Densitty >50%)	7.01
Moist Teak Forest	0.35
Total	13.21

b. **Mixed Miscellaneous Forests** (Type 3B/c2 Southern moist mixed deciduous forests and Type 5A/c3 Southern Dry Mixed Deciduous Forests)

Mixed Forests	**%**
Mixed Open Forest (Densitty <50%)	7.38
Mixed Closed Forest(Densitty >50%)	5.99
Moist Mixed Forest	0.48
Total	13.85

2.3.2 Other classes

A very small area of .08 % is covered by Salai Forests (Type 5E2 Boswellia Forests) these are nearly pure forests of Salai. One very important class from ecological sensitivity point of view is the Riparian Forests (Subgroup 4E Tropical Riparian Fringing Forests) which covers 0.44 percent of the area. Another important class Bamboo Forests covers an area of 0.94%. Degraded forest accounts for 6.12% of the area indicating heavy disturbance and biotic pressure. Plantations occupied 2.38% of the area. However, it was not possible to delineate old plantation whose tone on satellite imageries merged

up with the natural forests. The scrub lands (Type 5 DS2 Dry Deciduous Scrub) covers an area of 4.71%.

The most dominant classes amongst the overall classification of Betul District (including non Champion and Seth Classification) have been found to be 'Habitation interspersed with agriculture and fallow' covering an area of 29.26% followed by 'fallow with agriculture' 13.65%. The area occupied by other non-Champion and Seth Classes was 15.34%, details of which are as follows:

2.3.3 Non-Champion and Seth Classes

Non-Champion and Seth Classes	%
Rocky Outcrop Interspersed With Scrub and Grasses	3.26
Agriculture	1.84
Grassland	1.27
Habitation	2.07
Fallow	1.62
Water/River, Coarse	1.58
River Sand Interspersed With Grasses	0.02
Habitaion Interspersed with Agriculture	3.05
Revenue Tree Land	0.63

It was observed that 51.49% of the landuse in Betul district consists of habitations, fallow and agricultural lands, all together and 37.04% land is occupied by various kinds of forests including degraded forests and scrubland separately consituting 4.71% of the total area. This necessarily does not mean that it is the acutal tree cover that makes up that 37.04%.

The area estimates of the different vegetation/ landuse map in the BSP Complex and Betul district are appended.

2.4 Floral Characteristics of the area:

The BSP area is composed of teak and miscellaneous forests ranging from moist to dry teak. The Eastern part of the Bori sanctuary falls in the moist teak areas. The species in the upper storey here are: *Tectona grandis, Terminalia tomentosa, Adina cordifolia, Lagerstroemia parviflora, Lannea coromandalica, Diospyros melanoxylon etc*. Those in middle storey are *Schleichera oleosa, Carreya arborea, Chloroxylon swietenia, etc. Dendrocalamus strictus, Helicteris isora, Lantana camara etc.* form the shrub layer while the grass and herb layer is composed of *Cassia tora, Themeda quadrivalvis, Dichanthium annulata, Milletia auriculata, Bauhinia vahlii etc.* Remaining part of the Bori sanctuary and Satpura National Park fall under slightly moist teak forests. The composition is almost the same as the moist teak forests.

Moist miscellaneous forests are found in cool sheltered damp depressions and consist of *Mangifera indica, Ficus spp., Terminalia belerica, Syzigium cumini, Mallotus phillipensis etc.* Dry miscellaneous forests consist of species like *Terminalia tomentosa, Anogeissus latifolia, Chloroxylon swietenia, and Lannea coromandalica, Boswellia serrata, Soymida febrifuga, Hardwickia binata,* and also *Tectona grandis.*

Dry peninsular sal forests is spread over the Pachmarhi plateau and include *Shorea robusta, Chloroxylon swietenia, Terminalia sp., Buchnania lanzan, Madhuca indica, Mallotus phillipensis, Emblica officinalis, etc*. The shrub layer includes *Dodonea viscosa, Holarrhaena antidysentrica, Phoenix acaulis, etc. Dendrocalamus strictus* occurs in the entire Bori reserve. *Bambusa polymorpha* (exotic species) also occurs in compartment no. 40 as a preservation plot.

In Betul Managed Forests the dominant species is teak or *Tectona grandis* which ranges between 20 and 60% of the crop and in some places even 80%. Its quality ranges between MP quality III to IVa. The crop is mainly middle-aged with density 60 to 80%. Blank and under-stocked patches are very common and regeneration is insufficient. Miscellaneous species in the top canopy include *Terminalia tomentosa*, *Anogeissus latifolia, Boswellia serrata,*

Emblica officinalis, Lagerstroemia parviflora, Pterocarpus marsupium, and Soymida febrifuga. Middle canopy consists of *Emblica officinale, Butea monosperma, Grewia tillifolia, Zizyphus xylopyra, Bridelia retusa* and *Ougeinia oojeinensis*. Bamboo is found in the Amla range. The main shrub species are *Lantana camara, Helicteris isora, Grewia hirsuta, Dodonea viscosa, Woodfordia fruiticosa,* and *Vitex negundo*. Grasses include *Dichanthium ciliaris, Saccharum spontaneum, Ischaemum laxum,* and *Cymbopogon martinii*. *Butea superba, Bauhinia vahlii, Acacia torta, Ventilago calyculata etc*. are the main climbers. Kukroo area has *Terminalia belerica* and also old coffee plantations.

The Melghat forests are typical dry deciduous forests of Central India. They can be divided into Dry teak-bearing forests and Southern dry mixed deciduous forests. The dominant species is teak or *Tectona grandis* whose percentage ranges between 30 and 70 and in some places even 80. Miscellaneous species in the top canopy include *Terminalia tomentosa*, *Anogeissus latifolia, Boswellia serrata, Emblica officinalis, Lagerstroemia parviflora, Pterocarpus marsupium, and Soymida febrifuga*.Middle canopy consists of *Emblica officinalis, Butea monosperma, Grewia tiliaefolia, Zizyphus xylopyra, Bridelia retusa* and *Ougeinia oojeinensis*. The main shrub species are *Lantana camara, Helicteris isora, Grewia hirsuta, Dodonea viscosa, Woodfordia fruiticosa,* and *Vitex negundo.* Grasses include *Dichanthium ciliaris, Saccharum spontaneum, Iseilema laxum,* and *Cymbopogon martinii*. *Butea superba, Bauhinia vahlii, Acacia torta, Ventilago calyculata etc*. are the main climbers.

2.5 Species and communities of conservation importance:

The area around Pachmarhi *viz.* Jalgali and a few other areas are rich in insectivorous plants like *Drosera* and also rare pteridophytes and bryophytes like *Psilotum sp., Cythea sp., Osmunda sp., Lycopodium sp. etc. Convolvulus flavus* listed as a rare and threatened species for peninsular India has been collected from the Chikhalda range. *Utricularia,* an insectivorous plant is represented by *Striatula* spp. only on wet rocky cliffs along Belkund stream. *Drosera indica* is another insectivorous plant on the upper plateau which is becoming rare. The orchid flora of the reserve is interesting but has not been thoroughly explored. *Vanda tessellata* is common and occurs on variety of trees in almost all areas. *Aerides maculosum* occurs mostly on *Mangifera* trees in and around Semadoh. The terrestrial species of orchids *Habenaria grandifloriformis* and *H. roxburghii* occur in open situations at higher elevation; whereas *H. plantaginea* is fairly common on moist hill slopes throughout the reserve. Variety of bryophytes and pteridophytes in Melghat is much less; probably due to long dry periods.

Species common to the Western Ghats found in the Melghat Tiger Reserve are *Strobilanthes callosus* especially found on steep slopes and *Ceropegiaus* Spp. which was supposed to be occurring only in Western Ghats is found in moist localities in Melghat. Other semi evergreen tree species occurring are *Mallotus philipinensis, Trema orientalis, Kydia calycina, Zizyphus rugosa* etc. *Zizyphus rugosa* (churni, Saleri) which is rare, is abundant on the Chikhaldara plateau. There is village '*Churni*' and river '*Saleri*' supposed to have been named after it.

Other unique and rare species recorded by Witt in 1935 are *Firmiana colorata* on steep slopes of high hills, *Ailanthus triphysa*, few tree on Chikhaldara plateau, *Spondias mangifera*, restricted to Koktu valley and *Litsea monopetala*, restricted to the Semadoh valley. Another species *Radermachera xylocarpa* (*Tetumia*)(*Khadsingjhi*), thought to be rare, is abundant on Chikhaldara plateau, in fact there is a village bearing the name *Tetu*

The Indian Bison (Gaur) and Sambar form an important prey base for the tiger. Especially in Melghat the prominent species associated with habitats for Gaur and Sambar are as follows:

a. *Securnega virosa* (Pithondi)- It is a large shrub which gets new foliage in May, the pinch period, when browse is not available easily.

Gaur is usually found in Sucurnega areas namely Harisal, Chaurakund, Kolkaz and Malur areas.

b. *Heteropogon ritchiei*- It is a tall grass around 10 to 12 ft. growth, which is palatable and highly nutritious. A positive relationship of it has been established with Gaur distribution.

c. *Milletia auriculata*- A climber in habit, its tender shoots in early season are browsed by Gaur.

d. *Helicteris isora*- A shrub in habit serves as good nutritious fodder and bears positive association with distribution of Sambar.

e. *Clitoria biflora*- A leguminous herb abundantly occurring in ungrazed and low grazed areas (cattle grazing) away from villages. This species is certainly browsed by wild herbivores.

A special survey of grasslands on Pachmarhi Plateau was conducted with the help Shri M.M. Babu, Herbarium Technician, Wildlife Institute of India, Dehradun, titled "Vegetation Survey Of Grassland Outside Pachmarhi Wildlife Sanctuary". A list of species with their habits and status is appended as Appendix III (a).

2.6 Succession and disturbance process:

The primary sere on new riverain soils passes through a drier deciduous phase and may lead to a semi-evergreen post-climax of considerable stability. The secondary seres are more xerophytic and tend to resemble dry deciduous forest (Champion and Seth, 1965).

It is also seen that due to the rise in the water table on account of creation of the Tawa dam, there has been increase in the palatability of *Aristida* and other species, which were lower on the palatability scale earlier.

2.7 Temporal and spatial natural succession:

The teak plantations done about 100 years ago have now changed into miscellaneous forests with a low proportion of teak in the Bori sanctuary area. Teak and other species of the dry deciduous teak forests begin to appear with a rainfall of over 700mm. Two series of vegetation are recognized in these teak forests: Anogeissus-Terminalia-Tectona series with rainfall 700-1100mm and Tectona-Terminalia series where rainfall exceeds 1100mm. There are many species which are common to the above two types, however there may be some species exclusively restrictive to a particular type. In the Gawilgarh Hills where the Melghat Forests are situated, frost damage is caused to young regeneration which is open and have been once under cultivation or adjoining to cultivation. Usually no damage occurs to the forest, which is well stocked unless the frost is severe. Teak is most susceptible to frost damage. Other associated species occurring in the area are *Terminalia tomentosa*, *Grewia tiliaefolia, Butea monosperma*, the other species *Acacia catechu* and *Ziziphus mauritiana* are quite resistant to frost. Damage by frost is confined to tender shoots which get killed. In exceptional cases severe frost may also kill saplings and may result in damage to the crowns of old trees. In badly affected areas, teak trees are usually forked, branched and malformed. If such areas are cleared the tree growth gets obstructed and the areas get reduced to open savannahs. In Melghat most of the high level plateaus were under shifting cultivation for a long time (Gaussen *et al*). These areas have also been under stocked on account of high winds, frost and shallow soils. The seral stages encountered are:

a. Open Forests.

b. Scub-woodland, closed thicket and discontinuos thicket where grazing is excessive. Palatable species get eliminated due to browsing and grazing of herbs and grasses respectively. The risk of fire in such areas is minimized due to lack of inflammable material.

c. Savanna-woodland, tree savanna and shrub savanna, if fire is an important factor influencing. In such areas occurrence of fire will usually favour growth of tall grasses very typical of savanna formations.

d. Low scattered shrubs.

e. Tree pseudo-steppe, shrub pseudo-steppe in Anogeissus- Terminalia- Tectona series (Gaussen *et al*).

The physiognomic type in Anogeissus-Terminalia –Tectona series occurring in parts of Hoshangabad forests seems to have derived itself from dense forest which might have been subjected to over exploitation of the the upper tree storey or due to invasion of shrubby species on the ground cover. Hence this type consists of groups of trees separated by shrubby under growth in the form of thickets. The degraded stages of forests in case of Anogeissus- Terminalia- Tectona series and the Tectona- Terminalia series are floristically much closer to each other than the forest and open forest stages (Gaussen et al).

Savanna woodland and Tree savanna-

This type is a result of probably ancient practice of shifting cultivation, annual fires which prevented complete closure of the canopy. The trees are usually of 10m in height and density may be between 0.2 to 0.4. Fire resistant species of the forest stage also exists here. In case of the tree savanna the species encountered are almost the same as savanna woodland but the physiognomy differs in having more distantly spaced and scattered trees. The floral composition of savanna woodland and Tree savanna may be described into three categories: tree layer shrub layer and ground cover.

Tree Layer-

Tectona grandis, Anogeissus latifolia, Diospyrous melanoxylon, Terminalia tomentosa, Lagerstroemia parviflora, Madhuca indica, Soyamida febrifuja, Emblica officinalis, Buchnania lanzan, Cassia fistula, Bauhnia racemosa, Ougeinia oojeinensis and *Grewia tilieafolia*.

On skeletal soils *Boswellia serrata, Sterculia urens, Chochlspermum personatum* etc are dominant.

Chloroxylon switenia, Gardenia latifolia, Bridelia retusa, Stereospermum personatum etc occur in *Tectona –Terminalia* series while as *Hardwickia binata, Albizzia amara Clerodendron phlomidis* etc. occur in *Anogeissus-Terminalia – Tectona* series.

Shrub Layer-

The scattered shrubs found are *Acacia chundra, Acacia leucophloea, Ziziphus mauritiana, Ziziphus xylocarpa, Ziziphus oenoplia, Wrightia tinctoria, Holarrhena antidysentrica, Flacourtia indica, Woodfordia frutiosa, Carissa congesta, Grewia flavescenes* etc

Ground Cover- Grasses namely *Heteropogon contortous, Themeda triandra, Themeda quadrivalvis, Dicanthium annulatum, Schema nervosum, Cymbopogon martini, Andropogon pumilis, Chloris barbata* etc. Some herbs like *Cassia tora, Indigofera cordifolia, Crotolaria medicgenia* etc are found interspersed with grasses.

Shrub Savanna-

These are the areas, which have been subjected to fires, rampant grazing and excessive hacking. Here trees have altogether disappeared and have been reduced to a stature of shrubs. Because of the property of coppicing, *Tectona grandis* persists even in degraded state. *Butea monosperma* and *Diospyrous melanoxylon* increase in proportion to biotic distubance (Misra and Joshi, 1952). The major bulk of bidi (country cigarette) leaves come from the root suckers and young coppices of *Diospyrous melanoxylon* and not from grown trees. Their abundance as coppices in wastelands and the trees being found degraded, thus is explained (Working Plan, Hoshangabad Division) In case of *Butea monosperma* and *Diospyrous melanoxylon* biotic pressure is helpful in the sense that damage to the root system strongly stimulates production of root suckers (Champion and Seth, 1965) The other ligneous species existing are *Azadirachta indica, Acacia leucophloea, Ziziphus mauritina, Ziziphus xylocarpa, Ziziphus numalaria Carissa congesta* etc.

The grass cover comprises *Heteropogon contortus, Apluda mutica, Cymbopogon martini, Sehima nervosum, Sehima sulcatum, Dicanthium annulatum, Dicanthium caricosum, Themeda quadrivali, Seteria glauca, Ischaemum pilosum*. Pandeya (1952, 1961, 1962a, 1964) has given a good account of the grasslands of Madhya Pradesh. In the regions of heavy rainfall he has distinguished *Andropogon pumilus* and *Heteropogon contortus* type grasslands

2.8 Fire:

The area being largely a dry deciduous area is subjected to fires almost each year. Due to the highly combustible undergrowth consisting of a dense mass of dried grass and dried twigs of *Lantana*, a tiny spark can trigger off a big fire in a short time. As the forest areas are thinly populated, the labour is in short supply. The high hot winds during summer combined with the hilly configuration of the land, spreads fire easily when it occurs, and engulfs vast areas before it can be brought under control only by counter-firing.

Fires in the forests in study area are frequent inspite of the necessary precautions undertaken by the Department. Fire is a biotic factor as it is mostly caused by, man's activity. The moist areas in Bori and some parts of north Betul are comparatively less affected. The natural fires due to lightening are rare. It can be inferred that apart from the climatic, edaphic (including topographic and available soil water), fire is an important factor determining the plant species diversity and community structure in the tract. Several of the forest compartments get burnt up in one or the other year. It is a surface fire sweeping over the ground surface rapidly. The flames consume litter, living shrubs and scorch the base of trees it may encounter and its intensity varies. It may assume larger dimensions because the ground is covered by sizeable litter of the dried grasses and monsoon herbs, dropped leaves of the deciduous tree species and the occurrence of thickets of shrubby species like those of *Lantana camara, Colebrookia oppositifolia, Securinega virosa, Clerodendron serratum, Pogostemon plectranthoides, Nyctanthes arbot-tristis, Vernonia divergens, Indegofera cassioides, Eranthemum roseum* etc.

Fire fighting in Melghat, parts of north Betul and west Betul and parts of BSP PA complex which are hilly is a very hard task because of the very difficult terrain, paucity of plentiful water reservoirs and the thickets of bushy species. As regards fire sensitivity it appears that majority of the plant species as per the floristic component of Melghat Tiger Reserve are fire tolerant i.e. pyrophytic. Both animal and plant life have to face the fire hazard. However, there is a fundamental difference between the two forms of life in animals having the capacity of mobility, whereas, the physiology of a plant is such that it is to be permanently fixed in soil. Thus nature has gifted animal life with locomotion capacity to tide over the unfavourable circumstances or stressful situations in environment, but the plants are compelled to face adverse conditions where they are.

The floristic composition of Melghat Tiger Reserve show the existence of about seven hundred well naturalized plant species of flowering plants. Out of these about 100 species belong to the tree category, about 150 species are woody or herbaceous perennials or shrubs, 45 species as perennial grasses and the remaining four hundred species are annual herbs including fifty species of annual grasses. Thus as expected the annual herbaceous species numerically constitute the major proportion of the diversity in floristic composition.

The vegetation of Melghat Tiger Reserve is tree dominated. Anderson and Brown (1986) have explained how fire might function as a stabilizing mechanism within community dominated by trees. Further, more, it has been demonstrated that fire can act as a stabilizing or destabilizing force in such communities. They define community stability to be the approximate maintenance of species compositon and abundance and community structure over time, which depends upon the response of species to

burning. Abrahamson (1986) points out that the overall impact of fire on vegetation is interpreted in three ways (i) Deccelaration of the process of succession to an earlier stage, (ii) accelerating succession by breaking up a relatively stable association and (iii) considering fire as a natural environmental feature where past selective episodes involving fire have created species that are not seriously upset by fire. It appears that the impact of fire on the vegetation and floristic composition of Melghat Tiger Reserve belongs to the third category and it might not be that important factor in changing the species diversity. The situation is more or less the same in major part of SCA. Fire might have certain other effects such as lowering down the number of less fire tolerant species or helping in giving advantage to certain herbaceous species like *Clitoria biflora, Truiumfetta rhomboidea, Lagasca mollis, Hyptis suaveolens, Blainvillea acmells, Acanthospermum, hispidum, Cassia tora* etc. by removing less fire tolerant species from competition.

Abrahamson (1986) has stated that there is precedence in the ecological literature for his results, where fire has very less effect on the composition of vergetation. The earliest partial published record for flora of Melghat is by Witt (1911 and 1916). Witt listed about 40 fodder grasses found in Melghat in 1911. Dhore and Joshi listed ninty eight grasses from Melghat Tiger Reserve in 1988. Almost all the grasses listed by Witt occur in Melghat even after seventy five years since earlier recorded. Similarly, Witt (1916) listed the occurrence of 353 naturalised plant species in Melghat and the bordering plains whereas Patel (1968) decribed 409 species from the same territory. Dhore and Joshi (1988) in the publication, "Flora of Melghat Tiger Reserve" have listed about 650 naturalised species. Fifty additional flowering plant species have been identified since 1988. As compared to the two earlier floristic works mentioned above, Dhore and Joshi did not notice the occurrence of about thirty species. Some of them have been reported as rare by Witt or growing in specific habitats, some of the speices might have been eliminated from the habitat for which the causes can be other than fire or the habitats of their occurrenc might not have been visited.

Majority of the plant species that are naturalized in Melghat are either fire tolerant or got acclimatized to the conditions. Herbaceous perennials, shrubs and woody climbers suffer temporary injury. Most of these plants have underground perennating organs such as rhizomes, tubers, corms or the root stock. The perpetuation buds do not suffer lethal damage due to surface heat. Occasional fires in course of time might have led to the abundance of species like *Curcuma pseudomontana, Dioscorea* spp. *Milletia auriculata, Peuraria tuberosa* etc. certain ferns like *Adoanmtum lunulatum, A. phillipense, A. incisum, Athyrium* sp. etc. All these plants show sprouting immediately after the first good monsoon showers and appear above ground. The same is true for the perennial grasses.

Several perennial shrubby or woody climbing forms die down to the base leaving the perennating rootstock inside the ground as the summer approaches. Examples of this kind are *Cissampelos parries, Hemidesmus indicus, Flemingia bracteata, Orthosiphon rubicundus, Barleroa* spp. etc.

Density of tree species is quite good in several localities, however, most of the tree species shed their leaves quite early i.e. before the onset of real summer from March onwards. Hence, magnitude of crown fire traveling from the canopy of one plant to another is very less or negligible. Fires in Melghat forest and other parts of the study area mostly occur from January onwards to May end. The grass species and majority of the other herbaceous annuals dry up by November end after completing their life cycle. Thus abundant seed formation by most of the annual species is successfully carried out. Certain quantity of seeds of different species get worked into the surface of the soil and germinate intermittently for some years. In this way the annual herbaceous component is not much harmed. It has been observed that the fruit walls or seed coats of several herbaceous species mostly legumes such as *Clitoria biflora, Cassia tora, C. mimosodies, C. absus, Indigofera* spp., *Desmodium* spp., *Triumfetta* spp.

etc. are very hard and may not get sufficiently charred by surface fire to the extent of losing their viability. Such plants are common in many localities and appear year after year. Nearly all the annual herbaceous species might possess the same mechanism for persistence.

It may be unjustified to derive a conclusion that certain shrubs like *Clerodendron infortunatum, Glochidion velutina, Embelia ribes, Maesa indica, Litsea glutinosa* etc. are also fire tolerant because they also occur in locations which do not experience fire. The same is true for certain shrubs which occur in moist valleys and river beds such as *Syzygium heyneanua, Homonoia riparia, Rhabdia lysioides, Tamarix gallica, Maesa indica* etc. (Dhore and Wankhede,1992).

2.9 Grazing:

2.9.1 Maharashtra:

As per the grazing policy enunciated by the Govt. resolution No. MFD 1365/132211 dated 6/12/78 based on functional classification, permissible grazing incidences indicated are 10, 3, 2 and 1 acres per unit for protected forest, tree forests, miscellaneous forests and pasture lands respectively. Grazing incidences for grazing units in the tiger reserve are 24.6, 16.1, 10.4, 34.6, 19.3 and 19.5 acres per cattle unit for unit nos. 14, 15, 16, 17, 19 and 20 respectively based on above number of cattle units grazing in the area. There are also incidences of cattle (migratory) from the Berar plains availing the grazing resources of the tiger reserve, thereby dwindling the resources.

2.9.2 Madhya Pradesh:

The Satpura PA complex and Betul managed divisions are surrounded by villages from all sides and have some villages inside also. Stall-feeding is not the regular practice, and there has been an increase in the number of cattle. The MP grazing rules 1986 are followed in the state. In Selection-cum-improvement areas grazing shall be restricted up-to after 5 years of completion of the working plan, in protection-cum-rehabilitation areas it is restricted for 10 years, in legally restricted and experimental areas it shall be restricted lifelong. In plantations areas, grazing shall be restricted up-to 10 years or establishment of the seedling and in case of pastures, it is for 3 years or up-to establishment of seedling. The restrictions shall be lifted after inspection by the Divisional Forest Officer. Livestock population in Hoshangabad and Betul District may be referred to in Table 8, which gives an idea regarding population trends of various livestock since last 25 years in case of Betul and 6 years in case of Hoshangabad District. This data is based on the information published in Statistical Handbooks of the Districts.

2.10 Impact of herbivory and fire on floristic composition

The impact of grazing and fire creates pressure from introduced plants, insect damage to vegetation, food preferences of herbivores, ethnobotanical significance of certain component plant species etc. The two aspects i.e. impact of herbivory and fire on floristic composition were observed from different localities of Melghat Tiger Reserve (Dhore and Wankhede, 1992).

Hendrix (1988) states "Herbivores have a long evolutionary association with plants and although today the number of orders of animals utilizing plants either partially or completely as a food source is relatively small the diversity of herbivores within certain orders is enormous. Most striking is that approximately 50% of all insect species and 65% of all mammal species, covering 3046 species of mammals and 725,634 species of insects, are partially or completely phytophagus (i.e. feed on material of plant origin).

Many ecological problems are involved in the management of natural plant cover so as to provide forage for domestic cattle and wild herbivores. The buffer area of Melghat Tiger Reserve is interepersed with tribal villages who own cattle. There is certain amount of grazing pressure on the forest lands

around tribal villages as some pastoral community like *Gavalis* own large herds of cattle and these are inhabitants of Melghat. This has resulted in removal of certain palatable forage species producing more biomass, from the vicinity of villages and has resulted into promotion of growth of grasses like *Aristida redacta, A. funiculate, Pseudanthistiria hispida, Capillipedium assimele, Digitaria stricta, Andropogon pumilus, Cymbopogon martini* etc. Heavy grazing pressure around villages has also resulted in establishment of nonpalatable species of annual herbs such as *Acanthospermum hispidum, Lagasca mollis, Blainvillea achmelli, Sesamum indicum, Cleome viscose, Zinnia elegans, Achyranthes aspera, Alternanthera pungens, Gomphrena celosiodies* etc. Some of the exotics have also invaded. *Parthenium hysterophorus* has entered Melghat, which is gifted by nature with a very broad range of tolerance and has occupied grazing grounds in the plains of Amravati District within a very short period. Stray plants of *Parthenium hyterophorus* are seen near many villages in Melghat like Semadoh, Harisal, Chaurakund, Dhargad, Gullarghat, Koha, Adhao and even on Chikhaldara plateau.

2.11 Insects and diseases:

Teak defoliator and teak skeletonizer are seen to affect the teak trees in September-October. No other insects are found to damage the crop here.

Wild animals need protection against contagious diseases transmitted through domestic cattle. There have been number of instances of foot and mouth disease in the PAs in gaurs and sambars. Contagious diseases like rinderpest may prove to be serious menace and even wipe out entire herbivore population in the area.

2.12 Water Pollution:

Water pollution is a concern as regards the Pachmarhi plateau. Excessive tourism and growing township has led to pollution of the Banganga stream which meets river Denwa downstream. The catchment of Denwa serves as an important source of water for wild animals in the BSP Protected Area Complex. The Banganga stream is contaminated with untreated sewage which is disposed off by the Pachmarhi township. A short term preliminary survey involving Shri R.K. Singh, SRF, WII was conducted for studying Physicio-chemical properties of the Banganga stream at Pachmarhi.

2.12.1 The Methodology adopted was as follows:

Collection and analysis of water samples

After preliminary survey three zones viz. before township (Zone-1), within township (Zone-2) and after township (Zone-3) were identified for the collection of water samples along the Banganga stream. Total 8 numbers of sampling station (1 to 8) were selected for the collection of samples from these zones. The location of these zones and station is shown in **Diagram 5**. The details of zones and sampling stations are briefly discussed below:

Zone 1: This zone was identified in the upper catchment of Banganga stream. As the stretch of this zone is very small therefore only one sampling station 1 was identified just at the origin of Banganga stream.

Zone 2: The total stretch of Banganga stream meandering through Pachmarhi town was identified in this zone. Total 5 sampling stations (2 to 6) were identified on the basis of stream morphology and human activity to collect the water samples from this zone.

The details of different sampling stations are as follows:

2. It is situated just after the upper lake. Some domestic sewage and agricultural run-off enters the stream before this point.

3. This station is established on the bridge near the government garden and most likely receives

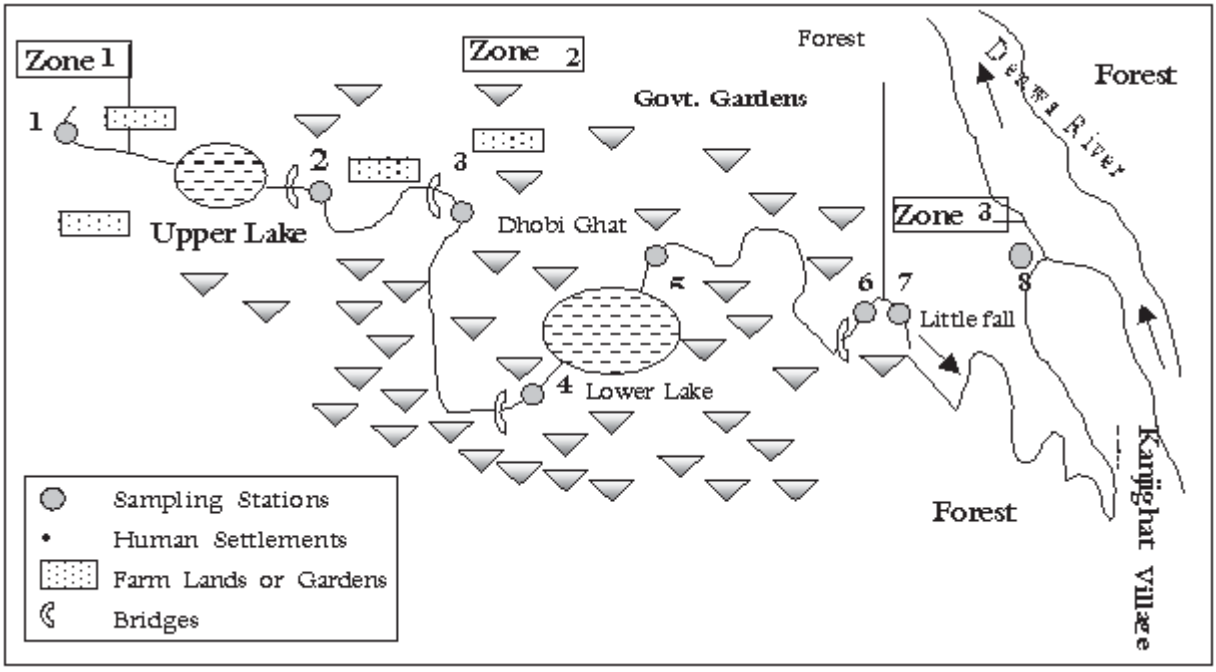


Diagram 5: Digramatic layout of zones and sampling stations along the Banganga stream

the run-off from the garden where large amounts of fertilizers and pesticides are used.

4. This station is located before the lower lake near a bridge and receives a large quantity of domestic sewage.

5. This station is located after the lower lake, near the *Dhobi ghat*.

6. This station is situated after the bazaar and near a bridge leading to the sanatorium. Before this site almost 99% of the domestic waste probably enters the Banganga stream.

Zone 3: The stretch of stream after the township area and within the Pachmarhi sanctuary was identified as zone 3. Two sampling stations (7 and 8) were located in this zone.

The details of station are:

7. The station is located on the boundary of Pachmarhi cantonment and Pachmarhi sanctuary.

8. This station is situated downstream of Banganga stream at a distance of around 500 metres from the point where the Banganga stream meets the Denwa river. A village named Kanjighat is situated at a distance of around 2 km.

Triplicate samples were collected from all the above mentioned stations and analysis was performed for Colour, Temperature, pH, Turbidity, Total Disolved Solids (TDS), and Dissolved oxygen (DO). For the rest 16 parameters the samples were preserved and brought to the lab and analyzed by following standard methods of APHA (1994). Each sample was subjected to the concerned analytical (gravimetric/ titrimetric/ clorimetric) technique.

2.12.2 Statistical analysis

One way univariate analysis was performed considering the zone as fixed effects. After ANOVA, for multiple comparisons Scheffe test was applied. The basic model was

$$Y_{ij} = \mu + Z_i + e_{ij}$$

where Y_{ij} is yield received at ith zone, μ is general mean, Z_i is effect of the ith zone and e_{ij} is the error term.

2.12.3 Preliminary findings

The reasons for variation in the water temperature may be the effect of ambient temperature during the sampling of water. But the increase in temperature after the zone 2 also reflects the increase in the chemical reactions taking place in water due to more and more influx of sewage. With this high temperature of water there are chances of high activity of microorganism, high rate of chemical reaction which can make the water very septic.

Dissolved oxygen is one of the most important parameters for water quality assessment and reflects the physical and biological processes prevailing in the water. Oxygen can be rapidly removed from the water by discharge of oxygen-demanding waste. Other inorganic reductants such as hydrogen sulphide, ammonia, nitrites, ferrous iron, and other oxidizable substances, which are generally present in the sewage also, tend to decrease dissolved oxygen in water. The concentration of DO is decreasing with an increase of sewage discharge, which is statistically non-significant. The increase in the DO level is also observed at the zone 3 where the water is mixing with the atmospheric oxygen due to high velocity of stream discharge and riffles. Low oxygen concentration is generally associated with heavy contamination by organic matter as observed in the case of zone 2.

Chemical oxygen demand is the oxygen required by the organic substances in water to get oxidized by a strong chemical oxidant. Therefore the value of COD might be reciprocal to the DO concentration. The determination of COD values is of great significance where Bilogical Oxygen Demand (BOD) values cannot be determined accurately due to the presence of toxins and other unfavorable conditions for growth of microorganisms. In the present survey, the concentration of COD and DO reflects that there are no toxins in the pollutant. But if the situation aggravates or the pollutant load increases any further, toxic effects are likely to occur. In general, the value of COD is more than the BOD for most industrial waste. COD values are taken as the basis for calculation of the efficiency of the treatment plants and also figure in the standards for discharging industrial/ domestic effluent in various kinds of waters, which is reflected at zone 2 which falls at the boundary of township.

Various forms of nitrogen were observed after the analysis of water from the Banganga. Nitrite was observed statistically significant whereas Nitrate was nonsignificant. The most important source of ammonia is the ammonification of organic matter. Except for zone 1, ammonia is present throughout the stream stretch, which confirms 'no pollution' at the reference (origin) zone. Therefore the occurrence of ammonia in water can be accepted as the chemical evidence of organic pollution.

Ammonia in higher concentration is harmful to fish and other biota. It is also toxic to man when at higher concentration. The toxicity of ammonia increases with pH. At higher pH most of the ammonia remains in a gaseous form.

There are no mineral sources of nitrite ion in natural water. Nitrite represents in an intermediate form during denitrification and nitrification reactions in nitrogen cycle. Nitrite is a very unstable ion and gets converted into either ammonia or nitrate depending upon the conditions prevailing in the water. Presence of even small quantity of nitrite will indicate organic pollution and the availability of partially oxidized nitrogenous matter, as in the case of zone 3. The high concentration of nitrite can also cause 'Blue-baby' (Methaemoglobinaemia).

Nitrate represents the highest oxidized form of nitrogen. The most important source of the nitrate is biological oxidation of nitrogenous substances. Domestic sewage contains very high amounts of nitrogenous compounds. Run-off from agricultural fields has high nitrate content. Atmospheric nitrogen fixed as nitrates is a significant contributor of nitrates in the water and the presence of nitrate at the zone 1 may probably be due to this reason.

Ground water has significant quantity of nitrates due to leaching and percolation of the nitrate in water. Sewage and other waste rich in nitrates can also contaminate ground water. Due to these reasons the non-significance of nitrate has been observed.

Nitrate are of prime concern because it causes methaemoglobinaemia if the concentration of nitrates exceeds 40 mg/L. In cattle, the concentration of nitrates is reported to cause more mortality in pigs and calves. Abortion in brood animals is commonly reported.

Phosphorus in natural water is presents mostly in inorganic forms. The rocks in which most of the phosphorus is found, are generally insoluble in water, and hence the phosphorus content in natural freshwater is low and biological growth is also limited due to its presence. The major sources of phosphorus are domestic sewage, detergents, and agricultural affluent with fertilizers and industrial wastewater. In the present study phosphate is non-significant but the concentration of phosphate increases to a very high extent at the zone 2 as compared to the other zones. The reason for this increase in concentration is due to the high load of municipal discharge containing detergent wash and sewage, which are the major contributors of phosphate in the surface water. The location of the *Dhobi ghat* is an obvious source of pollutant. The quality criteria for phosphorus in water are only to check nuisance growth of algae and process of eutrophication. According to US EPA (1976), it's concentration should not exceed 50 μg/L in any tributary, river or lake and 25 μg/L within these main resources.

Results of water analysis showed that the stretch of Banganga stream within the Pachmarhi town is mainly affected by the organic pollution. The colour of water in all the zones is having higher value than the limit prescribed by the Central Pollution Control Board (CPCB) for most clean river (A class river). Such higher level of colour can impact the growth regulation of many primary producers. The extremely low DO in Zone-2 is an alarming condition for the survival of several aquatic fauna. The result also suggests that the waste discharged in the stream is biodegradable in nature and thus, again the DO level is increased in Zone-3. Therefore, the sewage of Pachmarhi town can be easily treated either by construction of an oxidation pond of suitable size or by installing a low cost treatment plant.

Though the results are from a preliminary survey some indications of contamination of water are definitely there. A detailed study in future may lead to some more important findings.

2.13 Impact of silvicultural treatments:

The Betul forests are managed under following silvicultural systems **(Plate 34):**

i) Teak Conversion (TCFS)

ii) Coppice with Reserve (CWR)

iii) Improvement Felling (IMP)

iv) Selection-cum-improvement (SCI)

v) Rehabilitation of Degraded Forest (RDF)

The statement of area distribution under various working circles in the three managed forest divisions is given as Table 2. (**Plate 34**).

Table 2. Statement of area distribution under various working circles (in Sq. kms).

Divisions	TCFS	SCI	CWR	IMP	RDF	FV	UA	TOTAL
North Betul	476.86	219.00	152.88	157.48	87.66	78.28	11.31	1169.28
South Betul	—	782.28	—	362.68	—	92.63	—	1237.59
West Betul	—	703.92	—	—	94.28	—	—	824.61

Table 3. Distribution of the bamboo Overlapping working Circle.

North Betul	South Betul	West Betul
22.79sq.km.	92.16sq.km.	180.65 sq.km.

Though data was collected for all the tree species falling in the plots in different working circles, distribution and status of eight species was studied and the rest of the tree species were clubbed together.

Except for the RDF working circle all the other systems are high forest systems where vegetation is normally from seed origin, either natural or artificial (or combination of both) and where rotation is generally long. The CWR system falls under the coppice systems in which the crop originates from coppice and where rotation of the coppice is short. The improvement system is an accessory system where removal of inferior growing stock of all age classes and tending of crop is done. The Teak Conversion Working Circle is a conversion system. The concept of conversion involves a change in crop and/or the silvicultural system by which the crops are regenerated and replaced by a new crop of distinctive form.

1. **Teak Conversion Working Circle:** The best quality teak forests of Gawasen, Bhaura, Barbatpur and Betul Ranges with capability of growing large size trees and are fit to be worked under conversion system have been allotted. The main object of management of forests under this working circle is to attain normality in the valuable forest. The west and south Betul divisions do not have areas allotted to this working circle. The total area under this treatment of the Betul District is 476.86 sq. kms.

2. **Selection-cum-Improvement Working Circle:** This Working Circle includes remote forests in the three divisions viz., north south and west. This mainly comprises of teak forests of site quality varying from III to IVa improving to II along nallahs and areas with greater soil depth. Teak forest constitutes 50.1% and mixed forests 42-60% of the total forest area allotted to this WC. Selected trees are removed singly in the fellings. The selection and pre-selection girth of teak and its associates in various localities is given in Table 4. The type of crop is uneven-aged with all age classes mixed together on each unit area. The mode of regeneration is natural regeneration as a result of gaps created by fellings. Artificial regeneration is resorted to in case natural regeneration does not follow. The treatment in general is:

   1) Improving the growing stock by removal of dying diseased malformed and undesirable trees.
   2) Prevention of soil erosion and frost damage.
   3) Only silviculturally available trees to be removed.
   4) Overwood adequate enough to encourage regeneration is retained.
   5) System permits growth of all the species together.
   6) Choice of species is *Tectona grandis, Adina cordifolia, Pterocarpus marsupium, Dalbergia latifolia, Terminalia tomentosa, Anthocephalus kadamba, Anogeissus latifolia etc. Terminalia belerica, T. chebula* and *Sterculia urens* are preserved. The total area under this treatment is 1705.20 sq. kms.

3. **Coppice with Reserve Working Circle:** Coppice may originate mainly from stool coppice and where rotation of the coppice is short. This system has evolved in the erstwhile

Table 4. Selection and pre-selection Girths for Teak and its associates in various localities

S. No.	Species	Girth at Breast Height			
		Dry sites, hill tops, hotter aspects and poor site quality forest		Semi moist locality, cooler aspects, valleys and good quality forest	
		Selection Girth (cm)	Pre-selection Girth (cm)	Selection Girth (cm)	Pre-selection Girth (cm)
1.	Teak	120	90-120	135	110 to 135
2.	*Terminalia tomentosa, Adina cordifolia, Boswellia serrata, Lannea coromandelica*	120	90-120	135	110-135
3.	*Dalbergia sissoo, Largerstromia parviflora, Pterocarpus marsupium, Grewia tilaefolia*	90	60-90	110	75-110
4	*Ougeinia oogeinensis*	75	60-75	90	75-90

Central Province (MP) for dry deciduous forests with low proportions of teak and sal and where site quality varies greatly, influencing the composition and density from place to place even in the same compartment. Before 1927 the areas were worked under improvement fellings.

Forests were considered suitable for coppice systems but the risk was that on poorer sites if the coppice did not come up, the condition of the area might deteriorate. This is a system in which felling is done only in suitable areas likely to benefit after reserving all commercially immature growth of teak as well as miscellaneous species, either singly or in optimally spread groups, trees yielding products of economic importance and entire crop for protective reasons.

As regards pattern of felling, the emphasis is not on felling but on conservation. Under-stocked areas, areas around drainages, camping sites, places of worship etc, areas with dense pole crop of commercial species, and high quality areas are reserved. The reserved species include species yielding edible fruits, non-timber forest produce, industrial timber species worked under overlapping working circles, host of lac insects like *Butea monosperma, Zizyphus xylopyrus, Schlichera oleosa etc.* and species of rare occurrence.

Tending operations include climber cutting. Cleaning is carried out when the vegetation is between 5 – 8 years. Reduction of coppice shoots to 2 or 3 per stool. When crops are worked on large rotations of 30 or 40 years, thinnings are carried out at mid-rotation ages.

Advantages:

a) Improvement in the quality of the locality.

b) Improvement in condition and composition of the crop.

c) Fulfilment of the need of the local people as well as the industry.

d) Creation of suitable conditions for seedling, increment of valuable species.

e) Reservation of large no. of trees affects coppice growth

4. Improvement Working Circle: Improvement Working Circle is not a silvicultural system as it neither aims at regenerating the crop nor producing a crop of distinctive characteristics. Troupe (1947) has not recognised it as a silvicultural system in his monumental work "Silvicultural systems". Traur (1946) has suggested that large areas of

degraded and poor forests in India are likely to remain under improvement system to prepare these areas for application of more intensive systems and devise methods that will bring these forests to normal state by encouraging regeneration.

The method of treatment involves essentially removal of inferior stock in the view of better growth of more valuable individuals. It is usually applied to mixed even-aged stands. It includes felling of dead, dying and diseased trees, saleable wood in sound state, malformed trees, cutting back of malformed and damaged saplings, removal of undesired undergrowth and climber cutting. Choice of species in the study area is *Tectona grandis, Adina cordifolia, Pterocarpus marsupium, Dalbergia latifolia, Terminalia tomentosa, Anthocephalus kadamba, Anogeissus latifolia, Lannea coromandelica, Chloroxylon swietenia. Terminalia belerica, T. chebula, Bombax ceiba* and, *Sterculia urens* being rare species are reserved from felling. The felling cycle has been fixed at 20 years.

5. **Rehabilitation of Degraded Forest Working Circle:** Areas with large blanks and under-stocked areas which once supported forest cover are allotted to this working circle. Being close to habitations, these areas have degraded to a great extent, encroached and are more prone to soil$erosion. The area contains patches of teak and miscellaneous crop of SQ IVa and IVb. The crop is stunted and malformed. Scattered mature trees of *Madhuca indica, Terminalia tomentosa, Butea monosperma, Diospyros melanoxylon, Anogeissus latifolia* and *Lannea coromandelica* are distributed.

The main objective here is to provide ecological balance by rehabilitation of blanks and under-stocked areas through plantations. Water and soil conservation works are carried out. Available root stock is utilised for stocking up the area. Patches of workable forests are worked with light improvement fellings. The choice of species for plantation includes fuelwood and fodder species. Felling cycle is 20 years.

6. **Bamboo Overlapping Working Circle:** This working circle includes all the bamboo bearing areas and overlaps all other working circles. The only species of bamboo found in the area is *Dendrocalamus strictus*. It is found in teak as well as miscellaneous forests. It is found on hill slopes and valleys as scattered patches while in mixed forests it is found as understorey. It is absent on drier hill tops or ridges and flat open localities. Gawasen, Kurusna and Barbatpur are good bamboo-bearing areas. Gregarious flowering of bamboo occurred in 1967-68 and 1975-76. The objective here is to meet local need, to obtain sustainable yield and to extend the bamboo forest area. The felling cycle is 4 years.

The impacts of the above stated silvicultural systems on selected species in terms of distribution and status was attempted. The species were *Tectona grandis, Buchnania lanzan, Terminalia belerica, Diospyros melanoxylon, Madhuca indica, Lannea coromandalica, Ougenia dalbergioides* and *Terminalia tomentosa*.

1. *Tectona grandis* or Teak

The species belongs to family *Verbenacee*. This is one of the central India's most widely distributed and important timber species. A large deciduous tree has scented wood, dark golden – yellow when freshly cut and dark brown latter on. The wood is moderately hard and weighs 720 kg per cum for this locality. It is so far the best timber which can be used for almost all purposes. It is in great demand for ship building, railway cars, buildings, furniture etc. The leaves are used as thatch by the local people. The management of the forest in the managed forests in the study area is no doubt aimed at the well being of this valuable species.

Under favourable conditions teak reaches large dimensions. In the Indian peninsula the northern limit of teak is in the western Arvallis at 24 deg 42' N lat. Thence eastward through Central India to the Jhansi district at 25 deg 33', entering Banda district, thence in the south easterly direction to the Mahanadi

river. From this northern limit it extends southward to Tinnevelly and Travancore. Even the poorer classes of teak forest in the Indian peninsula are of considerable value as resources of local supply of for poles and timber. Teak has been planted in many localities outside its natural distribution.

Although teak prefers dry localities, subjected to great heat and drought, it thrives best and reaches its largest dimensions in fairly moist, warm, tropical climate, though in very moist tropical regions it tends to be replaced by evergreen forests. Majority of the teak forests are situated on hilly and undulating country, but there are considerable areas on flat alluvial well drained soils. It is also distributed on alluvial flats of limited size along the banks of rivers and streams. On well-drained deep alluvium teak occurs remarkably pure and attains large dimensions. It also attains very good development on the fertile lower slopes of hills where the soils are deep, but along dry ridges it becomes stunted, as is also the case on shallow soil. Teak occurs to a great extent in Betul, Hoshangabad and Amravati districts. Teak occurs on variety of geological formations, notably trap, limestone, gneiss, mica schist, sandsote, conglomerate and shale. An interesting teak forest which falls in the study area is the Bori forest in Hoshangabad district.

In dry situations and seasons the leaf fall starts from November and extends to January, while in moist loacalities trees may remain in leaf until March or even later. As a rule the trees are leafless throughout the greater part of the hot season. The new leaves ordinarily appear from April to June according to locality and season. White flowers appear during rainy season, as rule from June to August or September according to season and locality. During the rainy season the teak trees are conspicuous with masses of white inflorescence. The fruits ripen from November to January and fall gradually through the part of the hot season. The fruit is a hard, bony, irregularly globose nut some what pointed at the apex. The teak seedlings are sensitive to drought and frost, particularly during the first year when they are frequently killed outright. Young teak plants have a wonderful power of recovery from damage by fire and in burnt forest there stems can be killed back for many years in succession while in the mean time they produce a much thickened root stock from which a permanent shoot is finally produced when conditions are favourable for survival. Teak seedlings are intolerant to shade and are very sensitive to suppression by weeds. Young teak plants are not readily browsed by cattle or wild ungulates. Saplings growing under bamboos have there leading shoots damaged due to bamboo acting as 'whip' since the leading shoot is intolerant to such irritation. Teak has a greater power of resistance to fire than majority of its associates. It is a fact that in steep hill sides and on the ground covered with a dense inflammable grass the damage done by fire to teak trees in all stages is considerable, and it is not improbable that in such places much of the hollowness observable in the lower parts is attributable to effects of fire in the past. Debarking by wild ungulate of the pole crop is very common in the study area. Teak coppices and pollards vigorously and sometimes retains its power of coppicing to a considerable size. Natural reproduction of teak has a direct bearing on the following factors:

1. Spread of the seed: Chief transporting agency for teak seeds is water this hence accounts for vigorous growth on alluvial flats.
2. Factors influencing germination: Given a particular degree of moisture the chief factor is temperature, soil aeration and proper burying of the seed.

Grazing occurs to favour the reproduction of teak rather than otherwise by keeping down the grasses and the undergrowth. Artificial regeneration of teak can be best done by using root-shoot cuttings.

a) **The Teak Conversion Working Circle:** This working circle pertains only to the North Betul forest divisions as there is no best quality teak forest in the west and the south forest divisions. This working circle has the maximum area in

the Barbatpur range (14,255 Ha 57 % of the range) followed by the Gawasen Range (14,198 Ha 86% of the range) and the Bhaura range (13,138.30 Ha 42.7 % of the range), the other range being Betul with just around 4,631 Ha (22.4% of the range). The area pertaining to this working circle is 476.86 Sq. km that is 4.74% of the area of the Betul District landscape indicating that quite a small percentage of land is under good quality teak forest. Fig 1. gives the details of the population struture of *Tectona grandis* in different working circles. Teak is represented in almost all the girth classes. There is prescription for retention of certain amount of stems as a result of 10^{th}, 20^{th} ,30^{th} and 45^{th} year thinings and some abnormalities if exist indicate overuse of the species for local demand for agricultural implements, house building and other local uses. The exploitable girth has been fixed for teak at 135 cms with a 100 year rotation but looking at the results of the study it can be noted that trees in the girth class 121-150 are quite few indicating stress on the species. This also indicates that a restraint on felling may need to be adopted. The presence of teak in the GBH class 121-150 and 151 to 180 may be attributed to reservation against fellings as per the marking rules, trees in the sacred groves, the plus trees the mother trees and the over-matured trees. The system is doing well for the species but special attention needs to be given towards the natural regeneration and assisted natural regeneration looking to the low densities than expected in the class 91-120 cms and beyond. The recruitment definitely needs to be more. If not in Gawasen range but in the other ranges lesser regeneration may be attributed to grazing and fire incidences due biotic disturbances.

b) Selection-cum-Improvement Working Circle The selection girth for teak is shown in Table 5.

The selection and pre- selection girth of teak in dry site, hilltops, hotter aspects and poor quality forest is 120 and 90-120 cm respectively as against 135 and 110-135 cm for semi moist locality, cooler northern aspects, valleys and good quality forest. The analysis of data shows that the distribution of teak is maximum in the 61-90 cm girth class in this working circle (fig. 1.) i.e. around 200 trees/ha. The distribution of recruitment class and the pole crop is quite low i.e. less than 25-50 trees/ha. This indicates that regeneration is poor. Since the entire area is gone over and fellings are spread out all over, the area it might be that regeneration is adversely affected. A sudden dip in the density (trees/ha) i.e. 20 trees/ha in the age class 46-60 cm may be attributed to local use of the species in this girth class for making hut and agricultural implements. The distribution of trees of girth class 91-120 and 121-150 cm is the selection girth class for the entire area and the distribution seems to be very low i.e. around 10 trees/ha. This shows that very few trees make it to the exploitable girth class and in most of the cases it may not be economically and ecologically viable to undertake fellings. The girth classes above 150 cms also find a meagre distribution of below 10 trees/ha that may be on account of trees reserved against felling with respect to the felling rules, mother trees, malformed trees, trees silviculturally unavailable and trees in sacred groves.

Table 5. The selection girth for teak

Site	Girth at Breast Height			
	Dry sites, hill tops, hotter aspects and poor site quality forest		Semi moist locality, cooler aspects, valleys and good quality forest	
	Selection Girth cm	Pre-selection Girth cm	Selection Girth cm	Pre-selection Girth cm
Teak	120	90-120	135	110 to 135

It is necessary to go into devising methods to enhance regeneration of teak in this working circle and also set up a methodology to make a preliminary judgement as to whether fellings in particular areas is possible or not.

c) **Improvement Working Circle:** Teak enjoys the first priority in treatment under this working Circle. This working circle extends over 15.79 % of the forest area in Betul District. These are mostly degraded forests having inferior stocks and the main aim is encouraging regeneration. As regards the recruitment of teak the regeneration status seems to be inadequate. But reference to Fig. 1. indicates that the areas are responding well to the treatment in this silvicultural system. With the density percentages increasing from the girth class 15-20 to 46-60 cm gbh the trend seems to be satisfactory but a sudden dip of the tree density to less than 5 trees/ha in the gbh class 46-60 cm is alarming. There is again a rise in density in the girth class 61-90 cms (35 trees/ha) followed by a dip again in the girth class 91-120 cms (3 trees/ ha) and absence of the species in higher girth classes. This may be on account of poor site quality and biotic disturbance. These areas mostly degraded on account of being either inaccessible or nearer to habitations (Forests and Revenue villages) the sudden dip in density in the class may be due to local use for obvious purposes. There is no representation of this working circle in the gbh classes above 150 cm. The reason may be that the site quality or the edaphic status of the area is incompetent to support growth of the trees to that size. A major chunk of the trees in the girth class 91-120 (around 2.5 density percent) can be attributed to the trees in inaccessible areas, small valley pockets with stabilised soil, riparian areas and sacred groves.

d) **Rehabilitation of Degraded Forests (R.D.F):** Though the species finds representation in all the classes ranging from 15-20 to 91-120 (Fig.1) with fluctuations in density percentages these may be mostly trees in highly inaccessible areas, trees along nallah and riverbanks, those in the erosion prone areas and trees in areas of local value. A near negligible representation of the species in the class 121-150 (density around 1.0) may be due to the trees in inaccessible areas, mal formed trees with no economic value, trees in sacred groves. Though degraded, these areas have a sprinkle of good soil conditions and micro-climate and thus the same are of great ecological significance if not economical. Malformed and stag- headed trees have their own niche in supporting variety of wildlife species.

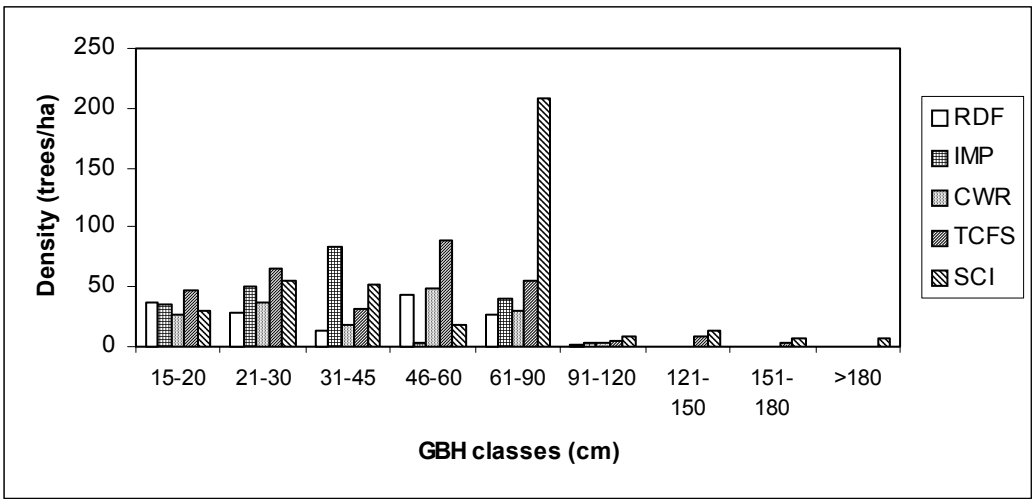


Fig. 1. Population structure of *Tectona grandis* in Betul divisions

It is essential to revert back into the past and evaluate the reasons of degradation of these areas and identifying them into manageable and un-manageable areas in relation to management intervention.

e) **Coppice with Reserve Working Circle:** The species seems to be doing well as regards this working circle is concerned. The system aims at conservation and not economical yield. Teak even shows itself as species of regional interest. The presence of teak in what ever form indicates the basis of adoption of this silvicultural system aiming towards prevention of degradation.

The species shows a reduced density percent in all the silvicultural systems except in the Improvement Working Circle. The reason may be that felling or economic gain is not the principle behind the adoption of the system.

2. *Buchnania lanzan* or Achar

A moderate-sized tree belonging to the family *Anacardiaceae*, almost evergreen, with a straight trunk; bark dark grey or black, 0.5-0.8 inches in thickness, regularly divided into small rectangular plates somewhat resembling crocodile hide with a reddish blaze. The wood is of poor quality but the tree is of high economic importance because of its gum and the edible fruits it yields. Its silvicultural importance lies in its great abundance in certain common types of forest and its utility for clothing dry hills in most of the dry deciduous forests of India, upto an altitude of 3000m. It is found more abundantly on clayey soils. In its natural habitat, the absolute maximum shade temperature varies from 105^0 F to 115^0 F, the absolute minimum from 30^0 F to 55^0 F and the normal rainfall from 30 to 85 inches.

It belongs to the family *Anacardiaceae*. The tree is leafless for a very short period during the hot season. The pyramidal panicles of small greenish white flowers appear from January to March and the fruits ripen during April-June. The fruit is an ovoid drupe of about 0.5 inch, long black when ripe, with a hard two-valved stone 0.34-0.4 inch in diameter enclosing an oily seed. The seeds lose their vitality when exposed to the sun. The seedlings are very sensitive to frost, drought and insect attack. Macaques, sloth bear and fruit-eating birds, eat the fruits. The fruits are extracted by the tribals for kernels, which constitute an important produce for trade, and is largely used in native sweetmeats (Watt, 1889). The kernel yields light yellow sweet oil used as an indigenous medicine.

The tree is a moderate light demander and avoids water-logged ground. It produces root-suckers and coppice shoots, though its coppicing power varies. The fruits fall at the commencement of the rainy season. If they are quickly covered with earth debris by the rain, or are protected by grass or other low cover, germination soon commences and the seedlings have a chance of establishing themselves, developing slowly while those lying exposed to the sun soon lose their vitality. Much mortality is also caused by insect attacks. Direct sowing is found to be more successful than transplantation from nursery beds.

a) **Teak Conversion WC:** There is absence of this species in all the girth classes except for 46-60 cm and 121-150 cms (Fig 2.) as the focus of this system is on conversion to teak. This species does not seem to have a future in this working circle. This indicates that regeneration is poor. Meagre representation in higher girth classe above 150 cms indicates retention of old trees for NTPF use.

b) **Selection cum Improvement:** This is the only working circle where the distribution of the species occurs in nearly all the girth classes, albeit in varying frequencies except for that 91-120 cm and above gbh classes. This system seems to be gentle on the species.

c) **Coppice with Reserve:** These are the areas more prone to biotic disturbance and it is the combined effect of historical factors and biotic

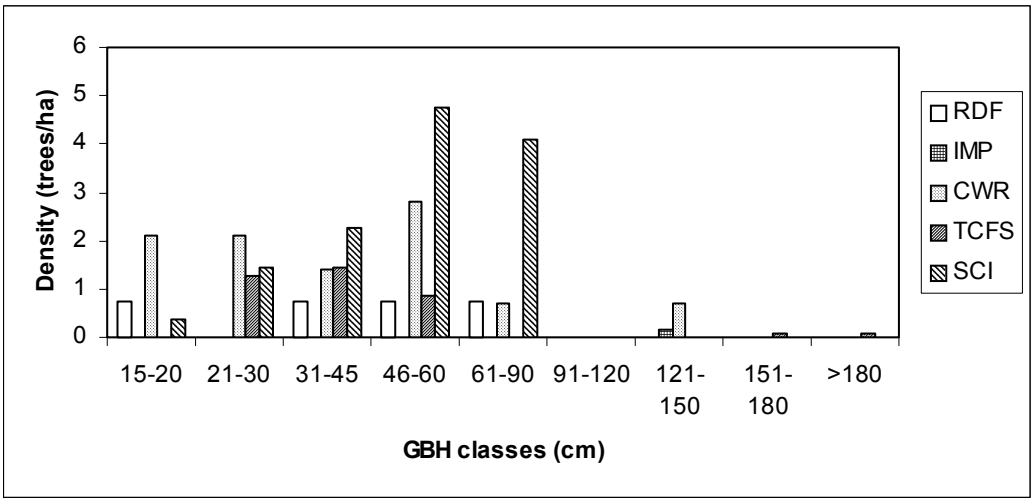


Fig. 2. Population structure of *Buchnania lanzan* in Betul divisions

impacts which has called for the adoption of such a system. The species seems to be of significant importance to people. Except for the girth classes 91-120 cms and above, the species seems to be present in all other girth classes. Large size trees above 150 cms are absent.

d) **Improvement Working Circle:** In this circle, the distribution lies in the range of 121-150 cms (0.125 trees/ha). These might be isolated trees left for the purpose of extraction or reserved from felling for one reason or the other. The absence in all the other gbh classes seems to be due to local use.

e) **Rehabilitation of Degraded Forests:** In the RDF areas, the lower to medium girth classes ranging from 15-30 cm to 61-90 cms (exception 21-30 cm) are the most common. The areas being close to habitations, the local people have been promoting this species in view of the local importance of the same. Besides, the departmental activities to assist and promote natural regeneration have also given good results. The point that local importance does not always mar the prospects of the species is proved here. With further awareness regarding the use of species and promoting further the growing stock, the species can do well and also cater to the requirement of the local people.

3. *Terminalia belerica* or Bahera

The species belongs to family *Combretaceae*. A large deciduous tree, attaining a height of 120 ft. and a girth of 10 ft. or more, usually with a straight tall bole; large trees are often buttressed at the base. Bark bluish or ashy grey, with numerous fine longitudinal cracks, yellow inside. Leaves broadly elliptical, 4-8 in. long, clustered at the end of the branchlets. Wood yellowish grey, hard, not durable, but lasts fairly well under water, used for planking, packing cases, boats and other purposes. The fruits are used for tanning but are inferior to those of *T chebula* (Troupe, 1986).

The tree is found in deciduous forests throughout the greater part of India and Burma, but not in arid regions. It is a common associate of the sal, the teak and other important trees, occurring more or less scattered and not gregarious. In the Indian peninsula, it occurs most frequently in moist valleys. In Burma, it is common in deciduous forests both of upper and of lower mixed types, with or without teak. In its natural habitat the absolute maximum shade temperature varies from 97^0 F to 115^0 F, the absolute minimum from 30^0 F to 60^0 F. and the normal rainfall from 40 to 120 in. or more.

In Northern India, the leaves commence falling in some cases as early as November, some trees

being almost leafless by the end of that month, when the new foliage appears. The spikes of small greenish white flowers appear in April-May with the young leaves; they have a strong honey-like smell, which is almost overpowering at times. The fruits ripen from November to February and fall during the cold and hot seasons. The fruit is somewhat dry fleshy drupe1-1.5 in. long, ovoid, pyriform, ellipsoidal or globose, grey velvetty, tomentose, with a hard, thick-walled woody light yellow putamen 0.7-1.1 in. long. The fruits are eaten by monkeys, squirrels, pig, deer, goats and other animals and never allowed to lie long on the ground before being stripped of their fleshy covering. During the cold season, the trees may often be seen with numerous withering branchlets, broken by monkeys in picking the fruits. The partiality of animals for the flesh of the ripe fruits is an assistance to spread the seed. On the other hand much of the fruit crop is rendered ineffective by insects. The immature fruits are attacked by insects during the rainy season, and may fall to the ground. The hard nuts of the fruits are very largely bored into, by insects while lying on the ground, and the whole crop may be destroyed in this way. The nuts are also broken open for the sake of the kernal inside, by squirrels, pigs and other animals and at times it may be difficult to find even a single sound nut on the ground in the beginning of the rainy season. The germinative power of the seed is better than most species of the genus and much better than that of *T. chebula*.

The tree is a light demander, though it can stand slight shade when young. It is decidedly sensitive to frost. As regards drought, it is somewhat hardier, though it does not occur in very dry localities. It coppices fairly well. The consumption of the fleshy portion of the fruit and the dissemination of hard nuts by animals has already been mentioned. Where the flesh is not consumed fully, it either rots off or is eaten off by white ants, the nuts being wholly or partly buried in the process. Germination takes place at different times during the rainy season. Successful regeneration is greatly assisted if the nuts are buried by rain since the radicle of germinating seedling is liable to be eaten by insects, birds or animals. Germination takes place more readily in moist localities.

a) **Teak conversion WC:** There is absence of this species in all the girth classes except for 121-150 cms (Fig 3.) as the focus of this system is on conversion to teak. This species does not seem to have a future in this working circle.

b) **Selection-cum-Improvement:** This is the only working circle where the distribution of the species occurs in nearly all the girth classes, albeit in varying frequencies except for 31-45 cm and that above 151-180 cm gbh. This system seems to be gentle on the species.

c) **Coppice with Reserve:** These are the areas more prone to biotic disturbance and it is the combined effect of historical factors and biotic impacts which has called for the adoption of such a system. The species seems to be of significant importance to people. Except for the girth classes 121-150 cms, the species seems to be absent in all other girth classes.

d) **Improvement Working Circle**: In this circle too, the distribution lies in the range of 121-150 (0.1 trees/ha). The absence in all other gbh classes seems to be due to local use and biotic disturbance.

e) **Rehabilitation of Degraded Forests:** In the RDF areas, there is no distribution of the species in any of the girth classes at all. The probable reasons are: a) Pressure on the species due to excessive local use.; b) Naturally low and scattered distribution of the species; c) fires and d) Grazing.

4. *Chloroxylon swietenia* or Bhirra

A moderately sized deciduous tree belonging to the family *Meliaceae* with a rather short bole and spreading light feathery crown with glaucous green pinnate aromatic leaves, bark thick, corky, yellow or light grey and aromatic. It is found commonly in the dry deciduous forests of the Indian peninsula

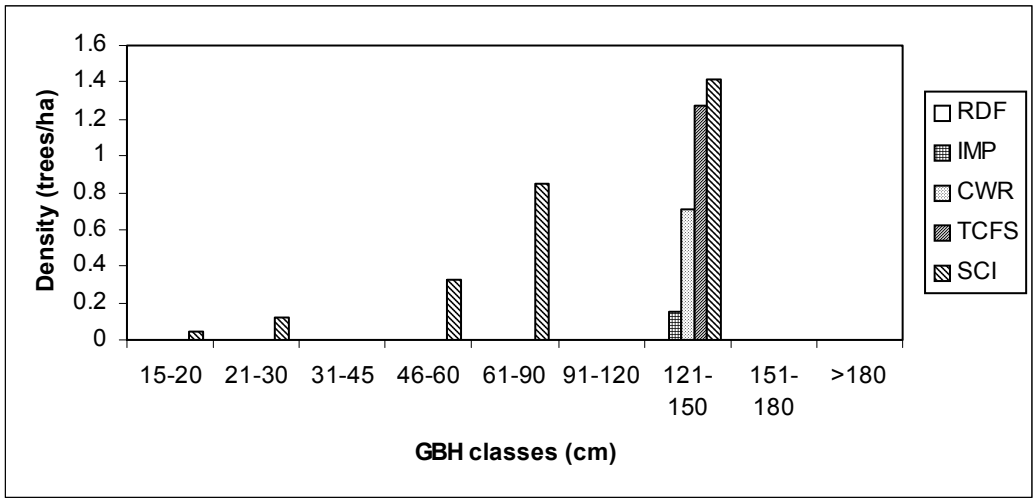


Fig. 3. Population structure of *Terminalia belerica* in Betul divisions

extending as far north as the Satpuras and Chota Nagpur. It is common in dry types of mixed deciduous forests on the metamorphic rocks, sandstone and laterite, provided the soil is not stiff and clayey; it will grow on bare rocky ground and on poorer soils if they are well-drained and contain a large proportion of sand or gravel, and even on black cotton soil. It attains comparatively large size on sandy loam eg. (Chanda district). Its chief associates are *Acacia catechu, Terminalia tomentosa, T. chebula, Anogeissus latifolia, Buchnania lanzan, Emblica officinalis, Cleistanthus collinus, Cassia fistula, Soymida febrifuga, Pterocarpus marsupium, Dalbergia latifolia, Dalbergia paniculata, Albizzia lebbeck, A. odoritissima, Lagerstroemia parviflora, Diospyros melanoxylon, Zizyphus jujuba, Z. xylopyrus, Cochlospermum gossypium* and other species of the dry miscellaneous forest.

The climatic conditions for this species include dry hot regions where the maximum shade temperature may rise to nearly 120° F, the absolute minimum being 35° F and the normal rainfall varies from 30 to 60 in.

The tree is usually leafless from February to May. The panicles of small cream-coloured flowers appear in March-April and the fruits ripen from May to August or sometimes later. The capsules are oblong, dark brown, coriaceous, 3-valved, 1-1.5 in. long. The seeds are brown with a broad wing at one end, the whole 0.6-0.8 in. long by 0.15-0.2 in. broad, the wing is brittle with one margin broad and angular. The seed does not retain its vitality long The tree seeds almost every year and is adapted for dissemination by wind to moderate distances. The germinating seeds and young seedlings are very apt to be washed away by heavy rain, the exposed radicle drying up or being eaten up by insects and the seedlings thus perishing. A long stout taproot is, however, quickly formed and thus saves many seedlings that would otherwise be washed away. Seedlings develop on porous soil free from weeds and badly on stiff soil with weeds that gives the young seedlings a tough competition.

Chloroxylon is a strong light demander, though the seedlings require protection from the sun in early youth. It is frost tender in its early stages (frosts do not naturally occur in its natural habitat). It recovers and survives in areas affected by hacking, burning and grazing. The deer rub the velvet off their antlers on the bark of this species and the goats and browsing animals find it unpalatable due to the presence of an acrid oil, protecting it from injury. The tree coppices and also produces root suckers.

The tree is liable to the attack of insects which bore into the pith of young shoots; also a large number of trees die from the attack of larva of a

beetle, probably a longicorn, which tunnels between the bark and the wood. Most miscellaneous forests containing *Chloroxylon swietenia* were worked under coppice with standard system, satinwood or *Chloroxylon* being one of the trees retained as standards. The girth has been seen to grow upto 3 feet in 45 years and 4.5 feet in 75 years.

a) **Teak Conversion WC:** There is absence of this species in all the girth classes except for 31-45 cms (1.5 trees/ha) and 46-60 cm (1 tree/ha) (Fig 4.) as the focus of this system is on conversion to teak. This species does not seem to have any future in this working circle.

b) **Selection cum Improvement :** This is the only working circle where the distribution of the species occurs in many girth classes *viz.* 31-45 (0.7 tree/ha), 46-60 cms (2.5 trees/ha), 61-90 cm (3.5 trees/ha) and 121-150 cm (1.25 trees/ha), albeit in varying frequencies. This system seems to be relatively gentle on the species.

c) **Coppice with Reserve :** These are the areas more prone to biotic disturbance and it is the combined effect of historical factors and biotic impacts which has called for the adoption of such a system Except for the girth classes 31-40 cms and 46-60 cms, the species seems to be absent in all other girth classes.

d) **Improvement Working Circle :** In this circle too, the distribution lies in the girth class 31-45 cms (0.75 tree/ha) and 46-60 cm gbh class (0.75 tree/ha). The absence in the other gbh classes seems to be due to local use and also preference of teak and its associates.

e) **Rehabilitation of Degraded Forests :** In the RDF areas, the species is not at all represented since these are highly disturbed areas which might not be allowing the regeneration to come up. Assisted Natural Regeneration or artificial regeneration might help.

5. *Anogeissus latifolia* or Dhaora

The species belongs to the family *Combretaceae*. The species is commonly known as *dhaora*, bakli etc. A moderate to large size deciduous tree with somewhat feathery rounded crown and drooping branches. The bark is thin, smooth, greenish or greyish white exfoliating in a regular manner. The tree seldom attains very large dimensions. A girth of 180 cm is not very common. The wood is very hard, strong and tough and is used in cart axles, shoulder poles, axe handles, furniture, agricultural equipments, rafters and for boat building works. The

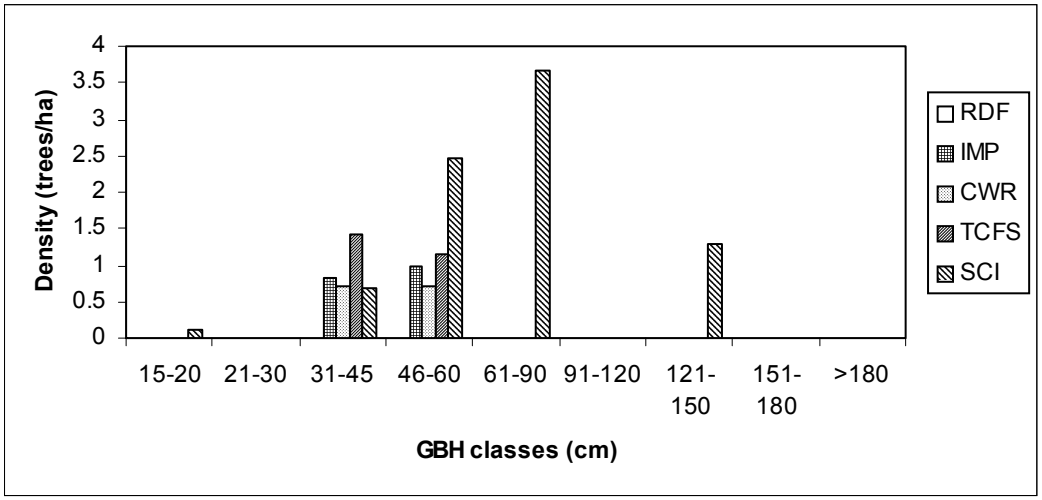


Fig. 4. Population structure of *Chloroxylon swietenia* in Betul divisions

leaves are rich in tannin and are collected for tanning purposes. The bark is also used for tanning and yields a gum used in calico printing. Apart from the economic use, the tree is useful ecologically and silviculturally in clothing dry hill sides and is an important constituent in certain dry types of forest. In central India, it is at times gregarious and an important constituents of mixed deciduous forests. It avoids moist regions but also does not extend to very dry habitats. Fire and mal-treatment results in stunted growth. The leaf fall starts in February and the tree remains leafless in April-May till the new foliage appears. The indehiscent fruits ripen from December-March and are found scattered on the forest floor February-March onwards. The tree seeds abundantly every year but the fertility of the seed is very poor. Growth of the seedling is moderate and it suffers little from frost. In dry localities, the seedlings may die-back annually for some years before they finally shoot up. The tree is a light demander but stands some amount of shade. It is less susceptible to damage by browsing than many other species. It suffers from fire and in severely burnt areas, it becomes gnarled and hollow. If cut at the dry season, it coppices and pollards very well in moist areas. It produces good amount of root suckers. Natural regeneration comes abundant in well-drained soils and where shade and moisture are favourable. The regeneration so obtained is highly intolerant of suppression by weeds. Good reproduction has been observed to spring up on burnt areas though its ultimate establishment is favoured by protection from fire and excessive grazing.

a) **Teak Conversion WC**: This species is represented in the girth classes 31-45 cm (0.5 trees/ha, 46-60 cm (1.75 trees/ha) and 61-90 cm (3 trees/ha) (Fig 5.). This species does not seem to have a good recruitment in this working circle. The species is not at all represented in the girth class 91-120 and above. The reason might be excessive lopping for fodder also leading to reduced seed production which, in turn, might be adversely affecting regeneration.

b) **Selection-cum-Improvement:** This is the only working circle where the distribution of the species occurs in nearly all the girth classes, albeit in varying frequencies except for that above 180 cm gbh. This system seems to be gentle on the species as all girth classes are promoted. Regeneration needs to be improved.

c) **Coppice with Reserve:** These are the areas more prone to biotic disturbance and it is the combined effect of historical factors and biotic impacts which has called for the adoption of such a system. Except for the girth classes 21-

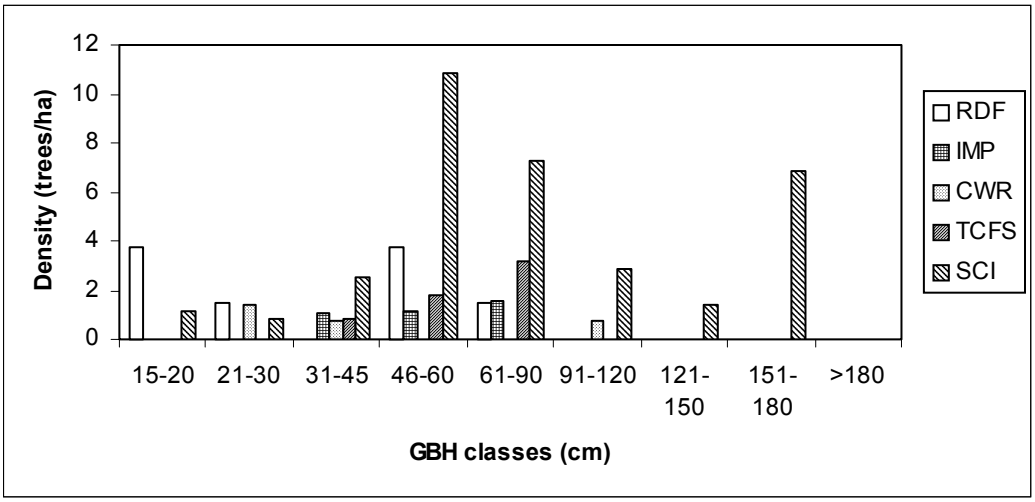


Fig. 5. Population structure of *Anogeissus latifolia* in Betul divisions

30 cm (1 tree/ha) and 31-45 cms (0.75 tree/ha) and 91-120 cms (0.75 tree/ha the species seems to be absent in all other girth classes. The CWR system usually favours lower and moderate girth classess for local use hence this might be partially responsible for it's representation in the aforesaid classes.

d) **Improvement Working Circle:** In this circle too, the distribution lies in the range of 31-45 (1 tree/ha), 46-60 (1 tree/ha) and 61-90 cms gbh class (1.75 trees/ha). The absence in the other gbh classes seems to be due to local use and biotic factors.

e) **Rehabilitation of Degraded Forests:** In the RDF areas, the lower girth classes ranging from 15-30 cms (4 trees/ha), 21-30 cms (1.5 trees/ha), 46-60 cms (4 trees/ha) and 61-90 cms (1.75 trees/ha), are the most common. The areas being close to habitations, the local people have been promoting this species in view of the local importance of the same.

6. *Adina cordifolia* or Haldu

The species belongs to the family *Rubiaceae* and is commonly known as *haldu*. It is a large deciduous tree with a large crown and cordate leaves. In forested conditions, the tree produces a straight clean bole but is often buttressed and fluted at the base. In more isolated conditions, it produces thick bole and massive branches with a spreading crown. *Adina cordifolia* is found scattered in deciduous forests in central India. The tree attains best dimensions in well drained soils e.g. the lower slopes of hills among boulders. It grows well on alluvial soils provided the drainage is good. The leaves are shed around February and the trees remain leafless upto May-June when new foliage appears. By October the globose fruit heads are almost fully formed but are green and unripe. They ripen and shed their seeds between April-June of the following year. The fruit heads that appear like small prickly balls fall to the ground and may be found there in considerable quantity during rainy season. The seeds are very small and light (0.062-0.12 inches long) with numerous minute wrinkles. Experiments at Dehradun have shown that the seeds if carefully stored retain their vitality up to a year. Germination takes place early in the rainy season. The seeds are produced in large numbers but the proportion of seedlings, which survive and establish themselves is very low. For successful germination under natural conditions, bare ground is essential and for successful establishment of young seedlings it is necessary that the seeds or even the young seedlings should be washed out of reach of floods during the rainy seasons. The seedlings have commonly been observed in following situations (i) small landslips on hill slopes, (ii) in loose earth and debris at the base of hills, (iii) on well drained alluvial soils near rivers, (iv) on abandoned cultivation e.g. taungya, (v) on the sides of embankment and ditches, (vi) on the edges of natural tanks and depressions, (vii) occasionally in the form of epiphytes in forks of or hollows in trees and (viii) in clefts in rocks. After germination the seedlings are extremely minute and delicate and are liable to be washed away or beaten by rain. During the first season, development is slow but rapid growth starts during the second growing season under favourable conditions. Stiff soils and weed are harmful for the growth. *Adina* seedlings are often mistakened for *Clerodendron infortunatum* seedlings, however the former can be distinguished by the terminal stipules enclosing the bud which are often reddish and the leaves are entire and glabrous. In case of the latter, the seedlings are serrate and pubescent.

Though the seedlings prefer shade from the sapling stage onwards, it is a strong light demander. Saplings are sensitive to rubbing of their leading shoots by overhead trees and their leaders tend to die where this takes place. Although the seedlings are sensitive to drought, the tree is moderately hardy. After the seedling stage it is moderately frost hardy. Young plants and coppice shoots suffer the most in comparison to other species from browsing by wild herbivores, goats and cattle. In spite of having a good power of recovery, it remains in bushy

condition if repeatedly browsed. Gaurs and sambar relish the woody saplings with bark. Protection from grazing is essential for the successful establishment of natural regeneration. As regards artificial regeneration, success has never been attained by means of direct sowing, however nursery raised seedlings can be transplanted.

a) **Teak Conversion WC:** There is absence of this species in all the girth classes except for 21-30 cms (2.5 trees/ha), 31-45 cm (1.25 trees/ha) and 91-120 cm (1.25 trees/ha) (Fig 6.) as the focus of this system is on conversion to teak. This species does not seem to have a future in this working circle.

b) **Selection-cum-Improvement:** This is the only working circle where the distribution of the species occurs in all the girth classes, albeit in varying frequencies. This system seems to be gentle on the species, however, the recruitment seems to be inadequate. There seem to be some large-sized trees too in this working circle which is a good sign.

c) **Coppice with Reserve:** These are the areas more prone to biotic disturbance and it is the combined effect of historical factors and biotic impacts which has called for the adoption of such a system. Except for the girth classes 21-30 (1.5 trees/ha), 31-40 cms (0.5 trees/ha) and 91-120 cms (0.75 trees/ha), the species seems to be absent in all other girth classes. The species is not at all represented in the recruitment class which might be due to biotic disturbance. This warrants management attention.

d) **Improvement Working Circle:** In this circle too, the distribution lies in the range of 21-30 cm (1.5 trees/ha), 31-45 cm (1.25 trees/ha) and 91-120 cm gbh class (1.25 trees/ha). The absence in the other gbh classes seems to be due to local use and biotic factors.

e) **Rehabilitation of Degraded Forests:** In the RDF areas, the lower to middle girth classes ranging from 15-30 cms and 61-90 cms, are absent pointing towards a poor regeneration. The areas being close to habitations, biotic disturbacce seems to be the reason. The species is only represented in the girth classes 91-120 cms that too in very low densities (0.75 trees/ha).

7. *Terminalia chebula* or Harra

Terminalia chebula is a large dimension tree with a rounded crown, spreading branches and a short trunk belonging to the family *Combretaceae*. It is widely distributed through the greater part of

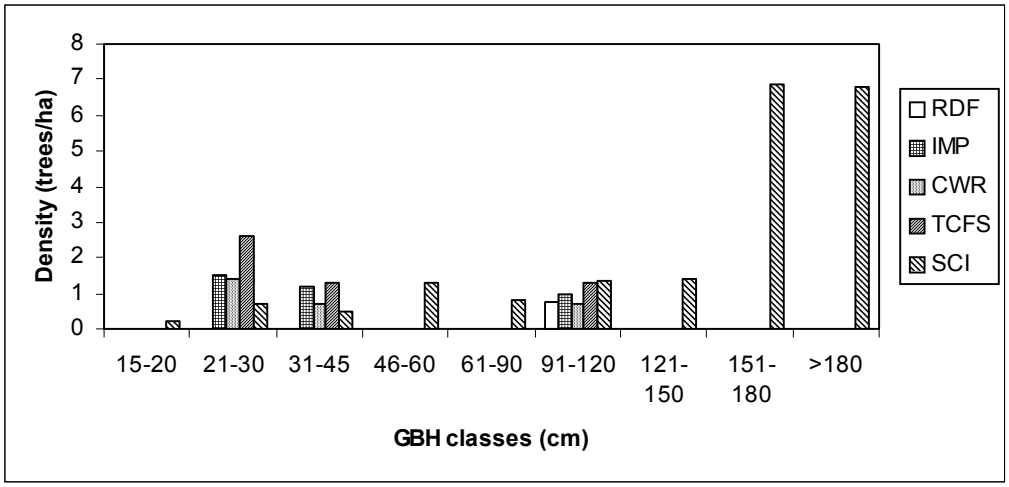


Fig. 6. Population structure of *Adina cordifolia* in Betul divisions

India and Burma in mixed deciduous forests extending into forests of comparatively dry types. It is found even upto 5000-6000 feet where rainfall is light. It is found on a variety of geological formations, and on clayey as well as sandy soil. In central India, it is found particularly on metamorphic rocks in open forest or village lands, but also occurs on other geological formations. In its natural habitat, the absolute maximum shade temperature varies from 98° F to 118° F, the absolute minimum from 30 ° F to 60 ° F and the normal rainfall from 20 to 130 inches.

In some localities the leaves commence falling in November, and by February or March the trees are usually leafless. New leaves appear from March to May; they are light green or sometimes copper-coloured. The spikes of greenish white flowers appear with the new leaves. In central India, flowering takes place to a small extent in July-August in addition to the usual flowering in April-May. The fruits ripen from November to March according to locality and fall after ripening. The fruit is a somewhat hard drupe 1-2 in. long obovoid, ellipsoid or ovoid, yellow to orange brown, sometimes tinged with red or black, 5 ribbed when dry. For commercial purposes, the fruits are collected when quite ripe and spread out in the sun until thoroughly dry. About 35 fresh fruits (or 60-75 dry fruits) weigh 1 lb. Germination is poor. Young seedling of *T. chebula* can be distinguished from *T. tomentosa* and *T. arjuna* by the length of the hypocotyl and cotyledonary petioles.

The tree is a light demander, though in youth it stands slight shade and even benefits from side protection by the sun. It is drought as well as frost hardy and withstands fire well. It is a good coppicer. The fallen fruits often become partially buried by rain making the soil around them black by the tannin they contain. Fleshy portion is eaten by white ants or degenerates, leaving the hard nut exposed and germination takes place in the rainy season. In some places there is a scarcity of natural reproduction. Lack of reproduction is attributable to some extent to the poor germinative power of the seed and because it is subject to attack by insects, rats and squirrels.

a) **Teak Conversion WC:** There is absence of this species in all the girth classes (Fig 7.) probably because of the focus of the system on conversion to teak. This species does not seem to have a future in this working circle.

b) **Selection-cum-Improvement:** This is the only working circle where the distribution of the species occurs in three girth classes, *viz* 15-

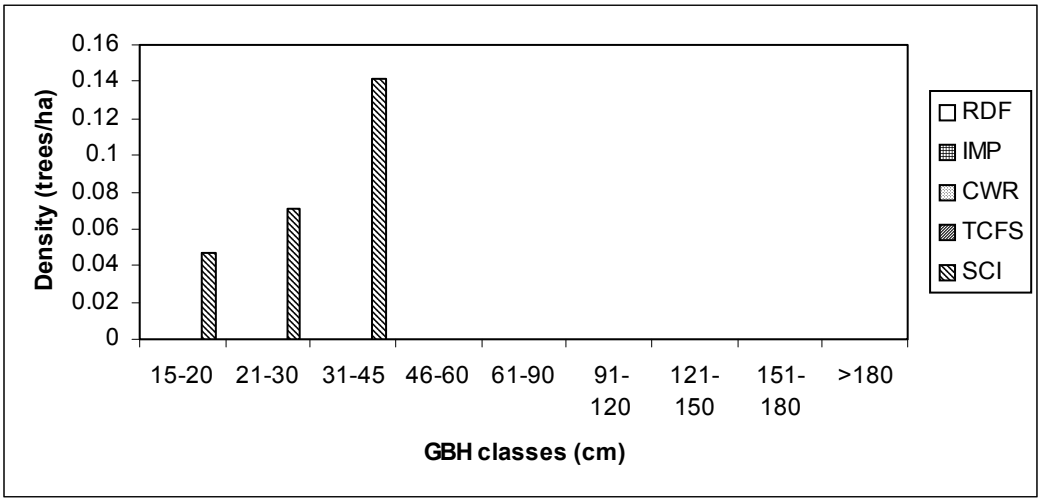


Fig. 7. Population structure of *Terminalia chebula* in Betul divisions

20 cm, 21-30 cm and 31-45 cm, that too in very, very low densities.

c) **Coppice with reserve:** These are the areas more prone to biotic disturbance and it is the combined effect of historical factors and biotic impacts which has called for the adoption of such a system. The species is absent in all the girth classes of this working circle.

d) **Improvement Working Circle:** In this circle too, there is no distribution in any of the girth classes.

e) **Rehabilitation of Degraded Forests:** In the RDF areas too, there is total absence of the species in all the girth classes.

8. *Acacia catechu* or Kaththa

The species belongs to the family *Leguminosae*. This is a moderate-sized deciduous tree with a light feathery crown and the branchlets armed with twin hooked prickles. The wood is largely used for house posts, agricultural implements, wheels, tool handles and other purposes. The substances '*cutc*h' and *'kattha'* are obtained by boiling down chips of the heartwood: the former being used for dying and tanning and the latter for chewing with betel nuts. The tree sometimes reaches a fair size upto 10.5 feet in girth. This tree is mainly found in:

i) Sandy alluvial beds of rivers and streams, which may or may not be dry for a considerable portion of the year. Here it is markedly gregarious, sometimes forming a pure patch, and

ii) Dry types of forests on highland away from water courses where it is frequently more or less gregarious, though commonly mixed with other species characteristic of dry regions.

Acacia catechu occurs on a variety of geological formations and soils, though it undoubtedly thrives best on porous alluvium composed of sand and shingle and on well-drained sandstone. It is known to occur on granite, gneiss, schist, quartzite, shale, basalt, trap, limestone, conglomerate and laterite. It is frequent on arid shallow stony soil and grows even on sheet rock. This tree is essentially a tree of comparatively dry regions, though in its alluvial form it extends into regions of heavy rainfall.

In the study area, it occurs in grasslands, and in teak forests of dry type as well as in forest devoid of teak, its commoner associates being *Terminalia tomentosa, T. chebula, Lagerstroemia parviflora, Anogeissus latifolia, Diospyros melanoxylon, Ougeinia dalbergiodes, Buchnania lanzan, Zizyphus jujuba, Z xylopyrus, Aegle marmelos, Butea monosperma, Emblica officinalis, Chloroxylon swietenia, Soymida febrifuga, Cleistanthuis collinus* etc as well as *Dendrocalamus strictus.*

At a time it was and in some places it still is heavily worked for catechu boiling. Tree is leafless during summers (March-May). The whitish flowering spikes appear in June and continue upto August or later, pods develop by September-October and ripen in December-January. The pods dehisce and seeds start falling in January, and to a considerable distance being air as well as water disseminated. The tree seeds every year.

Acacia catechu is a strong light demander. It is frost hardy within its habitat; however young seedlings are tender. Although it is xerophilous in its character, and capable of growing in dry situations, it may suffer in years of severe and abnormal drought as in 1899-1900 in peninsula and 1914-15 in Palamau. The tree produces root-suckers, particularly where the roots are exposed; coppice shoots, however require complete light for their development and the stools die off in shade. It is badly affected by grazing and responds readily to closure to grazing.

a) **Teak Conversion WC:** This species is present only in the girth class 31-45 cms (1.25 trees/ha) (Fig 8.) in this working circle. The

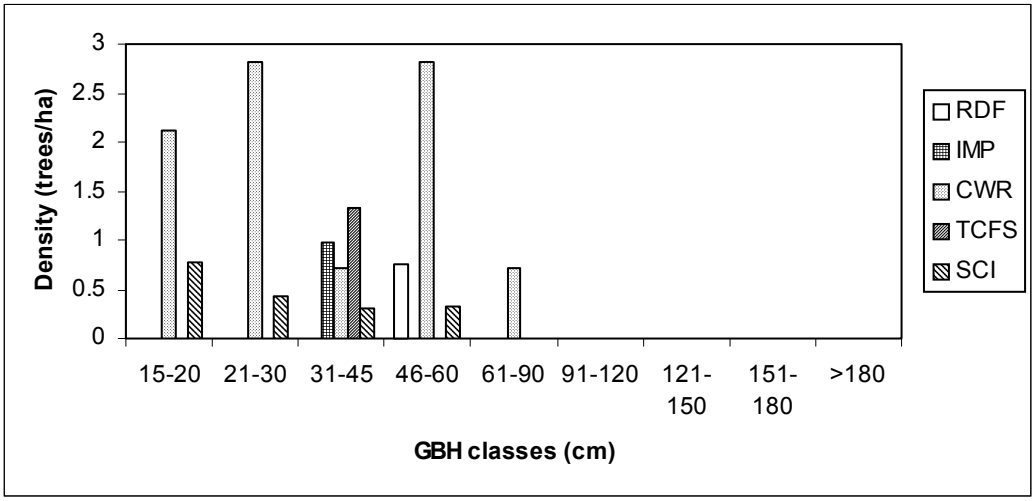


Fig. 8. Population structure of *Accacia catechu* in Betul divisions

management is focused on teak hence this species gets discouraged.

b) **Selection-cum-Improvement:** In this working circle, the distribution of the species occurs in nearly all the girth classes upto 41-60 cms, albeit in varying densities between 0.25 to 0.75 trees/ha. There is a steady decrease in density from gbh class 15-20 to 46-60 cms

c) **Coppice with Reserve:** These are the areas more prone to biotic disturbance and it is the combined effect of historical factors and biotic impacts which has called for the adoption of such a system. Except for the girth classes 15-20 cms (2 trees/ha) 21-30 (2.8 trees/ha), 31-40 cms (1.25 trees/ha), 46-60 cm (2.9 trees/ha) and 61-90 cm (0.6 trees/ha), the species seems to be absent in all other girth classes.

d) **Improvement Working Circle :** In this circle too, the distribution lies in the range of 31-45 cms (1.0 tree/ha). The absence in the other gbh classes seems to be due to local use and biotic disturbance.

e) **Rehabilitation of Degraded Forests:** In the RDF areas, the medium girth class ranging from 41-60 cms (0.6 trees/ha) is found.

9. *Lagerstroemia parviflora* or Dhaura

The species belongs to the family *Lythraceae* and is commonly known as *Dhaura, lendia* and *sidha*. It is a large deciduous tree but in poor localities it may be smaller. The bark is light grey to reddish, thin, smooth, exfoliating in narrow flakes. The wood is very hard and durable. It is used for buildings, agricultural implements, carts, boats, shafts, axe-handles etc. Large trees are often hollow in the center and the timber has the fault of splitting to a good deal in the center. Apart from its economical value the tree is important ecologically and silviculturally as a common companion of sal and teak. The tree is in fair quantity throughout, the dry mixed forests of the Indian peninsula as far south as the Nilgiris, in association with *Tectona grandis*, *Terminalia tomentosa, Anogeissus latifolia, Diospyros melanoxylon, Ougenia dalbergioides* and other associated species. In the Bori Reserve girth upto 450 cms has been measured.

The tree can accommodate itself to variety of soils and geological formations, including black cotton soil and trap. It thrives best on deep porous loam and although it is found in clay it does not tolerate water logging. In its natural habitat, the maximum absolute shade temperature is 100° to

118° F and the minimum 30° F to 50° F and the normal rainfall varies from 30-180 inches.

The leaf shedding starts in February- March and the new leaves start appearing by April- May. The flowers appear around April to June and the fruits ripen and open from December to February. They become brown on ripening and stay on the tree for some time. The seeds are brown with terminal papery wing having a stiff curved ridge along one edge. The germinative power of the seed is frequently poor.

The tree is a strong light demander, and soon becomes suppressed under shade. It is fairly frost hardy. Cattle avoid it and on heavily grazed areas coppice shoots often remain untouched after most of the other species have disappeared. The tree coppices and pollards vigorously.

a) **Teak Conversion WC** : There is absence of this species in all the girth classes beyond 91-120 cms (Fig 9.). But for the density in 31-45 cm class (0.5 trees/ha), the distribution seems to be normal (skewed).

b) **Selection cum Improvement:** In this working circle the distribution of the species occurs in all the girth classes, upto 91-120 cms, albeit in varying frequencies. Again, if the data of 31-45 cms class is omitted, the curve is normal. This system seems to be gentle on the species.

c) **Coppice with Reserve:** These are the areas more prone to biotic disturbance and it is the combined effect of historical factors and biotic impacts which has called for the adoption of such a system. The species seems to be of significant importance to people. The species is represented in the girth classes 15-20 cms to 61-90 cms in varying frequencies, the reason being that the coppies are not grazed and get a chance to survive. Low frequencies in the 31-45 and 61-90 cms, girth classes may be attributed to pressure on account of local use.

d) **Improvement Working Circle:** In this circle too, the distribution lies in the range upto 61-90 cms that too in low density. The absence in the other gbh classes seems to be due to local use and biotic disturbance.

e) **Rehabilitation of Degraded Forests:** In the RDF areas, the lower girth classes ranging from 15-30 cms and 91-120 cms, are present in low densities (upto 4 trees/ha). This is because the species can bear some amount of biotic disturbances, which are obvious in the areas under this treatment.

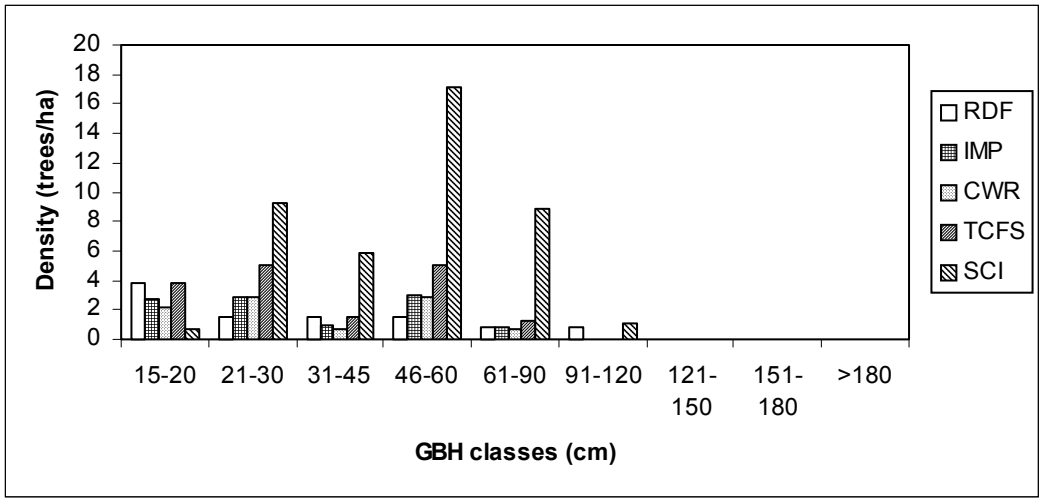


Fig. 9. Population structure of *Lagerstroemia parviflora* in Betul divisions

10. *Madhuca indica* or Mahua

The species belongs to the family Sapotaceae and is popularly known as *mahua* or *moha*. A large deciduous tree usually with a short bole, spreading branches and a large, round crown. The bark is grey and bears vertical cracks. This is one of the most important forest trees of India mainly due to the fleshy corolla of its flowers, which are eaten raw or cooked or are dried, ground or mixed with flour for making cakes or are distilled into liquor. A thick white oil extracted from the seed is used by tribals for cooking and burning. The oil is sold for the manufacture of margarine, soap and glycerine. The wood is of good quality, but the tree is seldom felled owing to the value of its flowers and fruits. It is the most common species of the deciduous forests of central India often growing on dry rocky or sandy soil and thriving on the Deccan trap. In the past whenever forested land had been cleared for cultivation, the *mahua* trees are carefully preserved, and may be found scattered over cultivated lands long after the clearing has taken place.

The leaf fall continues from February-April and new leaves appear between April and early May. The brown flower buds appear at the end of thick branchlets early in February and the flowers open from the end of February to April. The corolla is 0.5-0.6 inches long, cream coloured, fleshy and sweet and fall soon after opening. They are collected in large quantities off the ground usually in places swept bare under the trees. The flowers are eagerly devoured by sloth bear, deer, many other wild animals and even cattle. Fresh seeds have a high percentage of fertility but it loses its vitality on storage and is highly prone to attack by insects and fungi. Seeds so affected become rough and blistered, the surface often assuming a silvery colour. This has adverse effects on natural regeneration. The growth of the seedling is comparatively slow and does not tolerate weeds. It is capable of thriving on poor dry ground. However, it is apt to suffer adversely sometimes in cases of abnormal drought. It is ordinarily frost hardy but does not stand severe frost. In its younger stages, it is heavily browsed by wild herbivores and cattle. For successful germination, it is important that the seed should be covered by earth or debris otherwise it is liable to be attacked by fungi or may be eaten by insects. Natural seedlings are thus found mainly in slight hollows into which earth is washed at the onset of monsoon. As regards artificial regeneration the tree may be propagated either by direct sowing of seeds or by transplanting from nursery. It coppices fairly well if cut in dry season but not in rains. The *mahua* crop is of great importance to local tribals and villagers who eagerly look forward to a good flowering season since it does not occur every year. Trees are said to commence flowering and fruiting when about ten years old. The yield of *mahua* (corollas) per tree is said to be 82.5 lb a year when 15 years old and increases to around twice when in full bearing.

In central India, the tree suffers greatly from attacks of *Loranthus*, a parasite which kills the tree and dies after doing so. The parasite may affect large number of trees. Special measures are required to be adopted to deal with this parasite.

a) **Teak Conversion WC:** There is presence of this species in all the girth classes except for 31-45 cms and 121-150 cms (Fig 10.) since it is not felled and is of extreme importance to local tribals.

b) **Selection-cum-Improvement:** This is the only working circle where not only does the distribution of the species occur in all the girth classes, (in varying frequencies) but also the higher girth classes are found in higher densities (as it is reserved against felling). This system seems to be gentle on the species. However, the recruitment needs to be more and is probably affected by extensive collection, grazing and annual fires.

c) **Coppice with Reserve**: These are the areas more prone to biotic disturbance and it is the combined effect of historical factors and biotic impacts which has called for the adoption of such a system. The species seems to be of significant importance to people. Except for the

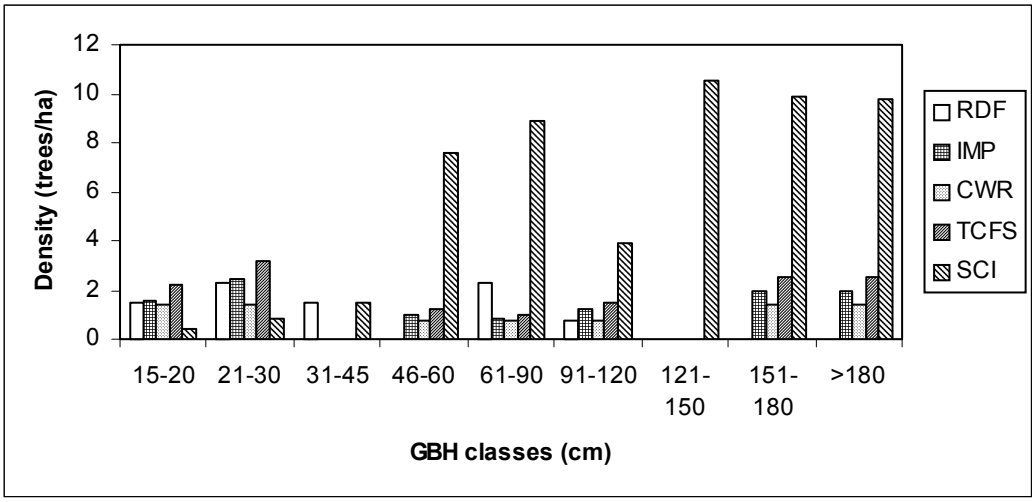


Fig. 10. Population structure of *Madhuca indica* in Betul divisions

girth classes 31-45 and 121-150 cms, the species seems to be present in all other girth classes but in lower densities.

d) **Improvement Working Circle:** In this circle too, there is absence of girth classes 31-45 and 121-150 cm.The lower and higher classes are seen to be more than the middle ones probably due to retention of large trees and protection by locals and improvement works by the Forest Department.

e) **Rehabilitation of Degraded Forests:** In the RDF areas lower girth classes ranging from 15-30 cms to 31-45 cms, are found and also 61-90 and 91-120 cms. The areas being close to habitations, the local people have been promoting this species in view of the local importance of the same. The point that local importance does not always mar the prospects of the species is proved here. With further awareness regarding the use of species and promoting further the growing stock, the species can do well and also cater to the requirement of local people.

11. *Lannea coromandelica* or Moyan

Lannea coromandelica is a large deciduous tree that grows throughout the greater part of India and has an ash coloured bark which has a red blaze. Flowers are purplish in crowded cymose fascicles. The wood is soft, weighs about 8 quintal per cubic metre and used for packing cases. The bark is used for tanning and the leaves are a good fodder.

a) **Teak Conversion WC**: There is presence of this species in all the girth classes except for 15-20 cms amd 151-180 cms and beyond (Fig 11.). There is no representation in the recruitment class indicating constraint in regeneration.

b) **Selection cum Improvement:** This is the only working circle where the distribution of the species occurs in nearly all the girth classes, albeit in varying frequencies except above 150 cm gbh. This system seems to be gentle on the species and the densities show a normal distribution.

c) **Coppice with Reserve:** These are the areas more prone to biotic disturbance and it is the combined effect of historical factors and biotic impacts which has called for the adoption of such a system. The species seems to be of significant importance to people. Except for the girth classes 15-20 cm and that beyond 150 cm the species seems to be present in all other girth classes although in low densities (except that in gbh class 46-60 cm where it is 3 trees/ha).

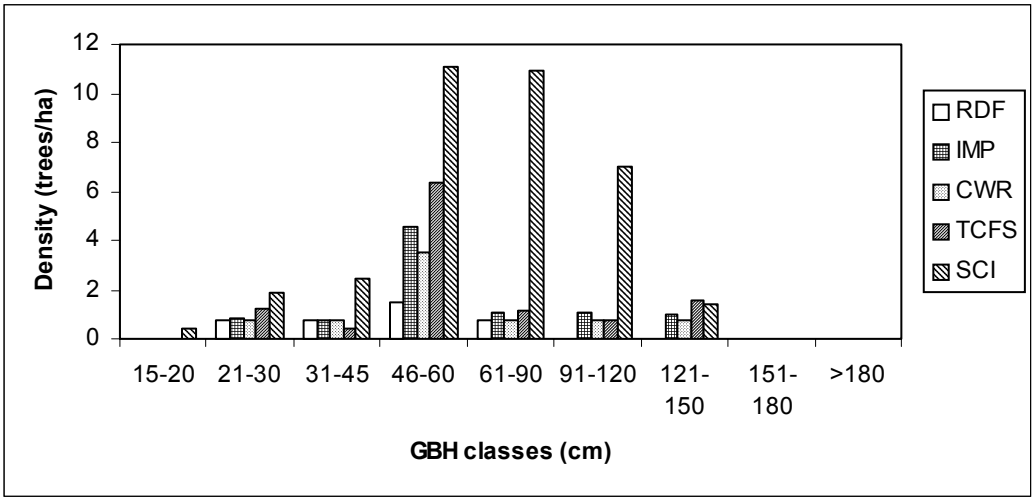


Fig. 11. Population structure of *Lannea coromandelica* in Betul divisions

d) **Improvement Working Circle:** In this circle too, the distribution lies in the range of 21-30 (1 tree/ha) and the density is almost same in the gbh classes ranging from 31-45 to 121-150 cms excepting an exceptionaly high density (4.5 trees/ha) in the gbh class 46-60 cms. The absence in the gbh classes 15-20 cms is a cause of concern.

e) **Rehabilitation of Degraded Forests:** In the RDF areas, the lower girth classes ranging from 21-30 cms and 61-90 cms, are found.

12. *Terminalia tomentosa* or Saja

The species belongs to the family Combretaceae and is locally known as *sain*, *ain, saja, asna, asan* in Hindi. It is a large deciduous tree with a long and clean bole and a full crown. The bark is typically known as crocodile bark, which is deep grey in colour, with longitudinal fissures, and transverse cracks dividing it into oblong scales and is red inside. The wood is dark brown with darker streaks, and is hard and is quite durable. The wood is used for buildings, carts, railway wagons, mine props, bedsteads etc. The wood lasts well under water.

Apart from its economic importance the species has a great ecological significance and is very important silviculturally as being one of the commonest of Indian forests trees and being suitable for afforestating clayey grounds. In favourable conditions it attains a girth of around 3.6 m. and a height of about 30 m. but on dry rocky ground and other unfavourable situations it remains stunted. One important feature to be noted as regards leaves is that as a rule, the leaves are large and tomentose in less favourable conditions and small and glabrous in best-suited conditions. It is one of the most common and most widely distributed of the Indian forest trees. The tree attains its largest dimensions in deep rich alluvial soil. On poor shallow soil, particularly on hilly ground, though often plentiful, it remains stunted. *Terminalia tomentosa* occurs pure or mixed with *Anogeissus latifolia* on rich alluvial ground besides rivers. *Terminalia tomentosa* is common in deciduous forests of central India and forms a common companion of sal and teak. It prefers black cotton soil here which most of the species avoid but does remain stunted. It tends to be gregarious near moist fertile alluvium near rivers and riparian areas. The leaves start falling in January or February in moist areas and March and April in drier areas. The new leaves appear in June. In early part of the rainy season the whitish blossom of inflorescence against delicate green leaves is a beautiful sight. The fruit ripens in March and falls upto May. It has a hard bony axis with five coriaceous wings and is brown

when ripe. Insects and birds often eat unripe fruits. Parakeets often eat most of the unripe fruits. The fertility of the seed is low. Tests indicate that the germination percent is 45%. The seedlings obtained are fairly hardy against drought but more sensitive to frost. Birds often eat the cotyledons of the seed and deer and cattle browse the seedlings and wild pigs uproot them most of the times.

Terminalia tomentosa is a light demander, and is rapidly suppressed by the under shade. It grows well in variety of soils. Trees upto medium size coppice and pollard well. It is extensively lopped for ash manure for crops in Maharashtra and in some localities it is lopped for cattle fodder. Despite poor regeneration power the species is gregarious. This may be because though the germination is less once germinated the seedlings do survive. Excessive grazing and trampling is a serious menace to natural reproduction. Fire destroys most of seeds fallen.

a) **Teak Conversion WC :** There is absence of this species in all the girth classes except for 21-35 cms, 61-90 cms, 151-180 cm and that above 180 cms (density 1tree/ha or lower in all cases) (Fig 12). The species lacks representation in the recruitment classes.

b) **Selection-cum-Improvement:** This is the only working circle where the distribution of the species occurs in all the girth classes, in varying frequencies and shows a normal distribution curve. This system seems to be very gentle on the species.

c) **Coppice with Reserve:** These are the areas more prone to biotic disturbance. Except for the girth classes 21-30 cms, 61-90 cms, 151-180 cms and >180 cms, the species seems to be absent in all other girth classes.

d) **Improvement Working Circle:** In this circle too, the distribution lies in the range of 21-30 cms, 61-90 cms, 151-180 cms and that above 180 cms with distribution equal to or above 1 tree/ha.

e) **Rehabilitation of Degraded Forests:** The species is represented (less than 1tree/ha) in the girth class 31-45 only.

13. *Diospyros melanoxylon* or Tendu

The species belongs to the family Ebenaceae. Its a small to moderate sized tree, occasionally a large tree, with leaves opposite, sub- opposite, alternate, coriaceous and varying much in size and form. The bark is greyish black exfoliating in regular rectangular scales. The wood is hard and reddish brown in colour, with irregular black heartwood sometimes streaked with purple or brown. The wood

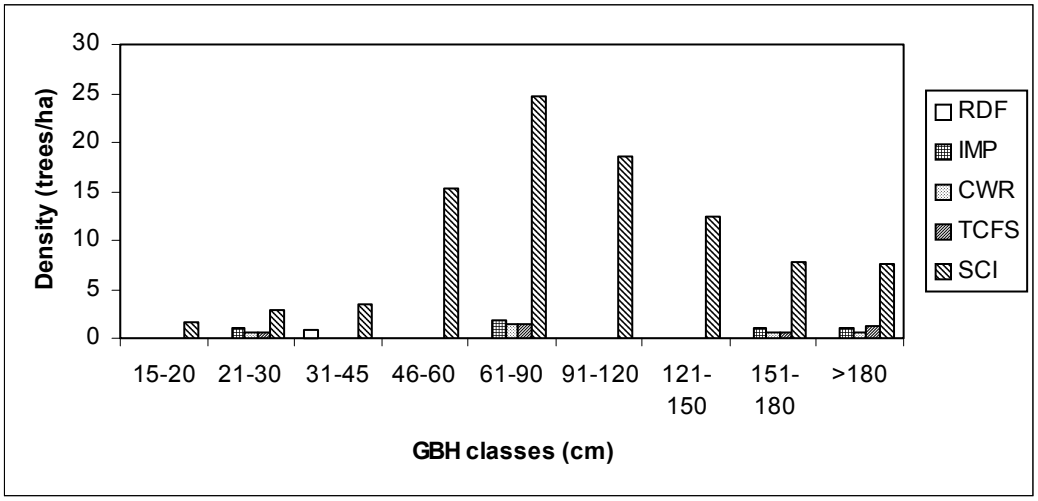


Fig. 12. Population structure of *Terminalia tomentosa* in Betul divisions

is used for buildings, shafts and shoulder poles. The wood can also be carved into walking sticks, picture frames and fancy articles. The wood while burning emits showers of sparks and therefore not safe for fuel. Silviculturally, this tree is of importance in clothing dry poor ground and is interesting owing to its wonderful hardiness in surviving mal-treatment. This is the most characteristic tree of dry mixed deciduous forest throughout India. It is locally common even in sal areas often replacing sal where the ground is poor to support the latter. In central Indian highlands it appears to reach its best on metamorphic formations. The tree is leafless for a short time of the year in the hot season. It is frequently never quite leafless. The flowers appear in April- June and the fruits ripen between April - June the following year. The seeds are oblong compressed 0.5 to 1.5 in. long brown with wrinkled testa. Fresh seeds have high fertility. The fruits are readily eaten by fruit bats and birds, notably hornbills which can be seen in large numbers around the trees at the time of fruiting. They serve as seed dispersal agents. During the first season the growth is quite fast but in the second growing season the growth slows down. Under unfavourable conditions dying back may take place especially in drought conditions.

In the seedling and the pole stage the tree stands moderate shade, but later requires light. It is frost hardy and resists frost more successfully than any other species. The species is highly drought resistant and is recorded to have survived the severest of droughts in India for example of that of the 1899-1900 one in the Indian Peninsula. Though it was affected adversely to some extent the root suckers escaped injuries. Young plants and suckers are immune from damage by browsing. Even in heavily grazed areas in central India prevalence of stunted growth of the species is a very familiar sight, the development of the seedling being probably hindered by trampling and hardening of the soil and not by browsing.

The tree coppices moderately well but the growth of coppice shoots is slow. The tree pollards better but the growth of pollard shoots is also slow. It is established through experiments in north Chandrapur that the coppicing power is poor after April and nearly nil during August. The extensive production of root suckers, however, is one of the remarkable characteristic features of the species. Its hardiness and immunity from damage by grazing assists it to establish gregariously. On cleared forest the sucker reproduction persists for many years after other species have disappeared and its eradication is difficult if the land is being prepared for cultivation. On abandoned cultivation sites sucker growth springs up readily, and if left alone may give rise to a pure crop of *Diospyros*.

Fruit-bats, hornbills and other birds assist in seed dispersal and sometimes seedlings are found in the forks of trees. Under natural conditions, germination begins in early rainy season and continues during the season. Some seed may remain dormant and germinate in the subsequent rainy season. The profusion and tenacity of sucker production is itself sufficient to ensure survival of the species even without the aid of seedling regeneration. The rate of growth of the species is very slow.

It is one of the most important non-timber forest produce used as 'bidi' wrappers. The tender (freshly matured) leaves obtained from coppices is used for making wrappers. A 'bidi' is prepared by rolling tobacco in a piece of tendu leaf. Semi-mature/ mature leaves are collected from cut-back tendu bushes/trees and after proper seasoning and drying, are used as 'bidi' wrappers. In most part of the study area, tendu leaf collection is a major source of income for tribals for their subsistence. Another important produce of '*tendu*' tree is its fruits which is very nutritious and resembles '*cheeku*'. These fruits are relished by the wild herbivores.

Since the species is usually moderate sized, the analysed data shows more distribution above the girth class 60-90 cm in any of the working circles except selection-cum-improvement and Teak Conversion Working Circle which may be the trees

prevented against marking due to inaccessibility, vicinity to roads or streams etc and retention of the species due to its utility (Fig.13).

a) **Teak Conversion Working Circle:** There is considerable distribution of the species in girth class upto 45 cm. but in very low densities i.e. below 5 trees/ha. (Fig. 13). This is owing to the high regenerating power of the seeds and production of root suckers which is the characteristic of the species. The classes 15-20, 21-30 and 31-45 cms contribute mainly to the collection of tendu leaves obtained from coppice and pollarded shoots. More distribution in these classes also indicates towards these being results of coppice shoots and pollard shoots. These may be basically coming from the trees and the reason for low distribution may be attributed to the fact that for tendu leaf collection only coppice and pollard shoots are maintained. As regards distribution of the species in the lower girth classes, these may be basically fringe areas, areas adjoining to villages and under extensive grazing pressure because in general, TCWC areas are areas with a good soil cover and favouring growth of teak and its associates. However, a sizable presence in the girth class 151-180 cm may be on account of trees which have survived along with teak and its main associates.

b) **Selection-cum-Improvement Working Circle:** This species is not important from the point of view of exploitation where selection and pre-selection girth are fixed for different target species (mostly teak and its dominant and co-dominant associates). Occurrence of sprinkles of this species in the girth class 61-90 and 91-120 cm (less than 1 tree/ha) may be attributed to trees in inaccessible areas and those which got reserved during felling as per the prescriptions. In spite of the species being a hardy one and with higher germination percent, the distribution in the girth class 15-20 cm is as low as (4 trees/ha) indicating very low recruitment. The distribution in the girth classes 21-30 cm and 31-45 cm is around (3.5 trees/ha). This is again not a steady recruitment for survival of species. The density in the girth class 46-60 cm (7 trees/ha) is again owing to the trees surviving in this class along with teak and its main associates. Since in this particular girth class, distribution is found in nearly all the working circles, it may be attributed to maintaining the trees for seed production and for its fruit which is of significant importance to the local people. Though some representation is found in all the girth classes of selection-cum-improvement system, it is not adequately supporting the survival of the species.

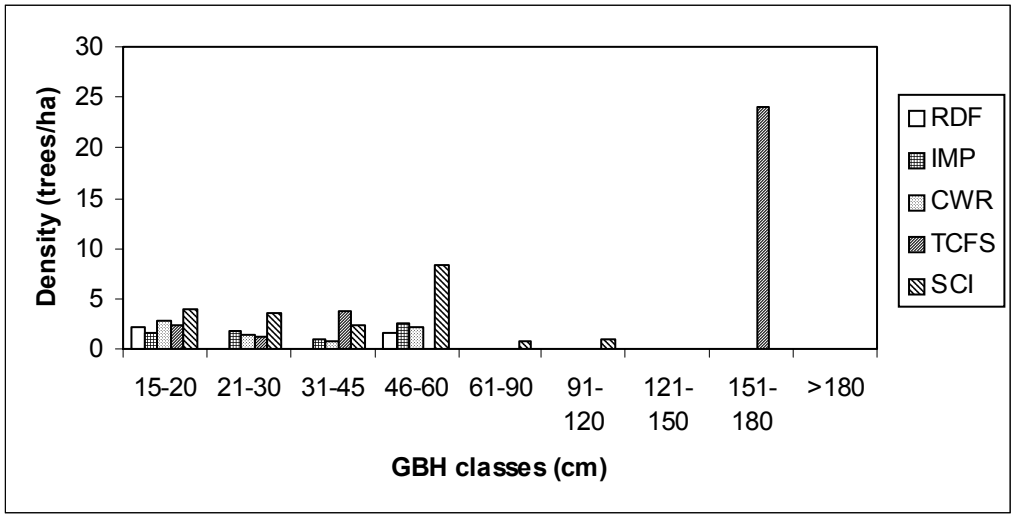


Fig. 13. Population structure of *Diospyros melanoxylon* in managed forests of Betul divisions

c) **Coppice with Reserve:** The presence in the GBH class 15-20 cm is the maximum (3 trees/ ha) indicating good recruitment by way of natural regeneration, root sucker production coppice and pollard shoots. In the GBH class 21-30 cm also a sizable distribution of 2 tree/ ha is observed. This indicates the species being favoured in these two girth classes on account of leaf collection. The trend in the girth classes 21-30 cm and 31-45 cm is somewhat the same as for the TCWC and SCI the reasons being the same thereof except for an additional reason of these being the reserves in CWR. The distribution trend in the girth class 46-60 is the same as in Improvement Working Circle (2.5 trees/ ha). The coppice with reserve system seems to be favouring the survival of the species and its utilization for tendu leaf collection.

d) **Improvement Working Circle:** Since these are highly degraded areas, which are unable to support good tree growth, such areas being suitable for the *Diospyros* it being a very hardy species, a maximum distribution (1 tree/ha) compared to other working circles is found in the girth class 15-20 cm. This is also a result of root sucker production, coppice, pollard shoots and to some extent regeneration by seeds. The distribution in the GBH class 21-30 cm is also around (1 tree/ha) which is far less than that in TCWC and CWR. This may be on account of more attention being paid to teak and its associated timber species of greater commercial value. The distribution trend in girth classes 31-45 cm and 46-60 cm is the same as in the preceding three working circles already discussed. The additional reasons that may be attributed to the distribution in these girth classes may be- a) these are basically areas close to habitation, inaccessible areas or areas degraded on account of less soil cover; b) dependency of local people for small timber and its edible fruits.

e) **Rehabilitation of Degraded Forests Working Circle:** Distribution of around 2 trees/ha is observed in GBH class 15-20 cm which may be purely attributed to the survival of the species on its own it being a die-hard and damage resistant species. Some amount of minor distribution (1 tree/ha) is observed in the girth class 46-60 cms. Though the working circle aims at reforestation of the areas by artificial regeneration and the choice of the species being those of economic importance, the species is doing well on its own. However, it would be in the interest of such areas that *Diospyros* be allowed to dress up the area and allow encouragement of the existing root stock of even the other species instead of going for planting of economically important species which may not survive in the long run.

14. *Ougeinia dalbergiodes* or Tinsa

This is a common tree of the plateaux in central India. The species belongs to the family *Leguminosae*. A small to moderate–sized tree, often with a crooked stem. Leaves are pinnately trifoliate, crown full and rounded in well-developed trees. Bark is upto 0.5 in thick, ashy grey or light brown with regular longitudinal and horizontal cracks, exuding a red gum when cut. The wood is hard, coarse-grained and in great demand for agricultural implements and carts. It also finds use in making furniture. In exceptional cases, the tree has been found to attain a girth of 7 feet and a height of 60 feet, but ordinarily it does not grow to more than 4.5 feet in girth and 30-40 feet in height.

It has a distribution in the sub-Himalayan tract and outer Himalayan valleys and slopes up to 5000 feet from Punjab to Bhutan, Chota Nagpur, Central India, Orissa and the Circars, the central provinces and Bombay. The tree occurs in parts of the Marwar state of Rajputana but is of small size and not abundant (Troup, 1986).

In the peninsula, it is found in mixed deciduous forest, where it is sometimes abundant and almost gregarious. In parts of the central provinces, it reaches very fair dimensions with a straight clean bole. It is by no means exacting on to soil, and is

found on a variety of geological formations including shale, gneiss, trap, laterite, sandstone, quartzite etc. and on a variety of soils including black cotton soil, red clay and gravel or boulder deposits. It also thrives on very poor ground, where it does not attain very large dimensions. It is very characteristic of landslips, banks, the sides of ravines, and other exposed places. In the peninsula, some of its most typical companions are *Terminalia tomentosa, T. belerica, Anogeissus latifolia, Lagerstroemia parviflora, Buchnania lanzan, Butea monosperma, Emblica officinalis, Pterocarpus marsupium, Dalbergia latifolia, Xylia xylopyra* and *Tectona grandis.* It is very common both in mixed deciduous forests and in sal forests; it ascends higher than most plain species, but at the higher elevations it is of small size. In its natural habitat, the absolute maximum shade temperature varies from 100^0 F to 115^0 F, the absolute minimum from less than 30^0 F to 45^0 F and the normal rainfall from 35 to 70 inches.

The leaves are shed in January-February, and the new leaves appear in March-April. The lilac or whitish flowers, in fascicled racemes appear in Feb-Mar. and the trees are a conspicuous and beautiful sight in the flowering season. The pods form quickly and ripen in May-June. They fall in June-July and are dehiscent during germination (not before that). The seed-year records show that the tree does not seed abundantly every year. Root suckers of comparatively small size produce flowers and fruits.

The tree stands a fair amount of shade when young and requires a certain amount of protection from the sun in its early stages. Once it is established, however it requires full overhead light for its best development. In its early stages it is tender to drought and frost however, after that it is hardy. It is also browsed by domestic as well as wild ungulates. It coppices well and produces root suckers particularly along steep banks and hill sides where suckers may be sprouting even from the joints on the sides of cliffs; hence this species is an important one for clothing unstable hillsides. This species is fire-sensitive and responds readily to fire protection. It is not exacting as regards soil and will grow on poor soil. The root system of the species is characteristic in that it has an often twisted taproot with numerous lateral rootlets for the purpose of nutrition that are superficial and very long and thick. Roots of the latter type have numerous buds from which root suckers are produced.

Under natural conditions, the flat light pods are carried by wind to some distance from the tree immediately before and at the commencement of the monsoon germination takes place. The seeds germinate and seedlings establish best on bare loose ground, and for this reason profuse natural seedling reproduction appears along sides of roads, ground exposed by landslips and also on cultivated ground. It is observed in experimental plots that

a) on hard bare ground, where the seed germinates on the surface, great mortality occurs through drought, the radicles drying up before they can penetrate the soil, particularly in open areas exposed to the sun;

b) seeds falling among weed and grass, if these are at all dense, tend to rot before or during germination, and natural reproduction thus fails; however in places exposed to the sun where weeds are scanty, these may be beneficial in affording protection from the sun;

c) slight or moderate shade favours germination and development of seedlings by protection from the sun but dense shade kills them off.

In the forest pure natural crops of high density are often met with, sometimes under the light shade of other trees and sometimes in gaps in the forest crop.

As regards artificial propagation, reproduction by stem cuttings gave indifferent results. While planting root cuttings was quite successful, a considerable portion sending up suckers; the thicker root cuttings were found to produce more vigorous shoots than thinner ones. As regards reproduction by seed, the best results were obtained by line

sowing with regular weeding. Transplanting from the nursery has also proved moderately successful provided young plants are used before they have developed long taproots.

a) **Teak Conversion WC:** There is absence of this species in all the girth classes except for 15-20 cms and 21-30 cms (1.25 trees/ha) (Fig 14). As the focus of this system is on conversion to teak, this species does not seem to have a future in this working circle.

b) **Selection-cum-Improvement:** This is the only working circle where the distribution of the species occurs in nearly all the girth classes, albeit in varying frequencies except for that above 121-150 cm gbh. This system seems to be gentle on the species.

c) **Coppice with Reserve**: These are the areas more prone to biotic disturbance and it is the combined effect of historical factors and biotic impacts which has called for the adoption of such a system. The species seems to be of significant importance to people. Except for the girth classes 15-20 and 21-30 cms, the species seems to be absent in all other girth classes

d) **Improvement Working Circle**: In this circle too, the distribution lies in the range of 15-20 cms (0.97 trees/ha) and 21-30 cm gbh class (1.1 trees/ha). The absence in the other gbh classes seems to be due to local use and biotic disturbance.

e) **Rehabilitation of Degraded Forests**: In the RDF areas, the lower girth classes ranging from 15-20 cms (1.5 trees/ha) and 31-45 cms (4.5 trees/ha) are the most common. The areas being close to habitations, the local people have been promoting this species in view of the local importance of the same. The point that local importance does not always mar the prospects of the species is proved here. With further awareness regarding the use of species and promoting further the growing stock, the species can do well and also cater to the requirement of the local people.

15. Other miscellaneous species: Other miscellaneous species include species that are distributed in the area in lower densities. However, these species are not less important in any way. These include *Lannea coromandelica, Sterculia urens, Butea monosperma, Emblica officinalis, Aegle marmelos, Acacia leucophloea, Zizyphus mauritiana, Carissa congesta, Zizyphus xylopyrus, Balanites aegyptiaca, Cassia fistula, Grevia tiliaefolia, Wrightia tinctoria, Zizyphus numularia,* and *Carissa auriculata*. The

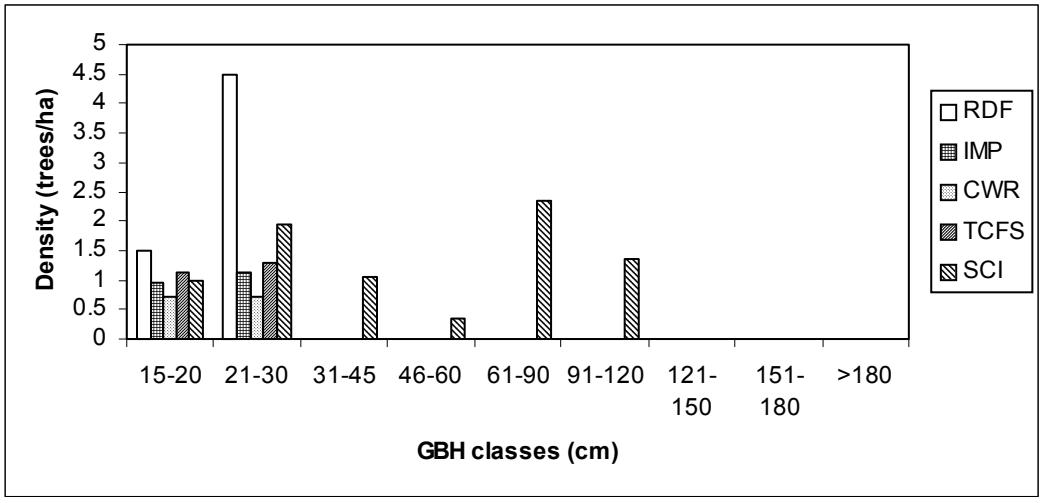


Fig. 14. Population structure of *Ougeinia dalbergiodes* in Betul divisions

performance of the other miscellaneous species is shown in Fig 15.

a) **Teak Conversion Working Circle:** In this working circle, other species are found in very low densities above 61-90 cms girth class and more below that and those that are present represent associates of teak mostly. The reason is quite obvious – preference of teak to other species.

b) **Selection-cum-improvement Working Circle:** This working circle shows a more or less normal distribution curve with low proportion of individuals in lower and higher girth classes and maximum in the middle.

c) **Coppice with Reserve Working Circle:** These species have relatively good distribution only upto 61-90 cms.

d) **Improvement Working Circle:** In this working circle, individuals are distributed upto 91-120 cm gbh classes.However, recruitment seems to be very low. There is an exceptionally high density in the class above 180 cms, which may be due to prescriptions of the Working Circle.

e) **Rehabilitation of Degraded Forests Working Circle:** The distribution of individuals in this working circle is very low (below 10 trees/ha) and only upto 61-90 cms girth class.

2.14 NTFP species

Non-timber forest produce diversity and utilization is culturally and economically significant for forest dwelling people. The term NTFP covers all products in the forest eco-system which do not contain wood, such as medicinal plants, resins, oils, fruits and the products from hunting animals. They are used at differing degrees of intensity depending on the eco-region. Non-Timber Forest Produce (NTFP) have been exploited for centuries in the managed forest divisions of Betul by local people. These non-timber forest products include a variety of edible, medicinal, horticultural, and craft products. They are used for personal consumption, raw sale, and processed sale. Commercial timber harvest has also been a regular feature of this area since 1862. The adjoining area consisting of the three protected areas *viz.* Satpura National Park, Bori Wildlife sanctuary and Pachmarhi Wildlife sanctuary are not under such pressures currently but had similar activities of commercial logging, grazing and NTFP collection in the past.

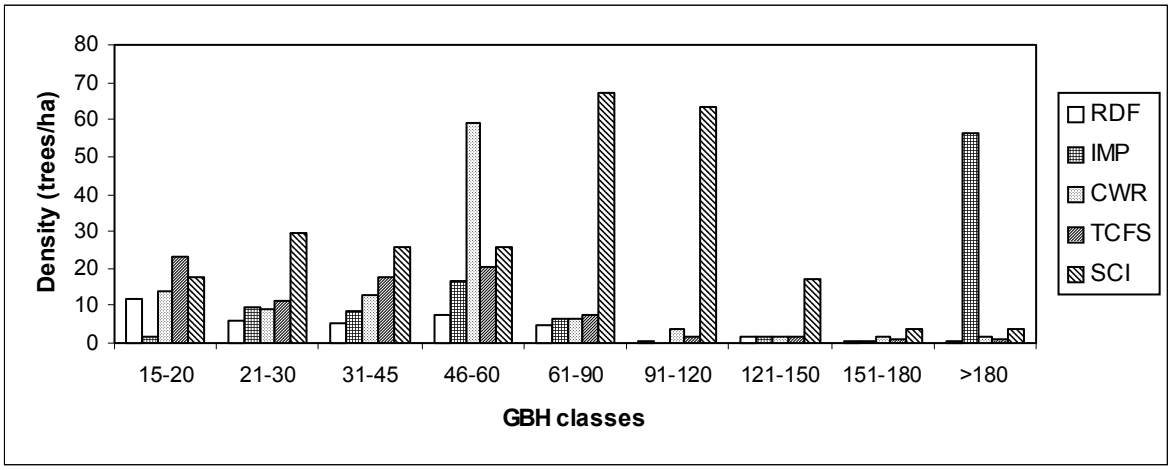


Fig. 15. Population structure of Other miscellaneous species in Betul divisions

The present study aimed at investigating the impacts of Non Timber Forest Produce collection on the overall density, diversity, population structure, and regeneration status of the managed forests as compared to Protected Areas, to evaluate the harvesting practices and their ecological sustainability. It attempts to throw light on the methods of NTFP collection, timber harvest, grazing, fires and biotic disturbance and its impacts on the forest composition, population structure, impact of methods of extraction and regeneration of selected NTFP species in managed forests and their comparison with the protected areas.

There were significant differences in overall tree densities at both the sites (373 trees per ha in the Managed Forests and 576 trees per ha in Protected Areas), which cannot be explained by differences in microclimate, edaphic factors, pest attack and the history of fire in the area, as both the areas are contiguous and not very different from one another (Fig. 17). The overall tree density of NTFP species is quite high in Protected Area as compared to Managed Forests. Marked difference between PAs and Managed Forests in the number of cut trees (<1%:>5%) also points towards the fact that due to current patterns of exploitation, there are more damaged trees in this site (Fig. 16.). Thus, in the present case, grazing pressure, high degree of lopping and cutting may be responsible for low tree density in the Betul managed forests. Managed Forests (disturbed sites) have more damaged/ lopped trees than Protected Areas that are less disturbed sites, indicating that biotic interference in managed forests have played a major role in lowering tree density in the area (Fig 16b). (Murli *et al.* 1996). The variety of NTFP species in the region is vast hence six species have been selected for detailed study.

The six selected NTFP species *viz. Emblica officinalis, Madhuca indica, Buchnania lanzan, Terminalia belerica, Terminalia chebula* and *Diospyros melanoxylon* showed higher densities in protected areas with much higher proportion of lopping and cutting in managed forests than the Satpura Protected Area complex. *Emblica officinalis, Buchnania lanzan,* and *Diospyros melanoxylon* had their populations skewed towards the lower size classes while *Madhuca indica, Terminalia belerica,* and *Terminalia chebula* were skewed towards the higher size class in managed forests as against protected areas where the size class distribution was more or less normal. The results have been discussed in the light of

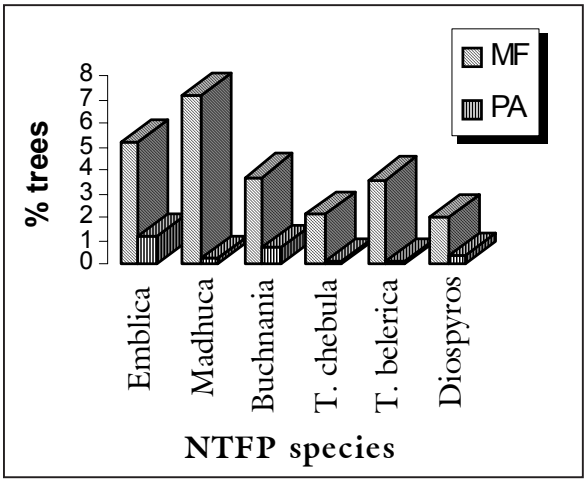


Fig. 16. Comparison of cut trees (selected NTFP species) in MF andPA.

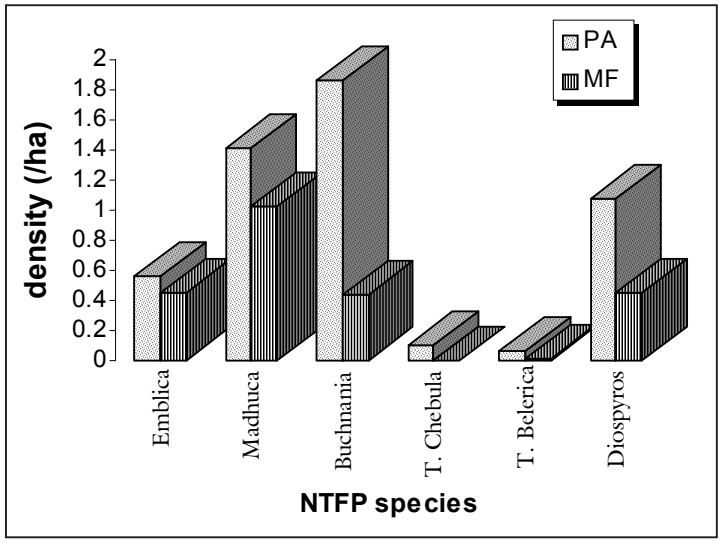


Fig. 16a. Density of selected NTFP species (No.per hectare)

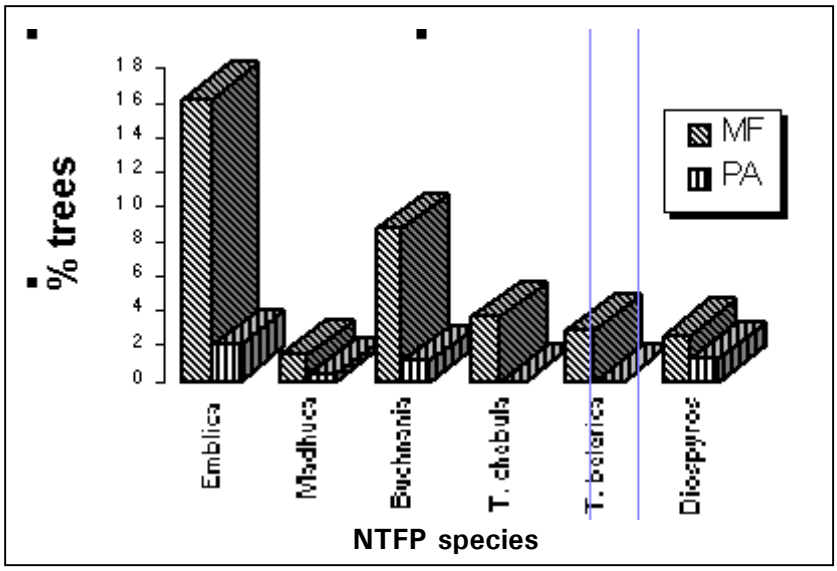


Fig. 16b. Comparison of lopped trees (selected NTFP species) in MF and PA.

methods of collection, timber harvest, grazing, fires and biotic disturbance.

1. *Diospyros melanoxylon* or Tendu

Nearly all girth classes between 15-30 cm and >180 cm are represented in the Protected Areas indicating that protection and minimal biotic disturbance favours regeneration and long term conservation of species. The Protected Areas have distribution in larger girth classess, which might be due to no maintenace of these trees as compared to that of the coppice growth. So also, the trees are retained due to the edible fruits being used by the locals.

As regards managed forests the species has no distribution in the girth classes 120-180 cm and > 180 cm indicating that the management is concentrated on lower and middle girth classes. Recruitment is comparable in managed forests and Protected Areas.

2. *Madhuca indica* or Mahua

The species is well represented in all girth classes and the distribution is around normal is protected areas. The density is more in the g.b.h. classes 61-90, 91-120, and 120-180 cms. with sizable presence also in the girth class >180 cm (Fig. 16 d), indicating the recognized use of the species and it being the favourite species among the local people.

As regards Managed Forests the specis is absent in recruitment class 15-30 cm and a meager density in the class 31-60 cm. This indicates problem in regeneration of the species, which needs to be investigated into. Maximum distribution is in the

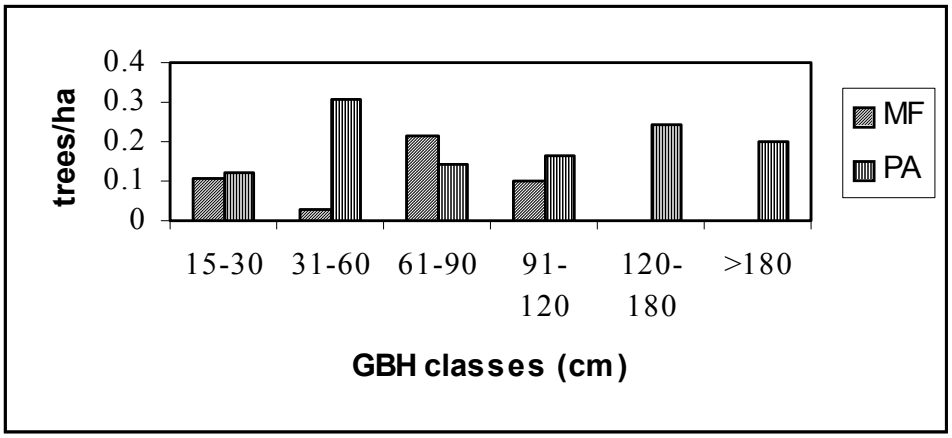


Fig.16c. Size class distribution of *Diospyros melanoxylon* in PA and MF

g.b.h. class 91-120 cm which indicates maintance of the species for local use, especially the floweres which are eaten and are also used for brewing local liquor by the local people. The density in higher g.b.h. classes is far less as compared to Protected Areas indicating that biotic disturbance and some of the management prescriptions might not be favouring the species.

3. *Terminalia chebula* or Harra

Terminalia chebula is found only in Protected Areas. In managed forests its presence was only as solitary trees or small isolated patches due to extensive collection for its use in medicine (Fig. 16e). In case of Managed Forest strategies need to be evolved to favour regeneration and conservation of the species.

4. *Terminalia belerica* or Bahera

Terminalia belerica too like *T. chebula* is found in Protected Areas in higher densities. In managed forests its presence is in low densities that too in the lower gbh classes due to extensive collection for its use in medicine (Fig. 16f). Very low density of the species in Managed Forests is a matter of concren and a detailed survey and insvetigation is required to evolve means to enhance regeneration status.

5. *Buchnania lanzan* or Achar

Buchnania lanzan is present in all g.b.h. classes in case of Protected Area but in case of Managed Forests it is represented only in three g.b.h. classes between 31 to 120 cms. One remarkable thing in case of Managed Forests is that the recruitment class

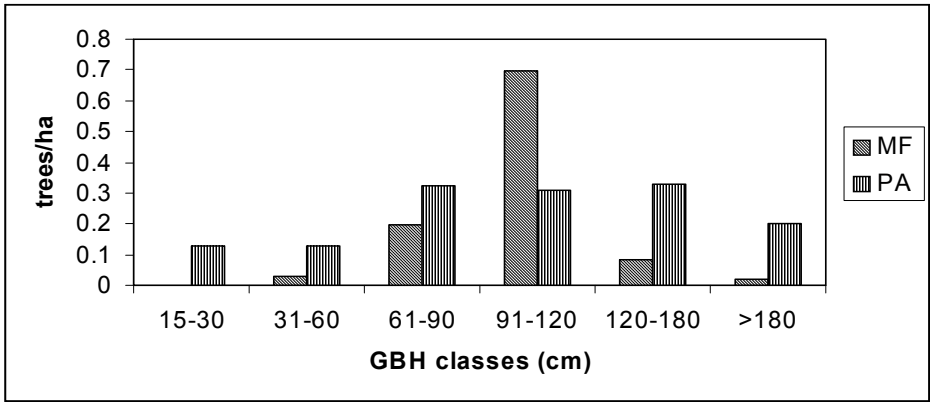


Fig. 16d. Size class distribution of *Madhuca indica* in PA and MF

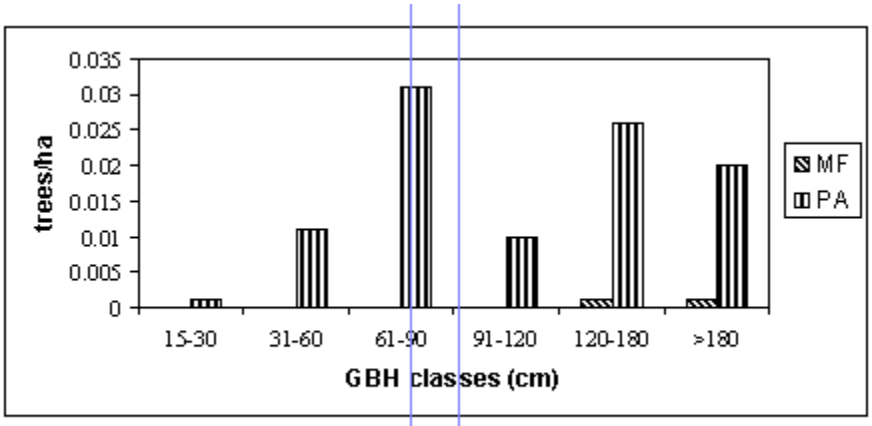


Fig.16e. Size class distribution of *Terminalia chebula* in PA and MF

is totally absent indicating poor or no regeneration, which is an alarming situation. It can be also seen that in case of Managed Forest *Buchmania lanzan* is absent above 120 cms g.b.h. (**Fig 16g**).

6. *Emblica officinalis* or Aonla

The tree belongs to the family *Euphorbeaceae*. The species is commonly known as *Aonla*. Its a moderate sized tree with feathery light green foliage and small narrow linear leaves. The bark is smooth, gray exfoliating in irregular rounded scales exposing the yellow bark underneath. The wood is red, hard, apt to split, durable under water and is used for agricultural implements, well construction and also serves as an inferior building material and furniture. The bark, leaves and fruits are used for tanning and the tree yields a tannin. Apart from this it serves as a source of an important Non Timber Forest Produce in the form of its edible fruits which are of great local importance.

The tree is common in mixed deciduous forests throughout the greater part of India. The leaves start falling around November or December and the trees are leafless from March to April, when new shoots start appearing. The fruits ripen from November to February or sometimes later. The fruit is globose 0.5 to 0.8 in. diameter, yellowish green, smooth and fleshy and very astringent. Experiments in Dehradun have shown that the percentage of fertility is comparatively low, and the seed does not retain vitality for long. The seeds kept for a year have failed to germinate. Once germinated under favourable conditions the growth of the seedlings is rapid and

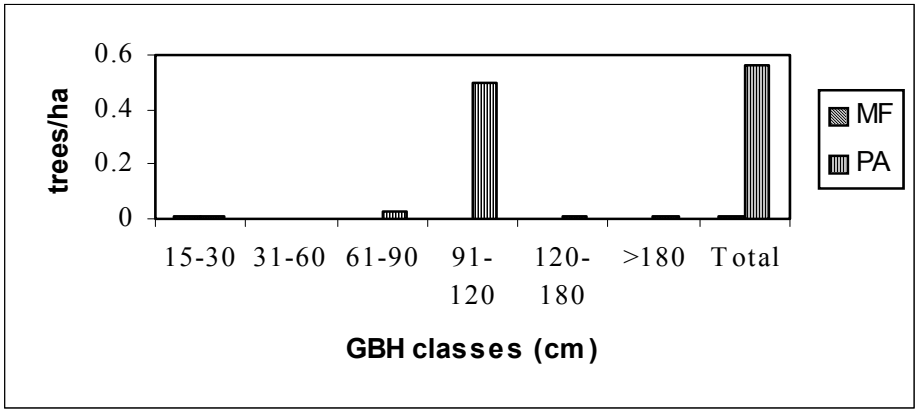


Fig.16f. Size class distribution of *Terminalia belerica* in PA and MF

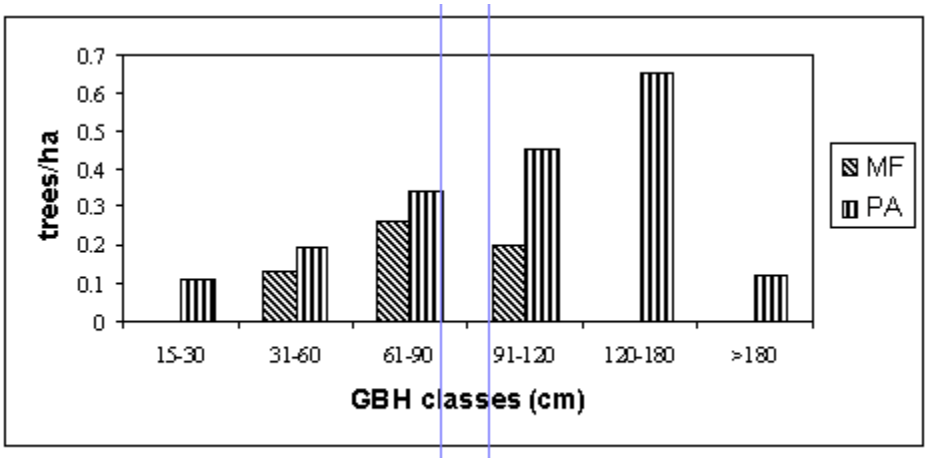


Fig.16g. Size class distribution of *Buchmania lanzan* in PA and MF

may attain a height of about 70 cms in the first year and about 3-4 metres in four years. Presence of weed greatly stimulates the growth of the species. The young plant is intolerant of shade or suppression of any kind. The seedlings are very sensitive to drought. The species is decidedly light demander and it is sensitive both to drought and frost. In severe frost the fruit becomes white and appears to have been boiled. The tree coppices well and pollards moderately well. The coppice shoots grow vigorously. As regards natural regeneration, the fruit falls during the latter part of the cold season and a portion of hot season. They lie on the ground untill the fleshy covering dries up and the hard fruit stones split open which they do with some force thus expelling the seed. The fruits are eaten by deer and the hard stones are disgorged during rumination and afterwards they dehisce on the ground. Natural reproduction is seldom found in abundance which is and partly due to the fact that the fertility of the seed is not high but mainly due to sensitiveness of the seedling in its early stages and to liability to insect attacks (Troupe, 1947). Seedlings of the species can be raised successfully artificially.

Though it finds a potential use, in production of tan which is supposed to be the main use, lack of constant supply of such raw material is not possible since the species has a lot of problem regenerating. This may be possible by raising artificially regenerated plantations. The primary use of the species currently is for collection of fruits by the local people through the Village Forest Committees in the area for different uses like preparation of pickle, medicinal preparations and for making '*mouth freshener*' after drying it.

It is clearly evident that *Emblica officinalis* is represented in almost all g.b.h. classes except in the g.b.h. class above 180cms. This may be attributed to the fact that *Emblica officinalis* rarely grows to that age class due to various pressures. In case of Managed Forest *Emblica officinalis* is well represented amongst the g.b.h. classes 31-60 and 61-90 cms. However, it is observed that in the recruitment class, that is g.b.h. class 15-30 cms, recruitment is far less in case of Manged Forests compared to Protected Areas. Lack of recruitment in case of Managed Forests may be attributed to improper harvesting technique and heavy biotic pressure (**Fig. 17**).

In contrast to species like *Tectona grandis*, and *Terminalia tomentosa,* for which plant parts other than seeds/fruits were harvested, species exploited for fruits and seeds e.g. *Madhuca indica, Emblica officinalis, Terminalia belerica, Terminalia chebula,* and *Buchnania lanzan,* showed poor recruitment in the managed forest. Thus, it is evident that the harvest of seeds and fruits, which form the seed bank for future trees, affect the population of harvested tree species. Poor recruitment of these NTFP species could be the outcome of fire, grazing or compaction of soil as a result of grazing but since these factors were operating on the timber species as well it might be that the timber species are adapted to the disturbance for a longer period. Teak regeneration could be high due to thinning and tending operations carried by the Forest Department to increase timber yield, but these factors do not explain the good regeneration of these species in the protected areas which are free from such anthropogenic pressures. This explanation should also hold true for NTFP species, which have been exploited for decades. Seeds of all selected NTFP species and *B. racemosa* are dispersed by animals. According to Janzen (1971), 99% of the crop can be lost to pre- and post-dispersal seed predators. The low recruitment of younger age classes of NTFPs in the managed forest site may be due to seed dispersers acting as seed predators. But again, in protected areas the presence of seed predators should be higher, as it is a protected area and shows good recruitment.

Results show that distribution of size classes of the same tree species at two sites is different. Differences in the population structure distribution of the same species in Protected Areas and managed forests could be attributed to many factors, like past forest management history of the area and biotic factors *viz*. fire, cattle grazing, etc. Some parts of the protected areas included sites where clear-felling

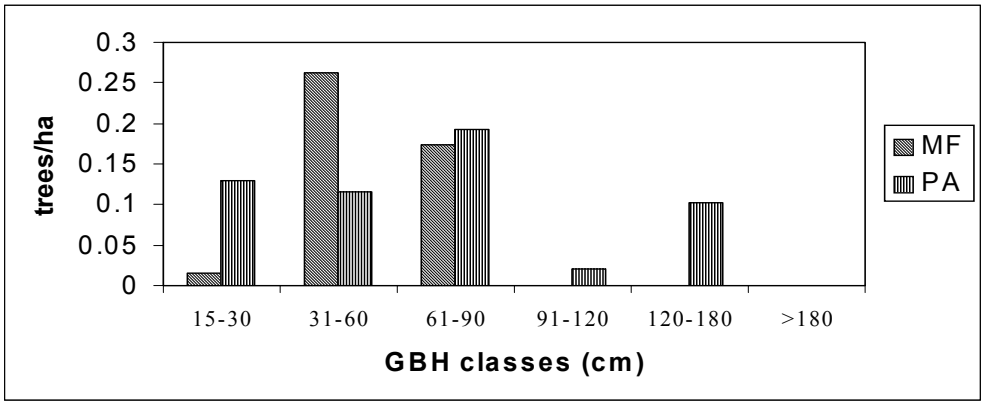


Fig.17. Size class distribution of *Emblica officinalis* in PA and MF

was carried out 20-25 years ago. Thus, higher age classes of timber species were lesser in this site; however there were higher age classes of NTFP species since they were not felled. Older *Madhuca indica* (Mahua) trees with higher girth class are also being protected in the crop fields.

In the protected areas, size-class distribution shows sudden dip in certain size classes for example, size class of 91 to 120cm shows dip in the frequency of *E officinalis*, 15-90 and 120-180 in *T .belerica* and size class of 15-30cm in case of *T chebula*. The sudden decrease in the frequency of these size classes may be due to natural pest attack, drought, or man-made factors that might have occurred in the past (selective felling, fire).

Economically, the value of sustainably harvested NTFP species in tropical forests can often outweigh the value of other land uses such as logging, farming, or grazing (Peters, Gentry and Mendelsohn, 1989; Balick and Mendelsohn, 1995; Grimes *et. al.*, 1994)

Production and extraction were estimated on the basis of data collected during the study period. Aonla production in 1997 was poor compared to previous years. Data shows 93.6% of fruits per tree were collected while only 63% of fruiting trees were harvested. It is speculated that fruit extraction per tree was higher due to lower fruit production, as collectors might have collected more to maximise the effort of collection. It was also observed that 37% trees left in the protected areas had very little fruit and there was 83.6% harvest per tree. Such levels of collection interfere with regeneration of the species.

It was observed that the density of the recruitment class at the managed forest site for "Aonla" and "Achar" was almost negligible. A seed before germination has to pass through several stages during which it is susceptible to predation and to natural mortality. Apart from all these natural factors, man-induced pressures like extraction of seeds can push seed banks below the threshold level required to maintain the population. So even the above-mentioned higher percentage of harvest taking place in the study area may cause low regeneration. This fact is also supported by the findings of Uma Shaankar *et al.* (1996) in their study done in the Biligiri Rangan hills.

Extractive activities are most likely to be unsustainable if they result in killing and damage of the target species (Salfasky *et. al.*, 1992). "*Aonla*" and "*Achar*" trees were both felled and lopped during collection. The practice of felling trees would spell disaster not only in terms of regeneration of that species, but also in terms of irreplaceable loss of future income source for the native population. Panwar and Mishra (1994), based on their study on fodder trees in Rajaji N.P indicate that trees which are lopped, cease to flower and show total absence of regeneration. Lopping results in sap loss, attracts

insect attacks, and ultimately results in plant mortality (Khati, unpublished).

Though the local people seem to be aware of the adverse consequences of their faulty practices, yet it continues due to several reasons. The season of Aonla harvest coincides with the period of agricultural activities, during which the people are hard-pressed for time. Thus, in order to gain maximum yield of Aonla in the least time possible, they tend to opt for the easiest means of fruit harvest, i.e., by lopping/felling which requires less time and is also labour intensive when compared to climbing the tree and plucking/beating. Achar is very valuable commercially, and is harvested when the fruit is still unripe, as ripe fruits are eaten by animals. The unripe fruit is difficult to harvest by the alternative methods of beating/plucking, and hence felling is the easier option for the people who aim to maximise their harvest.

2.15 Conclusion

The results of this study clearly indicate that the extraction of NTFP species has a detrimental effect on the plant community in the area. Densities of adult trees, and those of the recruitment class (i.e., saplings), were lower in the sites of extraction when compared with those in the undisturbed site. The disturbance factors i.e. cutting, lopping, grazing, fires etc. were also higher in managed forest than in protected areas.

The collection of NTFP species has serious repercussions for both humans and for the survival of the species they exploit. Though the proximate outcome of this activity translates into direct economic gain for the people involved in it, the ultimate consequences would benefit neither man nor his environment. This situation is quite obvious to the people concerned with the activity, but they still persist in doing it, for lack of better alternatives. For them it is not a question of what is better or worse, but quite simply, what is available. Given a chance of an alternative means to a livelihood, most would be willing to take it. Interviews with people revealed that the collection of NTFP species was not a preferred activity, because it is labour intensive, and seasonal, thus not assuring the people of a steady source of income all the year round. However, their present circumstances compel them to eke out a livelihood from whatever means available to them and the forest is the cheapest alternative. It is difficult, in such an instance, to pass judgement on the nature of this activity. The adverse effects it would have on the survival and reproduction/ regeneration of the harvested species would, ultimately, adversely affect the people, who would have less to harvest each year. For the people, however, it is a question of *their* survival, as much as it is a question of the survival of the exploited species.

In India, the problem of biotic pressures on natural areas is not an uncommon one. The results of this study present a picture, which is difficult to interpret. As is always the case where humans are concerned, answers to the problem are never easy. Activities such as the collection of NTFP species, impose a pressure that our forested areas can ill-afford. However, it is important that the management authorities handle the issue sensitively, keeping in mind the needs and compulsions of the people, when suggesting remedies to the situation.

NTFP harvesters, are not easily characterized. Some folks are experts on the flora of their local area. Others may travel throughout the region following seasonal timing for best quality. Different products attract different harvesters. Some products are typically harvested by groups of migrant pickers, often Asian or Hispanic workers. Other products are mainly collected by local harvesters for personal uses or small local businesses. Some large industries contract with pickers for commercial quantities. In contrast to trees, many NTFP species can be sustainably harvested more frequently. NTFP species are an exciting economic opportunity in place of or in combination with timber harvest. For example, after a fire, although timber trees may have been lost, some of the early seral species, those which

rapidly take hold in the open spaces after a fire, are NTFP species. By utilizing these species for the few years they are abundant, the land manager may be able to maintain a more constant profit, and actually reduce the amount of trees necessary to harvest later.

A significant proportion of India's population is still partly or wholly dependent on nature for their basic needs. They do not get water by turning on a faucet but from a stream. Cooking energy does not come from an electrical outlet or the gas line but by collecting firewood from the forests. They do not buy the construction material for their houses from the supermarket but collect clay, mud, and timber from their natural surroundings. They do not go to offices but till the land or make artifacts, for which they need green manure and raw materials from nature. Milk does not come from cartons but by herding cattle, for whom fodder is required.

Most of these demands, unfortunately, are perceived as conflicting with what is considered to be the requirements of biodiversity conservation. Consequently, Indian laws stipulate that none of these activities are permitted in a national park, and only limited grazing is permitted in a sanctuary. As a result, the network of protected areas in India effectively displaces hundreds of thousands of often the poorest of poor people by denying them access to the resources they require for their survival.

Over the years the proportion of the population living below the poverty line has decreased. However, their absolute numbers have greatly increased. This growing population of wilderness-dependent people, their growing aspirations, and the growing consciousness regarding biodiversity conservation, at least among environmentalists, has created conflicts that are becoming increasingly difficult to resolve.

i) ***Buchnania lanzan:*** Achar fruits in May-June and is very valuable commercially (chironji, its seed being sold for Rs. 200-300 per kg). It is usually harvested when the fruit is still unripe, as ripe fruits are eaten by animals.

ii) ***Emblica officinalis:*** The season of *Emblica officinalis* (aonla) is March-May. The collection season of this species coincides with the agricultural activities in the area and its collection is too labour-intensive hence this is not extracted optimally.

iii) ***Diospyros melanoxylon*:** *Diospyros melanoxylon* or 'tendu' is a genus belonging to the family Ebenaceae. It is a medium to large-sized tree found in deciduous forests with black bark exfoliating in regular, rectangular scales. It is one of the most important non-timber forest produce used as 'bidi' wrappers. A 'bidi' is prepared by rolling tobacco in a piece of tendu leaf. Semi-mature/mature leaves are collected from cut-back tendu bushes/trees and after proper seasoning and drying, are used as 'bidi' wrappers. In most part of the study area, tendu leaf collection is a major source of income for tribals for their subsistence. Another important produce of tendu tree is its fruits which is very nutritious and resembles 'cheeku'. The data for this produce was secondary and taken from the forest department as its collection was done through them.

vi) ***Madhuca indica:*** Mahua flowers are utilised mostly locally for distilling liquor or even as food. The seed called *gulli* is used for extracting oil which is used for cooking as well as burning of country lamps.

2.16 Trends:

In the earlier days, the market forces did not have much impact on the NTFP and it was only for tribal and plant communities. By the middle of the century, the situation changed and many products are largely influenced by market demand. These include fuel-wood, bamboo, gum, various fruits and seeds which yield tannins, medicinal constituents, oils and other such basic raw material for small to large industries. What is considered to be a concession for domestic use is now market trade which is the single biggest threat to a variety of species as well as impact on sites.

About 34.9% of income of local people on an overall basis is generated from NTFP species. The agro-pastoralists derive 44% of their income from NTFP species, while NTFP forms 23.5% of the income of the tribals. *Mahua* flowers alone contribute 44.17% of the total income from NTFP species. *Mahua* being a common species and present close at hand, demands less physical labour for its harvest, and therefore is expected to be harvested more intensively. Secondly, by the start of the *Mahua* season, agricultural activities are already over, and so there is 100% involvement in *Mahua* collection. *Mahua* trees are more common in the agricultural fields as compared to that in the forest. Hence, collection is first done from the forest by the people and later from their fields. Mahua contributes only 26.3 percent of the total income generated by the NTFPs. Tribals in contrast to "*Gaolies*" use the collected *Mahua* to distil liquor which they use largely for their own consumption, due to which they may fetch less income from the Mahua flower.

The leaves of *tendu* (*Diospyros melanoxylon*) contribute 42.61% of the total income generated by NTFPs for the "*Gaolies*", and 45.8% for the tribal communities. The native population is more involved in the collection of tendu leaves because of following reasons:

1. During the collection period there are no other income generating activities.
2. Density of Tendu is very high in this area. So opportunity cost of collection is comparatively less.
3. It doesn't involve processing.
4. The payment for the product is made instantly and rates are fixed by the state Government. There is no investment for transportation of the product as collection centres ("Phadi") are set up at every village.

In case of tribals, Aonla and Achar form 19.0% and 7.7% of total income produced by the NTFPs respectively, which is very less in case of Gaolies.

Achar collection was preferred as an occupation even though it did not translate into high economic benefits, because during the season of its collection, people were not involved in any other activity, and were thus free to devote their time to the collection of this fruit. *Gulli* (the fruit of mahua), was collected mainly for subsistence. However, the people confirmed that in past years, when its availability/ production was higher, the surplus crop used to be sold. Due to lower production in recent years, this was no longer the case, and this activity scored low both on the scale of preference as well as that of income generated.

2.17 Comparison of tree densities in Managed Forests and Protected Area

A forest with high proportion of individuals in the recruitment class, points to the potential of the area, for sustaining more trees in the future. An age/ size distribution which decays nearly exponentially reflects a population with many more juveniles than adults, and may be assumed to be self-replacing and in stable density (Hall and Bawa, 1993). Comparisons of g.b.h. class distributions of the selected tree species, across the two areas, Protected Area and Managed Forest shows a significant difference in the population structure. In case of Protected Area all the girth classes are represented but in case of Mangaed Forests girth classes above 120 cms are totally missing. The reason is quite obvious because this size class falls in the range of selection girth class as per the selection-cum-improvement system. Even in case of Teak Conversion Working Circle trees of these girth classes are liable to be felled. As regard the recruitment class, recruitment is considerably high in the Protected Areas as compared to the Managed Forests. This may be attributed to biotic pressures like grazing, fire, illicit felling of matured trees etc. (**Fig 18**).

It was found that the overall tree density in case of Protected Area was found to be higher in all the three strata selected *viz.* Mixed miscellaneous (590 trees/ha), Mixed teak (400 trees/ha) and Teak mixed

(570 trees/ha) than that of Managed Forests Mixed miscellaneous (330 trees/ha), Mixed teak (310 trees/ha) and Teak mixed (400 trees/ha) (**Fig 19**). However, the individual densities of selected species showed different trends depending on its hardiness, use by man and management practices**.** (In case of Fig 19 the bar for PA may be read as MF in case of Mixed Teak (MT) stratum).

2.18 Wildlife use:

Wildlife use was found to be strikingly high in case of protected areas. The only wildlife evidences that were encountered in case of managed forests were those of wild pig, hare, nilgai and on rare occasion, sambars. In many areas bears were also present during the fruiting season of Mahua, Achar *etc.* (*i.e.* summers). Parts of South Betul that shared their boundary with Melghat also had evidences of Leopards and sometimes Tigers as well. Tribals in Pathakera, near Sawalmendha, close to the Maharashtra state boundary also talked about sightings of another species of leopard which was much smaller in size when adult. It could be the leopard cat.

The comparison of dung densities in various forest strata in Managed Forest and Protected Area is illustrated in **Fig 20** along with wildlife dung densites. There is a significant difference between the Managaed Forest and Protected Area in all the three strata. Dung densities are extremely high in case of Protected Areas and in case of Managed Forests the dung density is very low or negligible.

2.19 Study of change in landuse/ landcover of the landscape of Betul Distsrict (part) between 1975-85

For assessment of change, selected (available) vegetation maps prepared by Forest Survey of India were digitized and the classification scheme was made uniform and change was assessed using ARC/ INFO and ARCVIEW GIS packages.

The 1975 map consisted of the following categories:

1. Dense Forest
2. Open Forest
3. Tree forest
4. Tree farmland
5. Scrub
6. Water bodies
7. Blanks/grasslands/non-forest

The classification scheme for both the 1975 and 1985 **(Plate 37, 38 and Plate 41)** maps were brought to the same platform and the change detection was carried out for the following recognized classes:

1. Forest
2. Scrub
3. Forest blanks/non-forest
4. No data (Data not available)

The map of the change detection may be refferd to at **(Plate 39)** The point of concern is that the change from the Forest to Non forest which is 34.37 Sq mtrs and that too when only 1/3rd of the area of Betul didistrict was taken up for change detection due to non availability of data for entire area It can be also seen that some of the forests areas tuning to 33.4 sq km have changed from Forest to scrub. There has been a considerable decline in tree forest in those ten years. This also speaks of tremendous biotic presuure on the area.

Table 6. GIS Estimates of change detection between 1975-1985

S.No	Change	Area (sq. km.)
1	Forest to Non-forest	34.37
2	Forest to Scrub	33.44
3	Scrub to Non-forest	160.03
4	No Change	2685.62

Plate 26 Vegetation /Landuse Map of Satpura National Park, Bori and Pachmarhi WLS

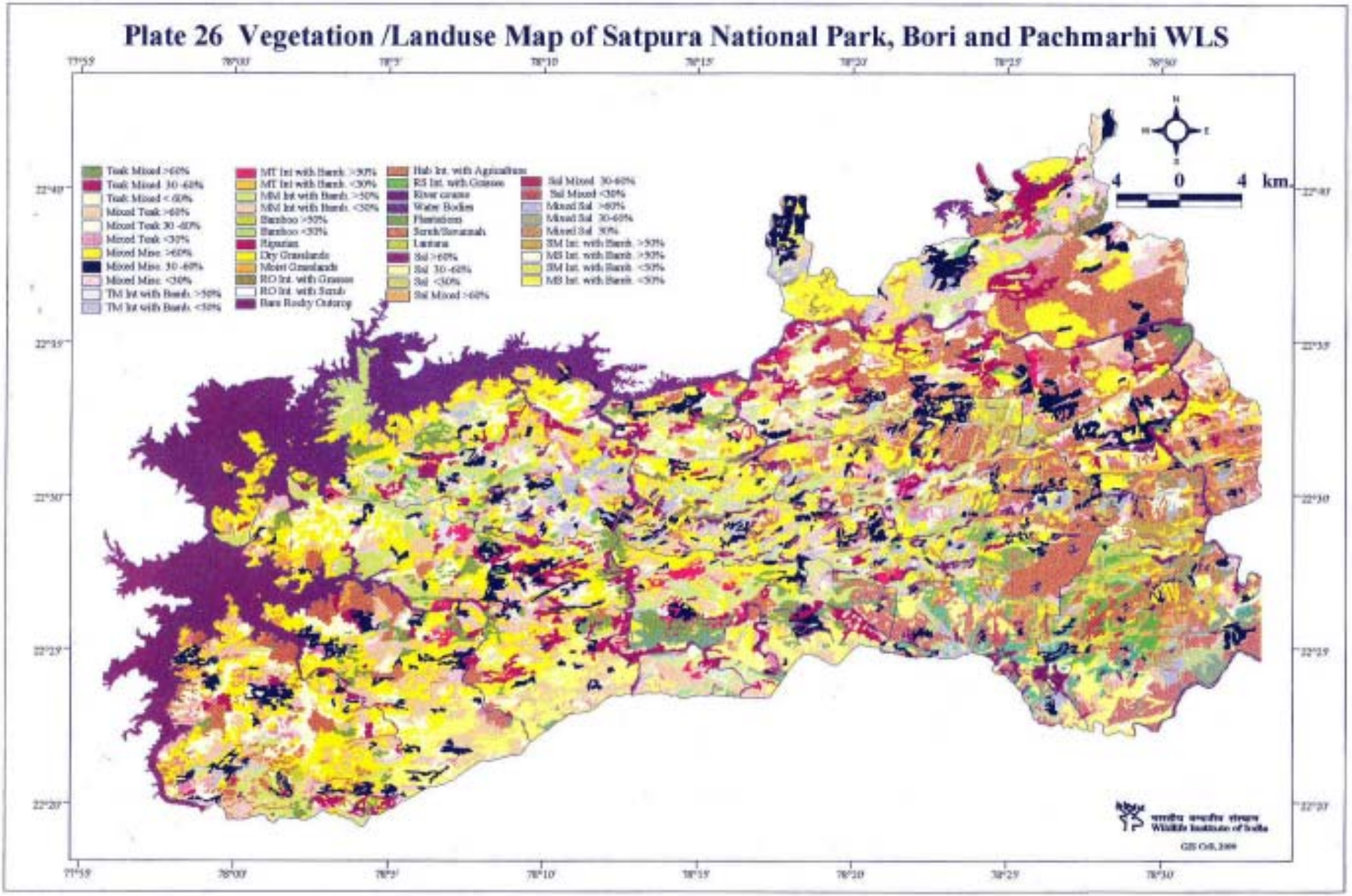


Plate 27 Broad Vegetation Classes in Satpura Protected Area Complex

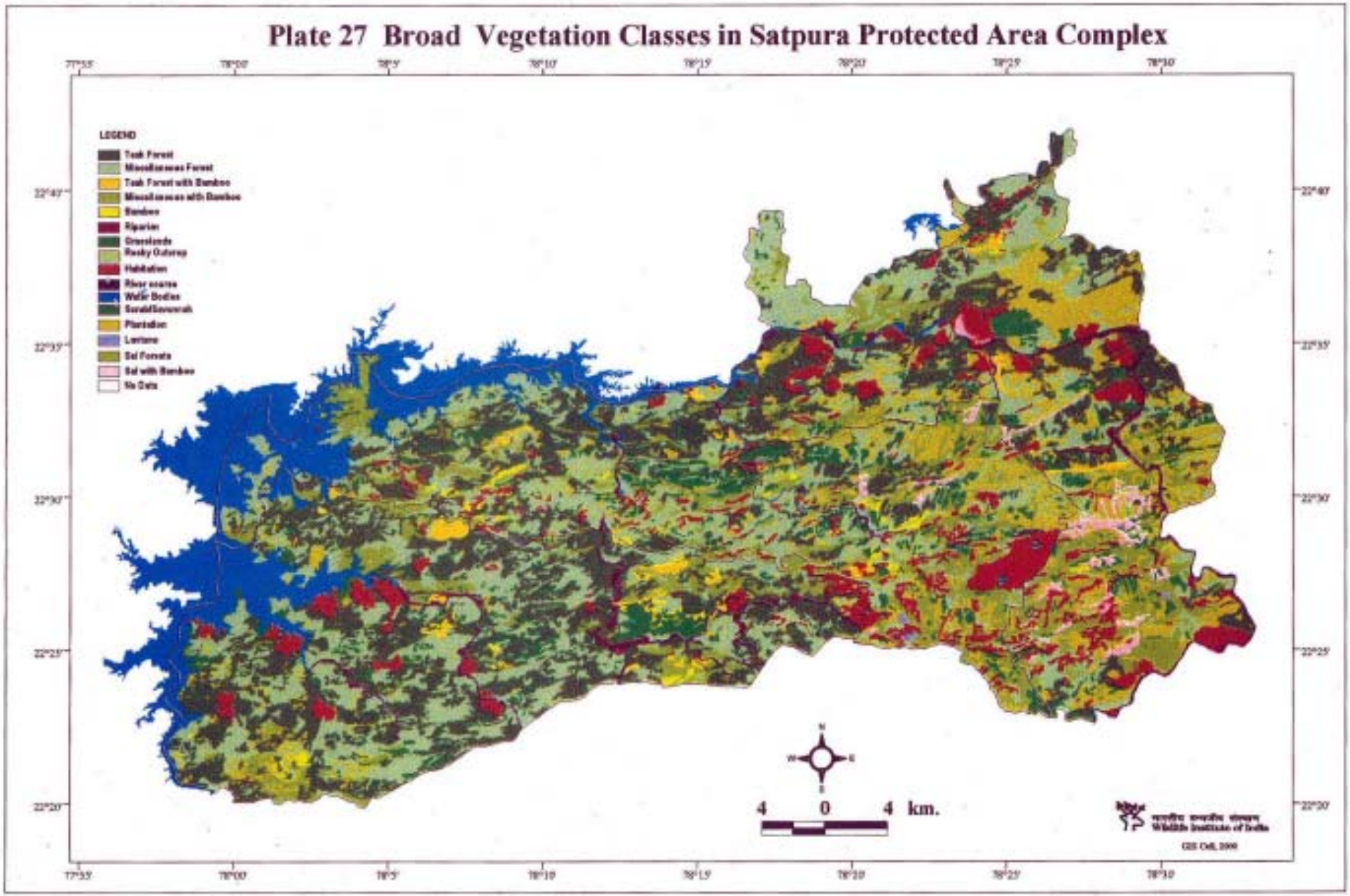


Plate 28 Site Quality Map of Satpura National Park, Bori and Pachmarhi WLS

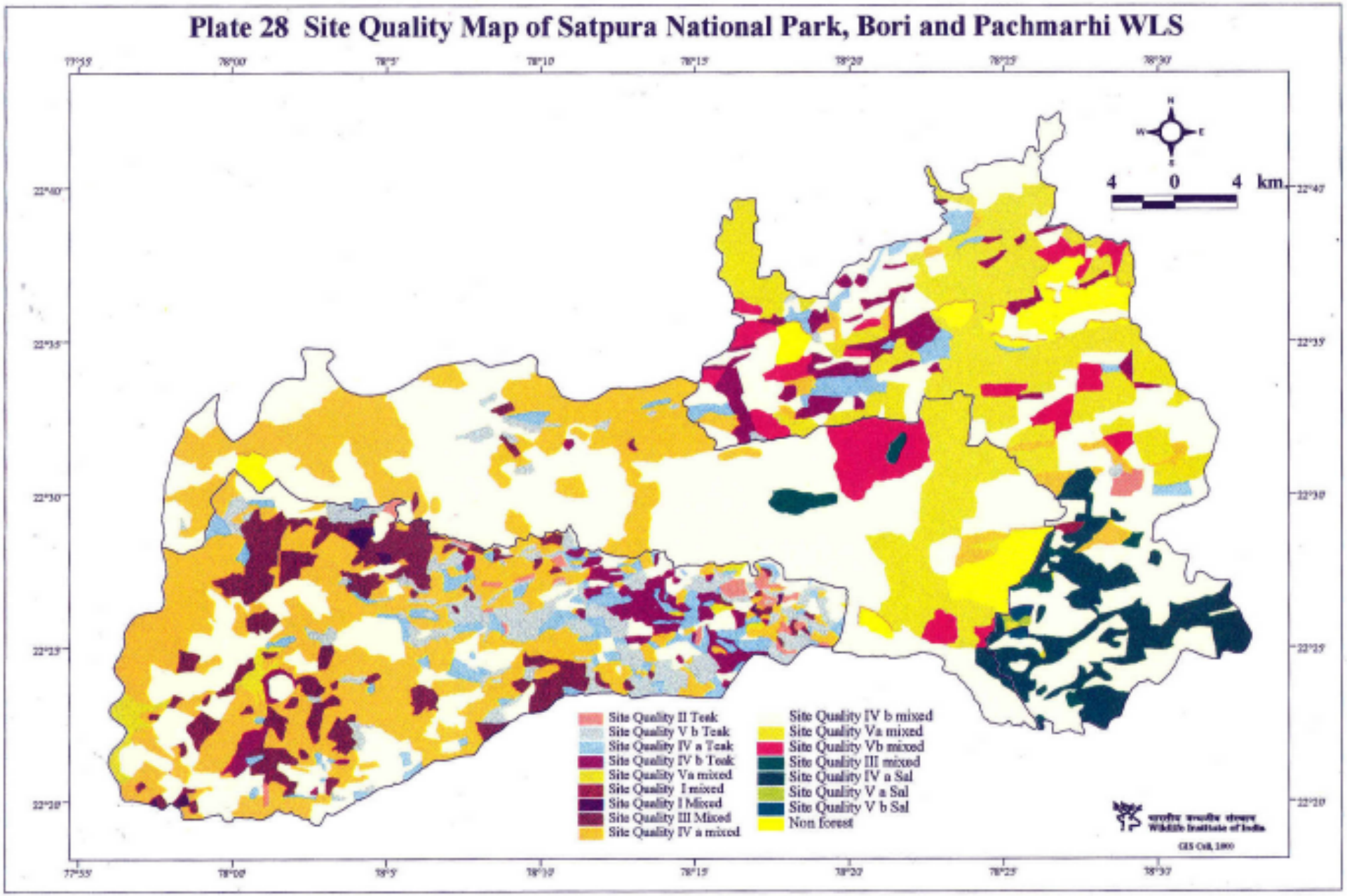


Plate 29 Map of Satpura National Park, Bori and Pachmarhi WLS Showing Forest Age Class Distribution

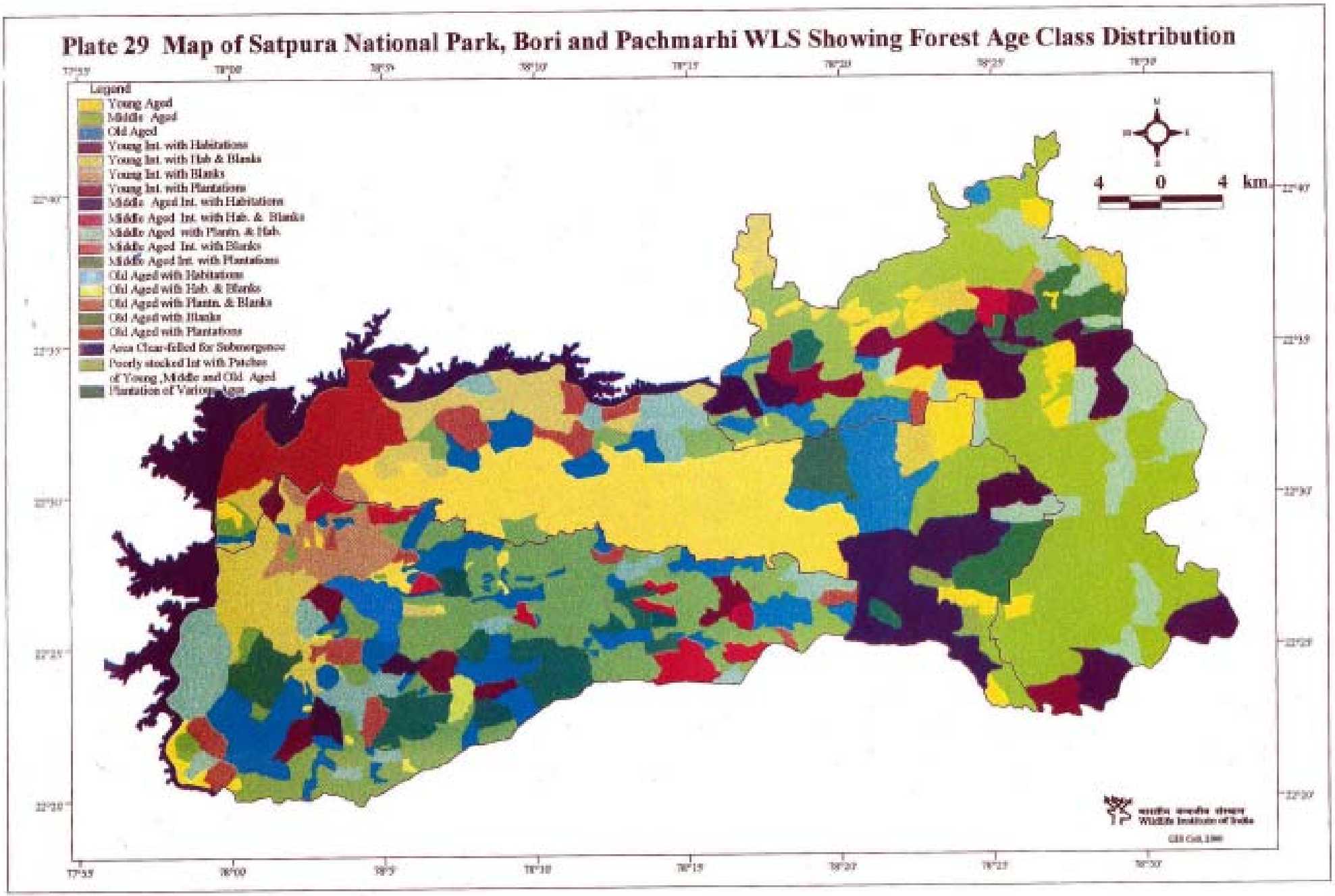


Plate 30 Map of Satpura National Park, Bori and Pachmarhi WLS showing Allotment to Working Circles

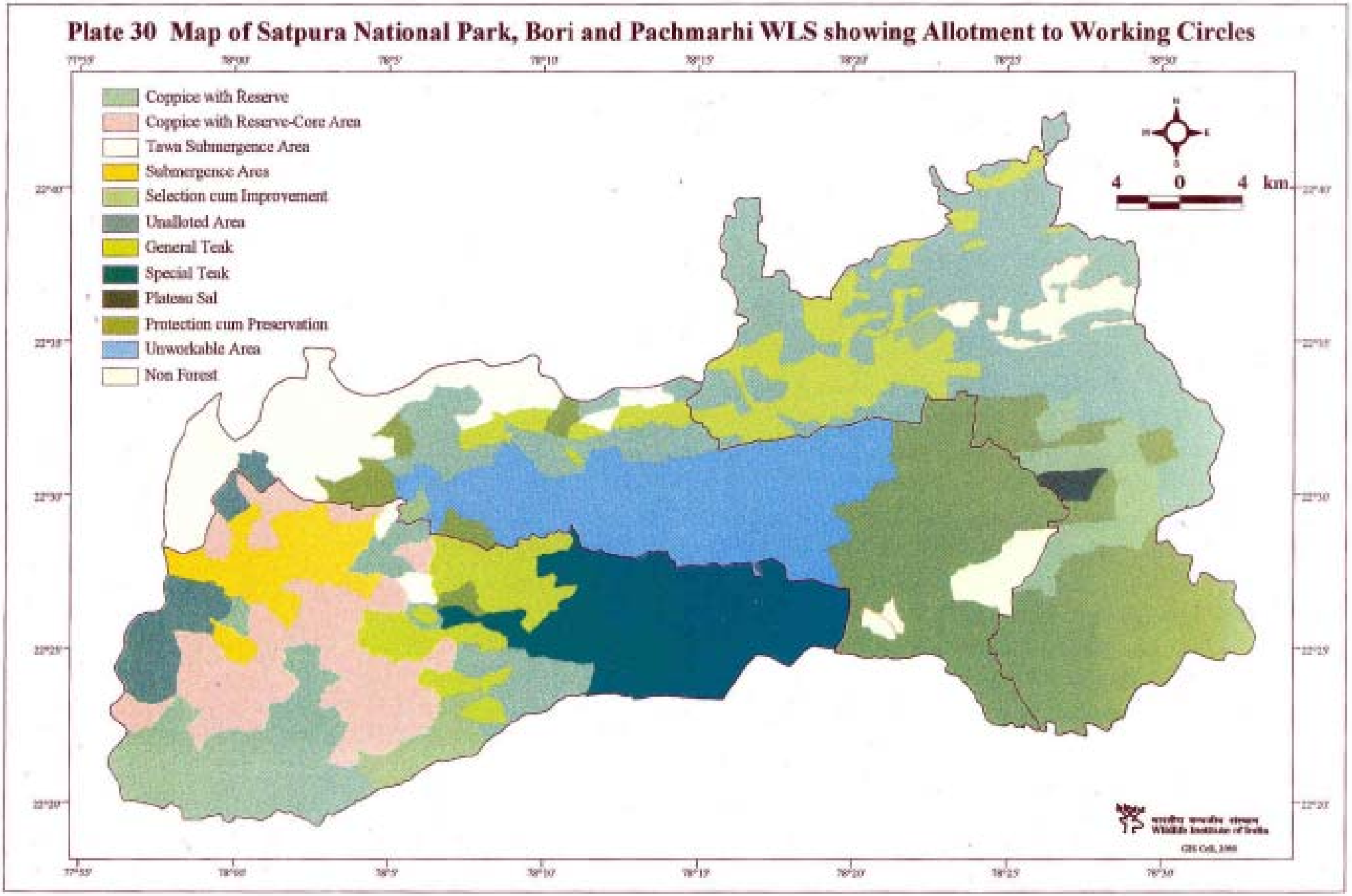


Plate 31 Compartment Map of Satpura National Park, Bori and Pachmarhi WLS

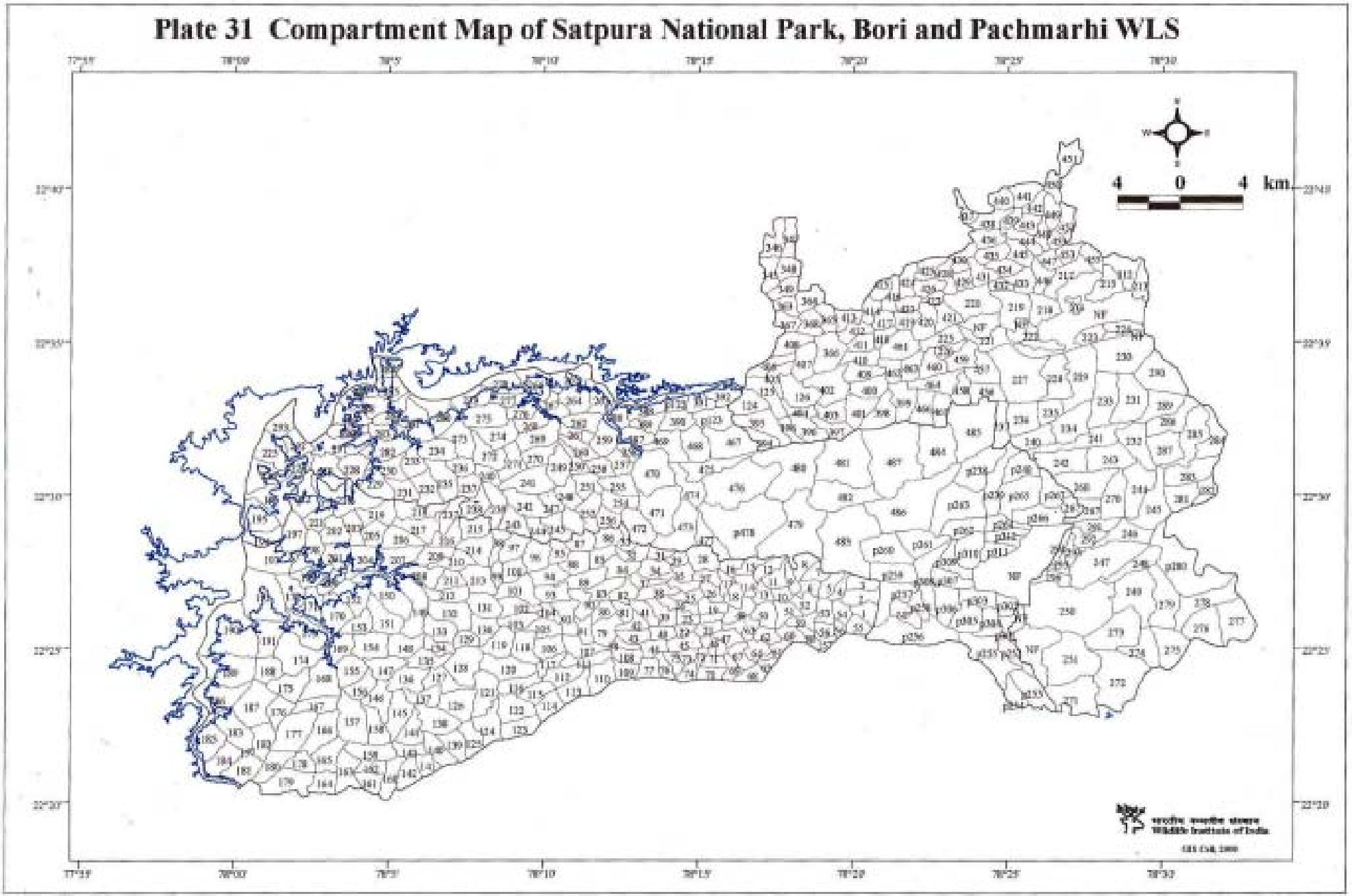


Plate 32 Compartment Map of Managed Forest Divisions of Betul District , Madhya Pradesh

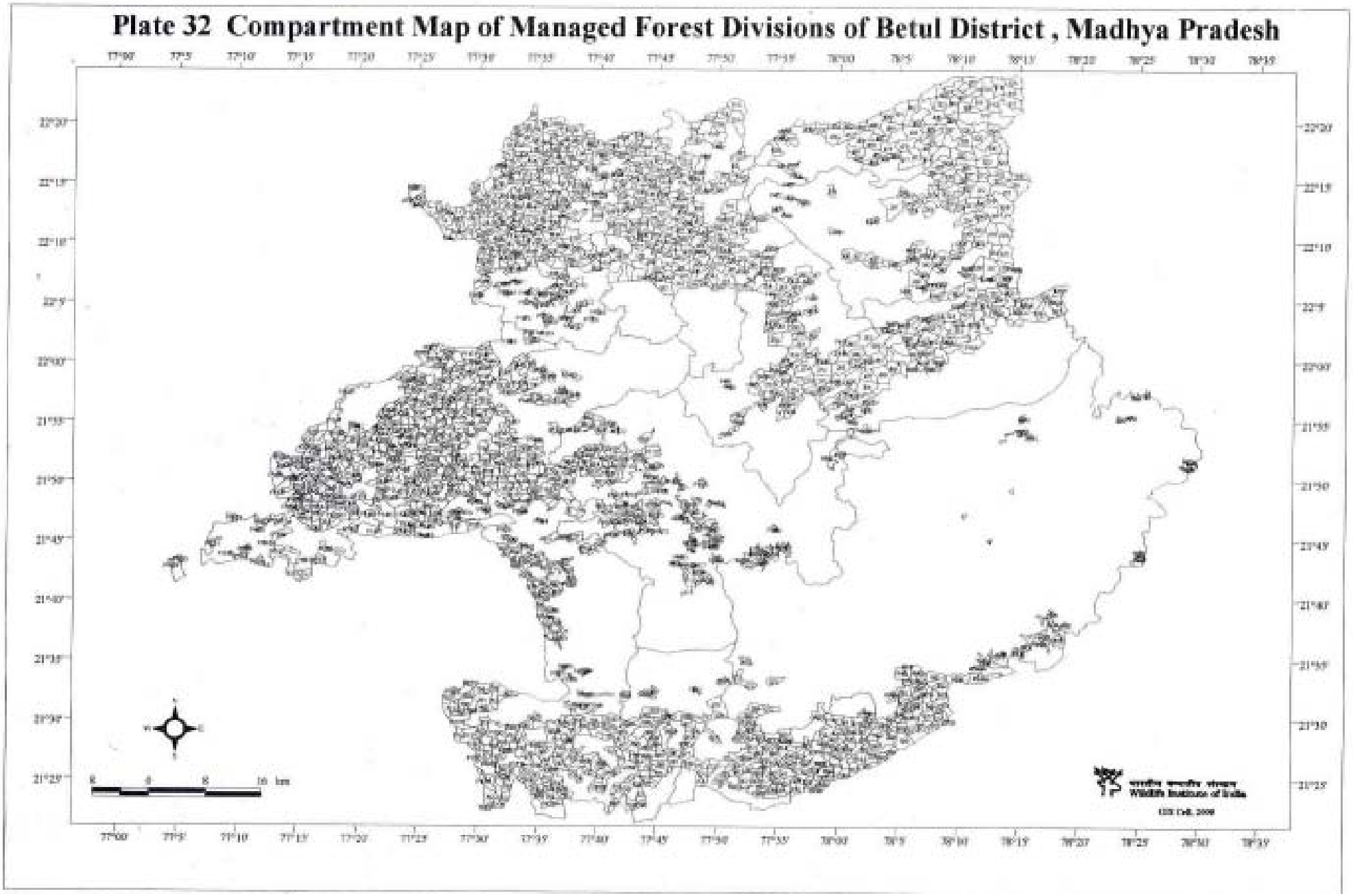


Plate 33 Compartment Map of Melghat Tiger Reserve

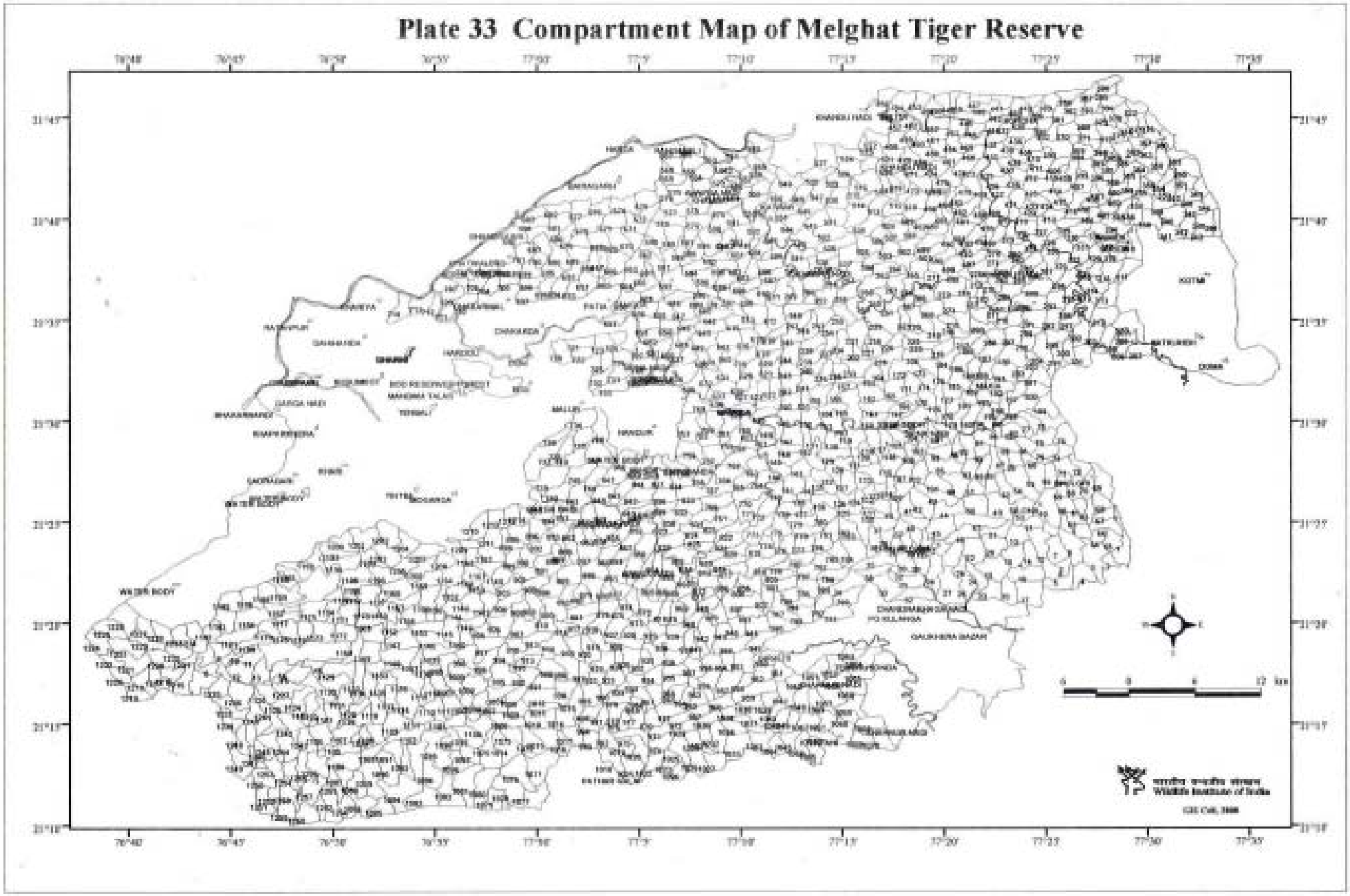


Plate 34 Working Circle Map of Managed Forest Divisions of Betul District , Madhya Pradesh

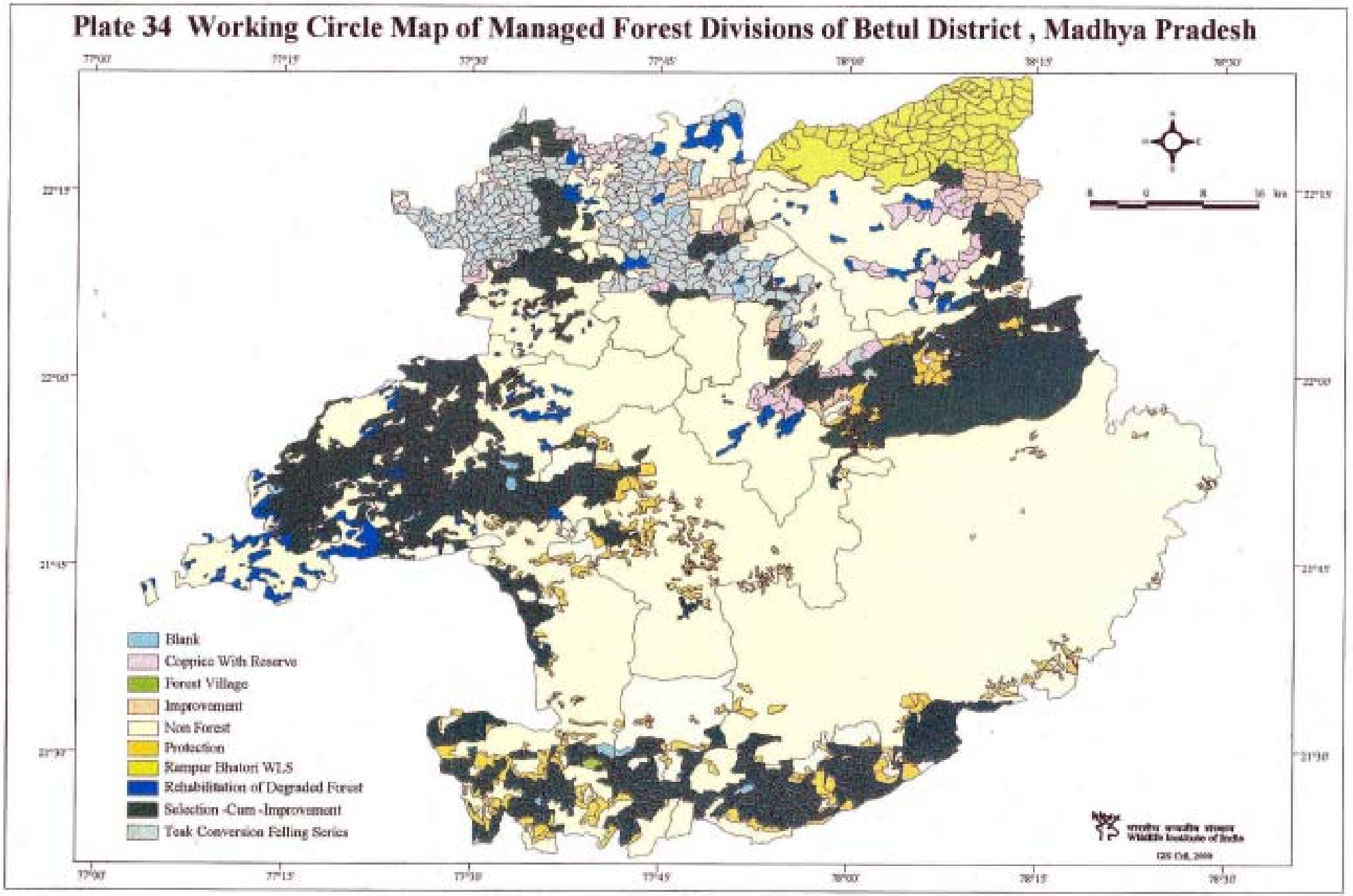


Plate 35 Map Showing Bamboo Site Quality Distribution in Satpura NP,Bori and Pachmarhi WLS

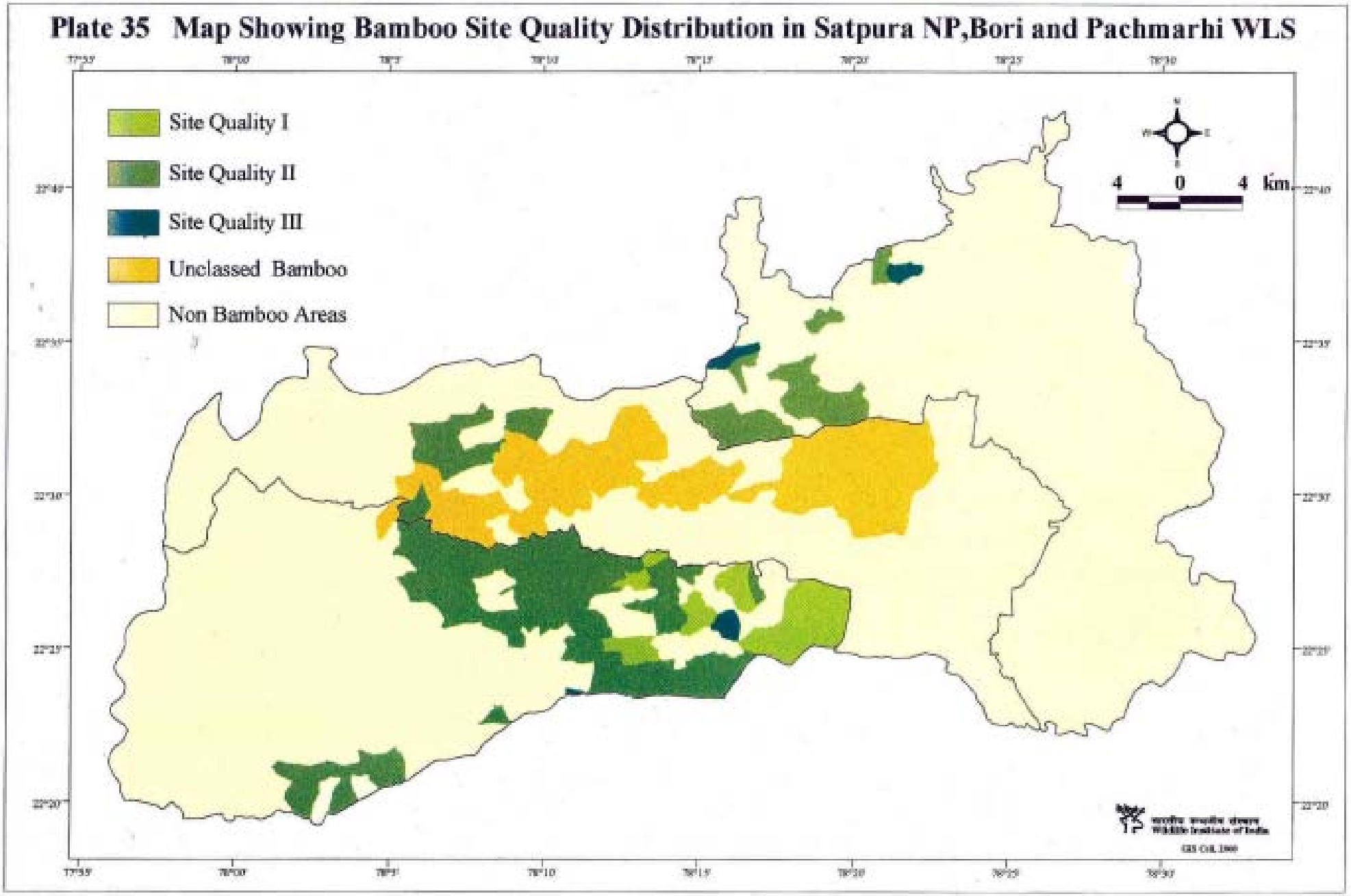


Plate 36 Map Showing Plantations in BSP Protected Area Complex

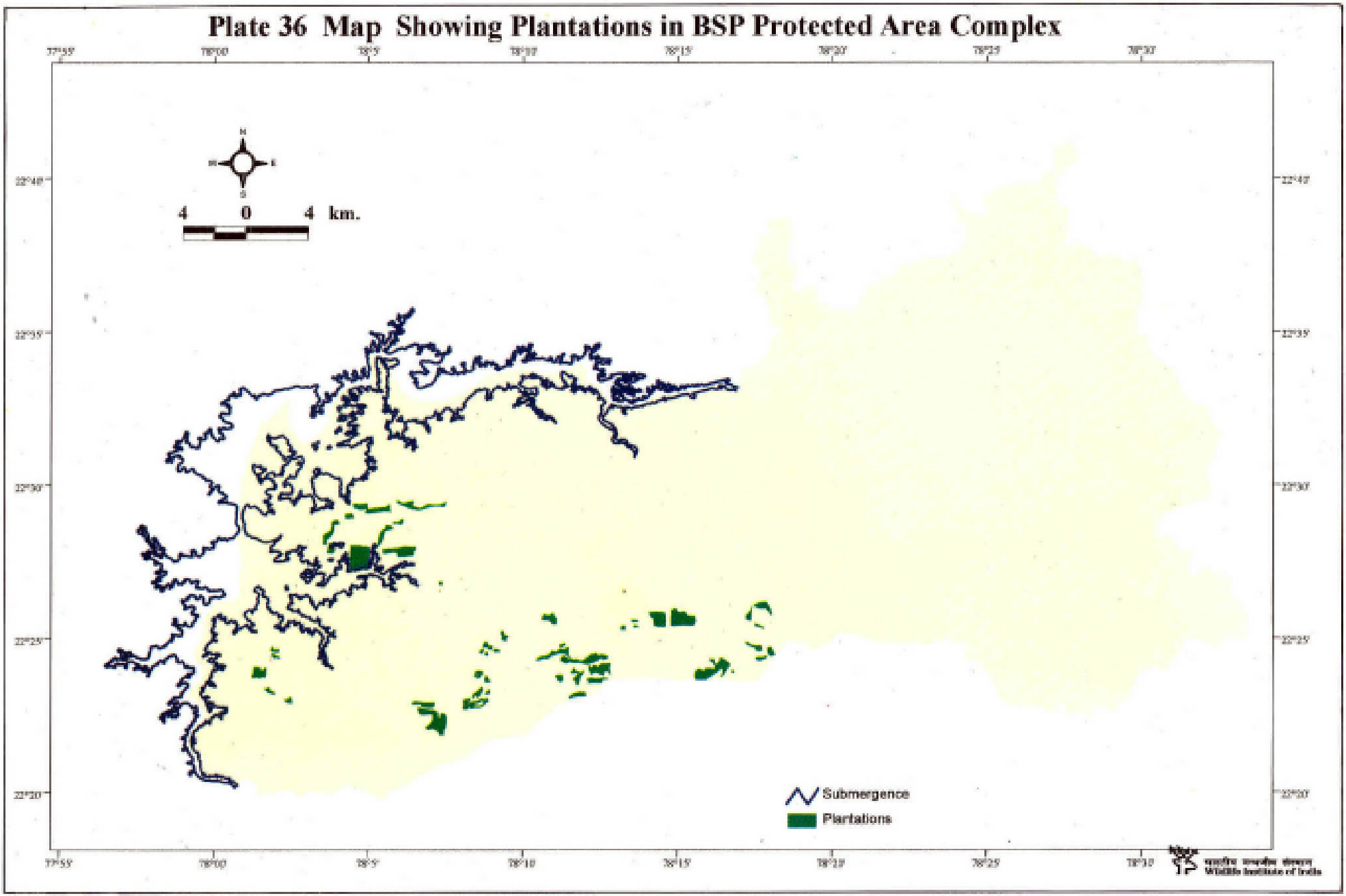


Plate 37 Vegetation Map(1975) of Managed Forest Divisions of Betul District, Madhya Pradesh
(Area for which Data is available)

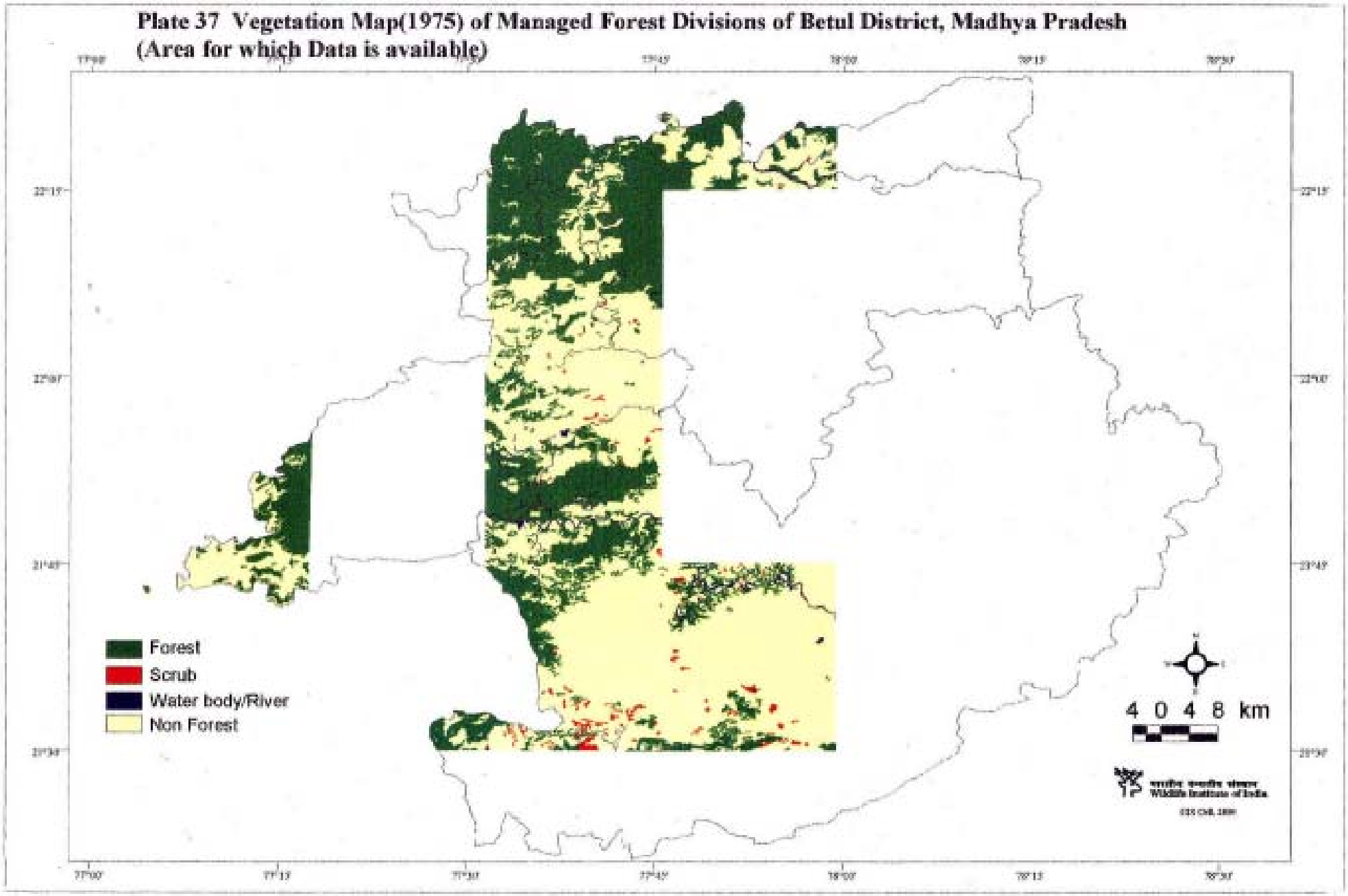


Plate 38 Vegetation Map(1985) of Managed Forest Divisions of Betul District, Madhya Pradesh

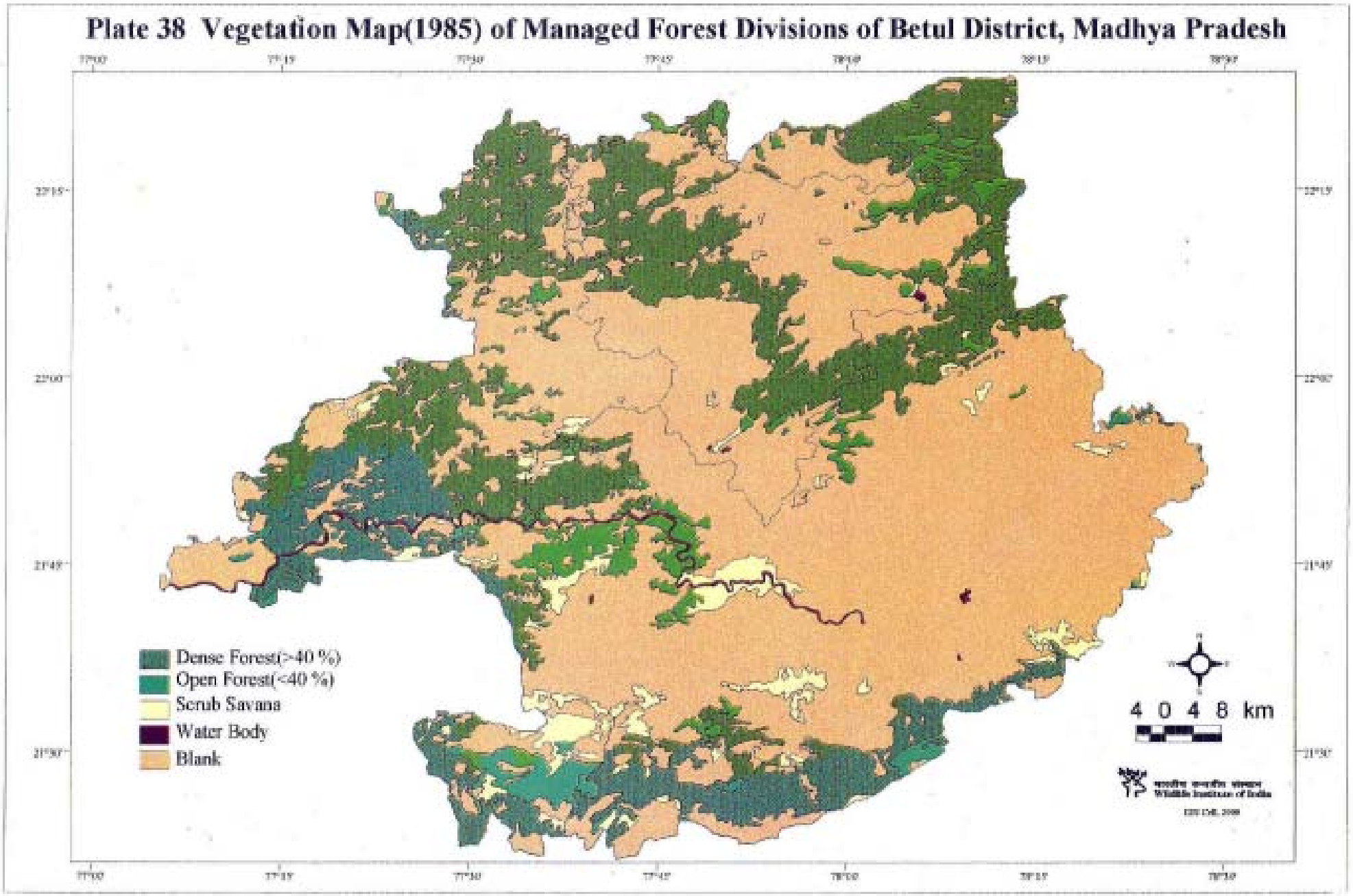


Plate 39 Map showing changes in Landuse /Vegetaion (1975-1985) for Managed Forest Divisions of Betul District, Madhya Pradesh(Area for which data is available)

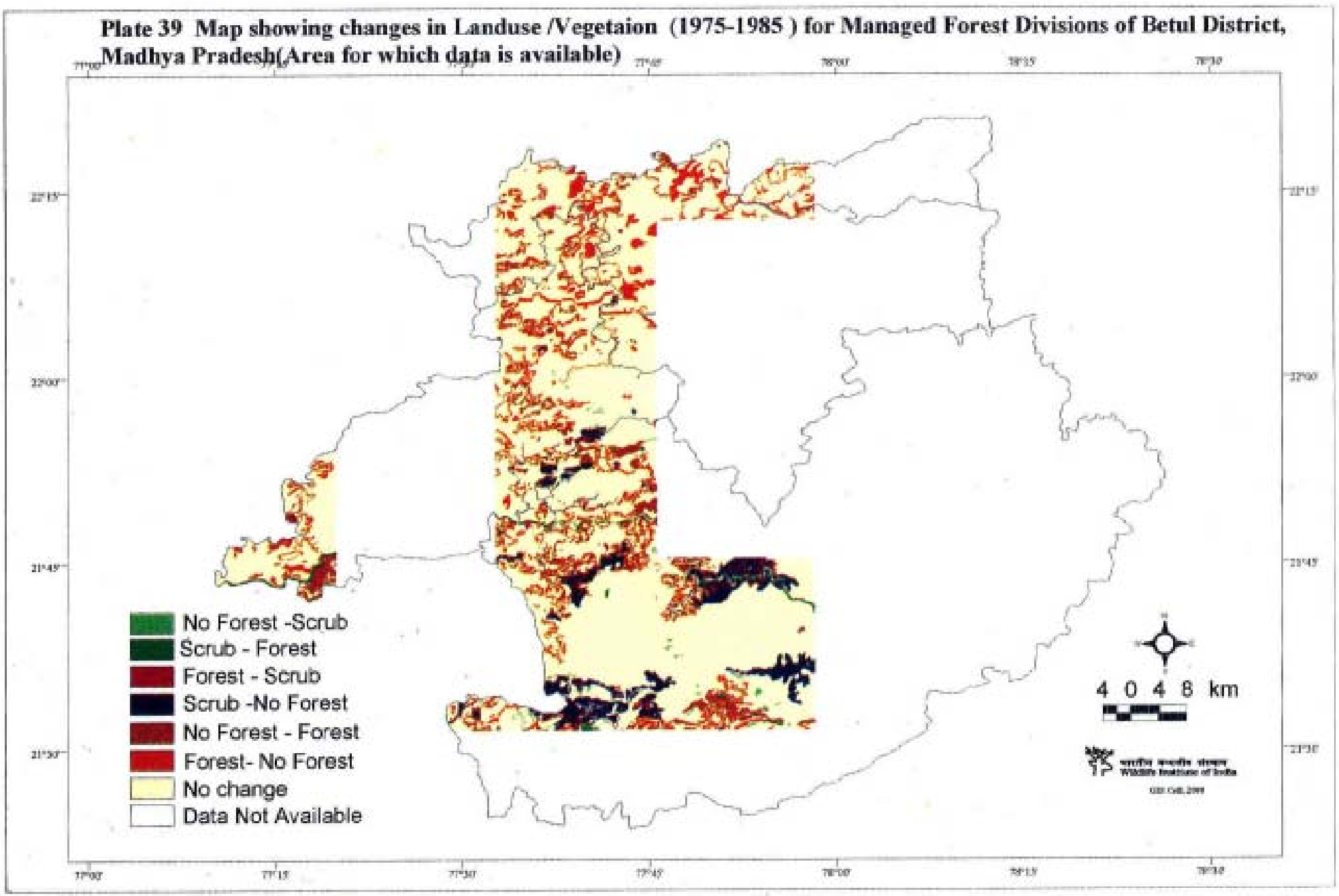


Plate 40 Map showing Vegetation/Landuse of Betul District , Madhya Pradesh . (IRS 1B LISS II 1996)

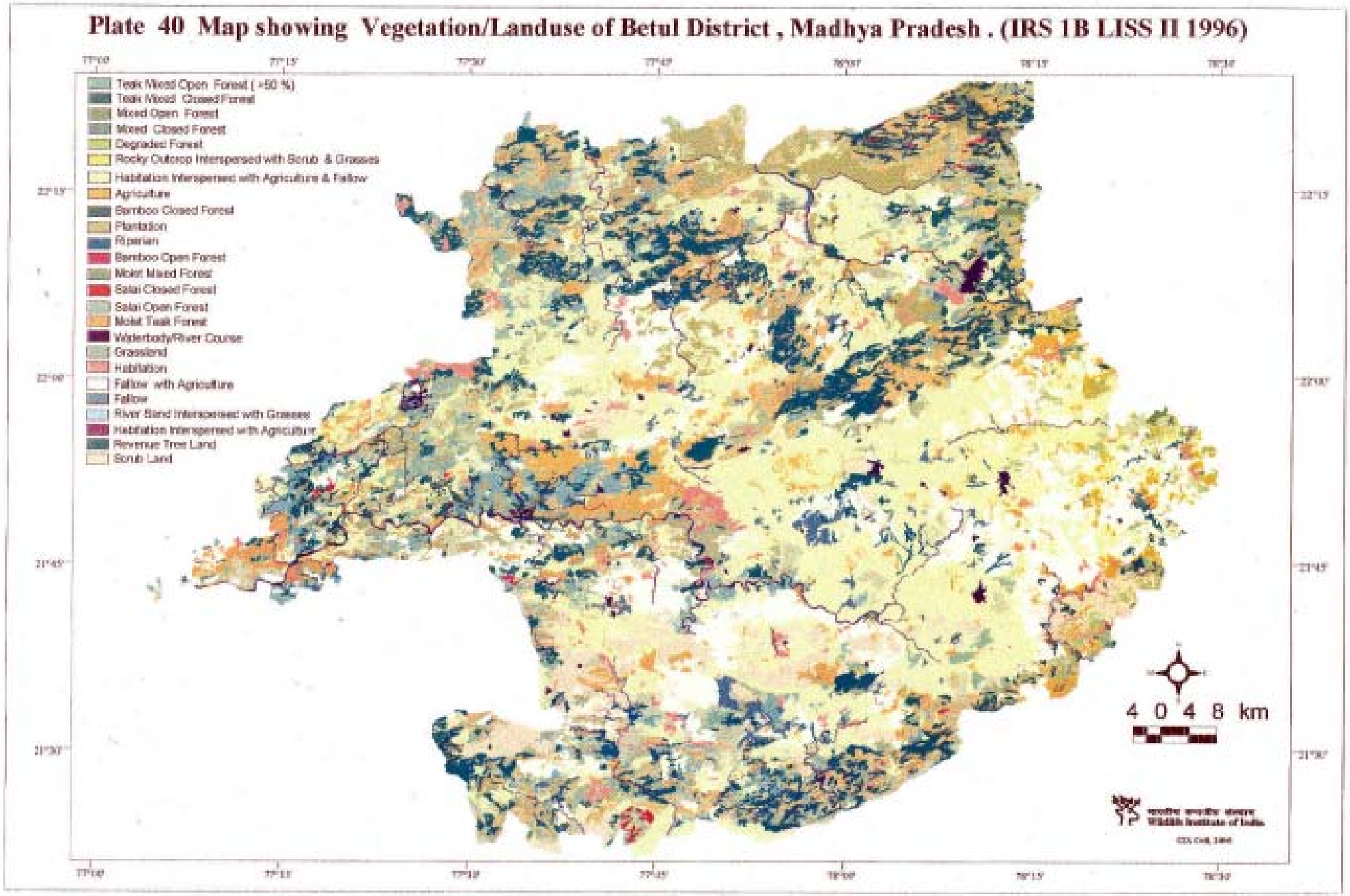


Plate 41 Vegetation Map(1985) of Managed Forest Divisions of Betul District, Madhya Pradesh
(Area carved out of 1985 Vegetation Map)

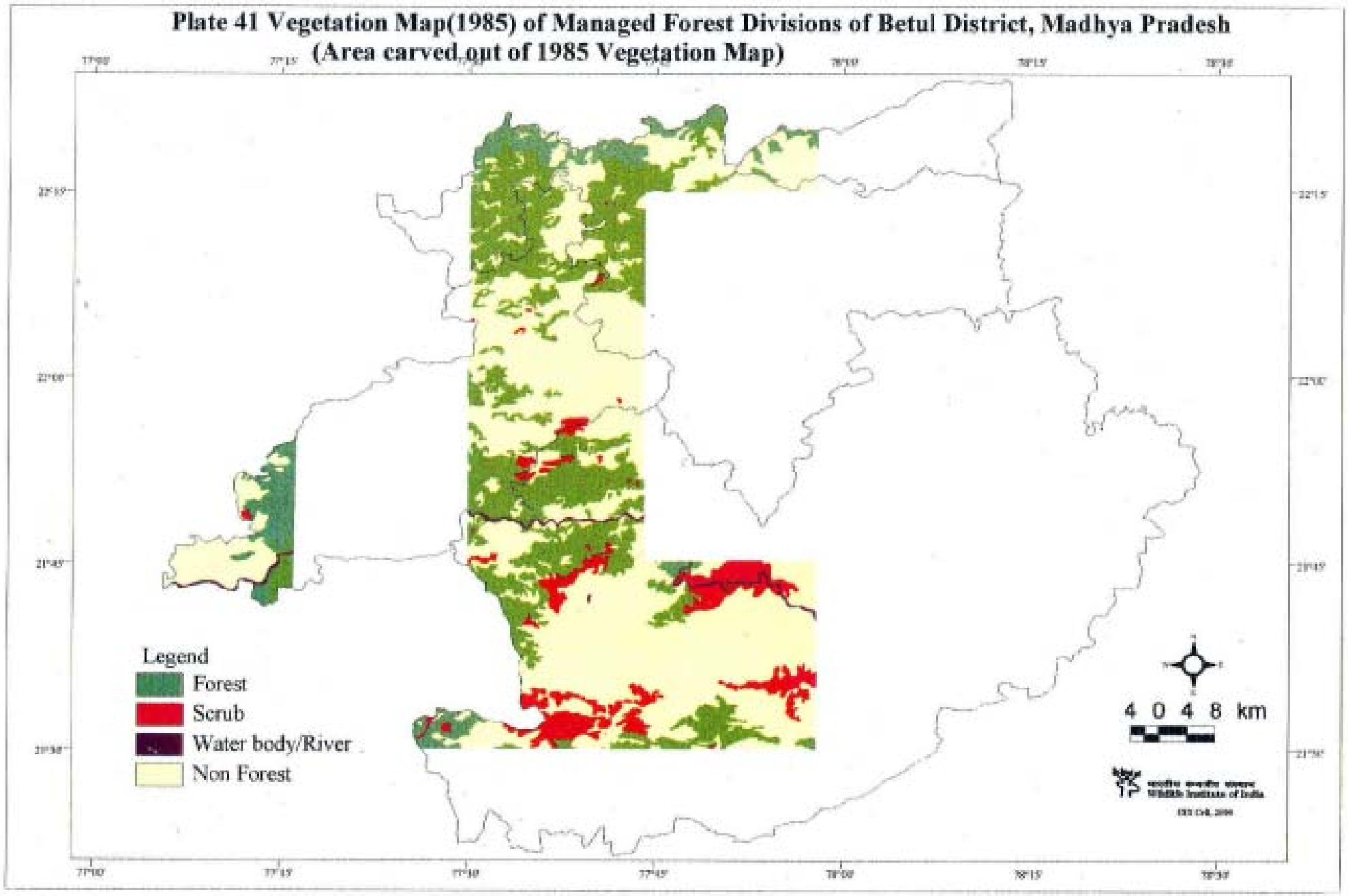


Plate 41 a Map Showing Transect layout in BSP Protected Area Complex

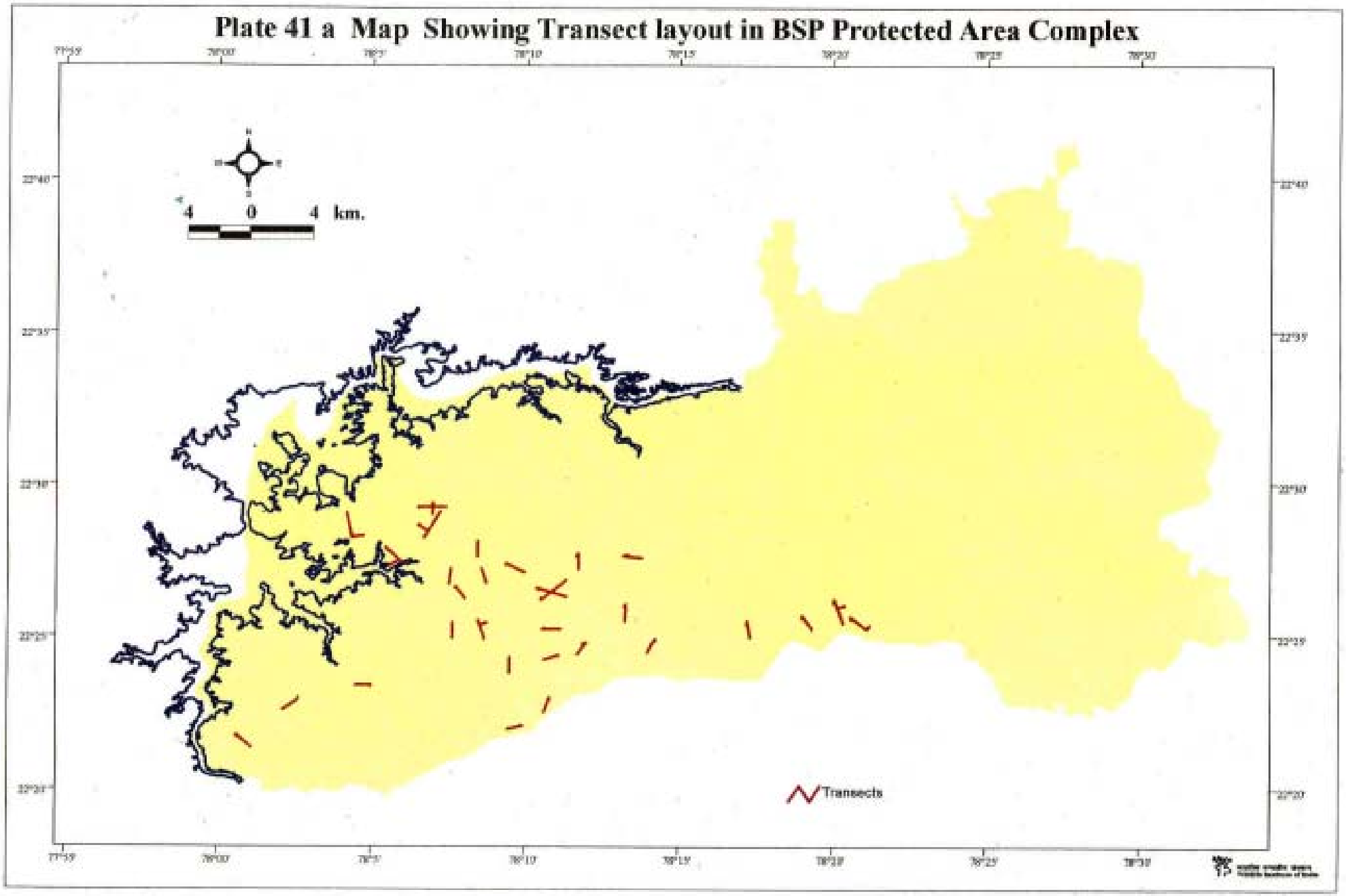
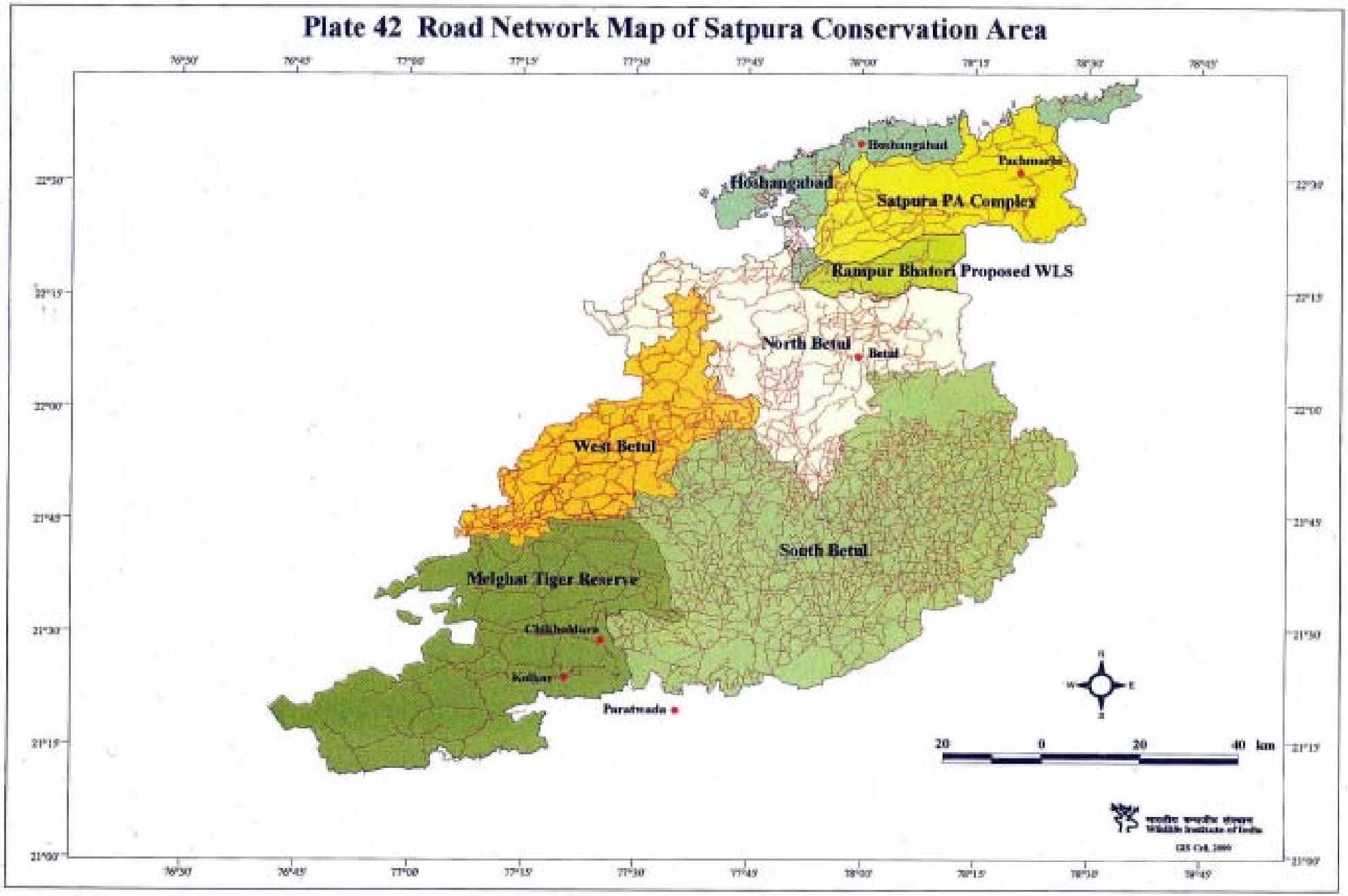


Plate 42 Road Network Map of Satpura Conservation Area



OVERALL TREE DENSITIES IN THE THREE STRATA IN MF AND PA

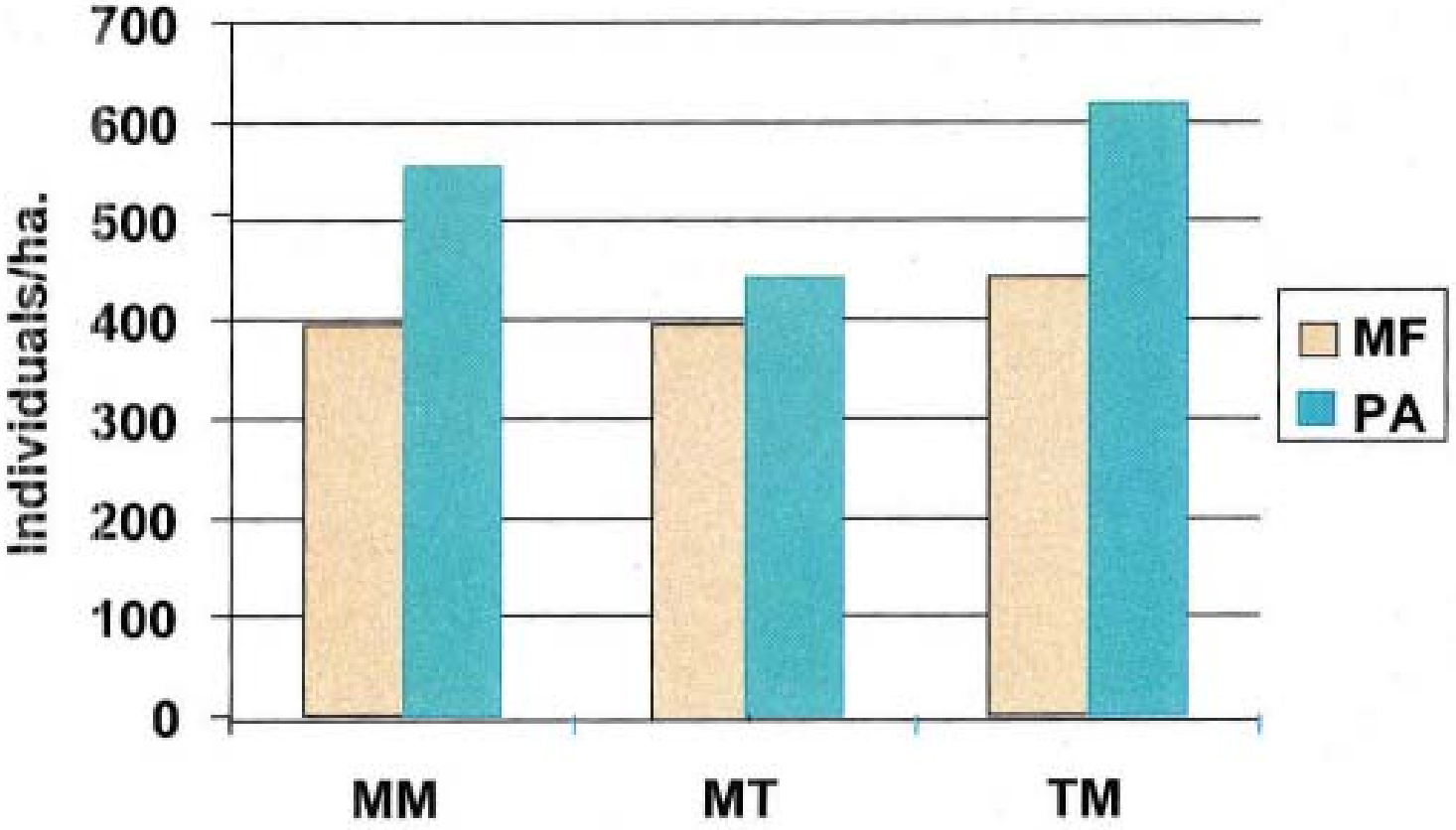


Figure 17

OVERALL GBH CLASSES IN PA AND MF

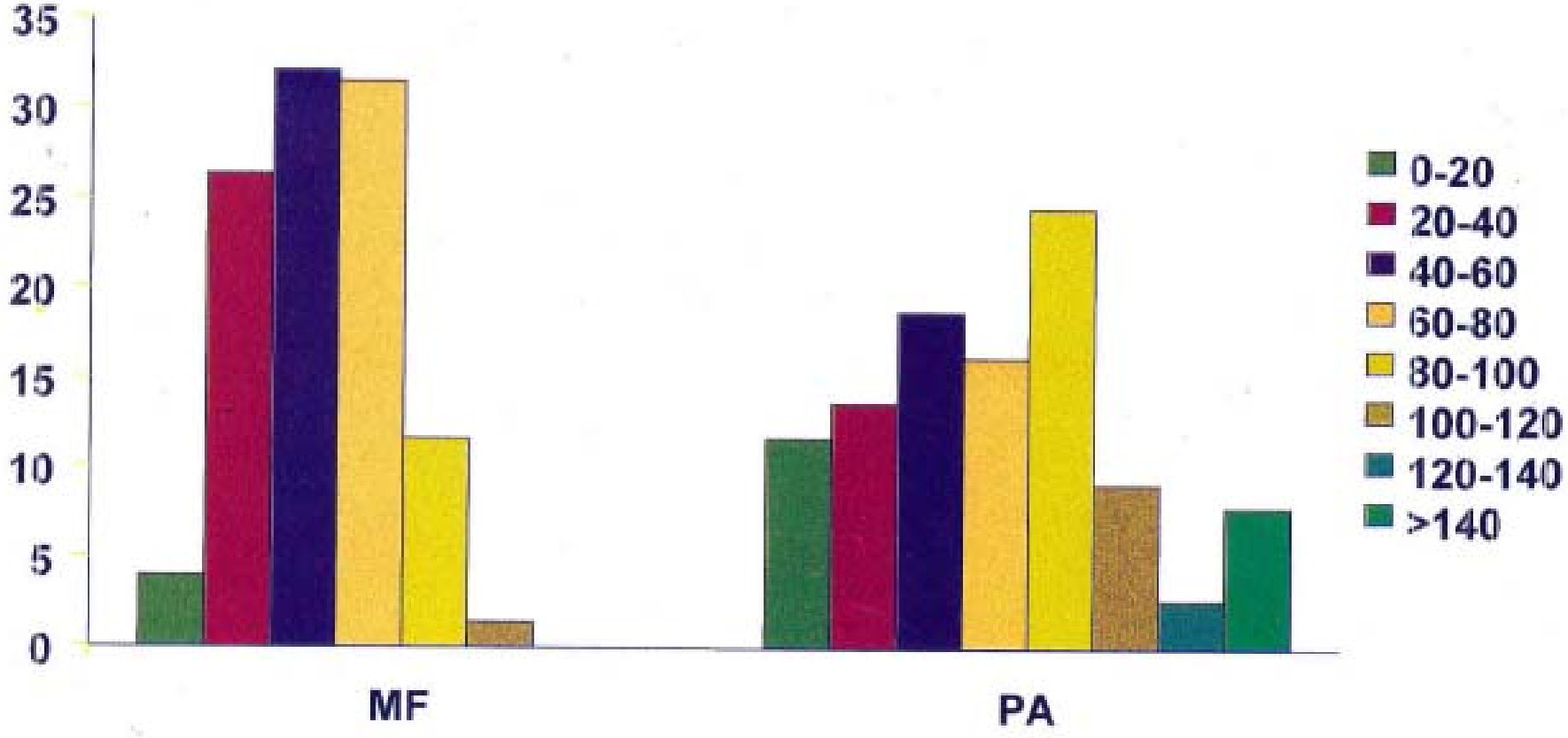


Figure 18

COMPARISON OF THE COMPOSITION OF SELECTED
TREE SPECIES BETWEEN MANAGED FORESTS AND PROTECTED AREAS

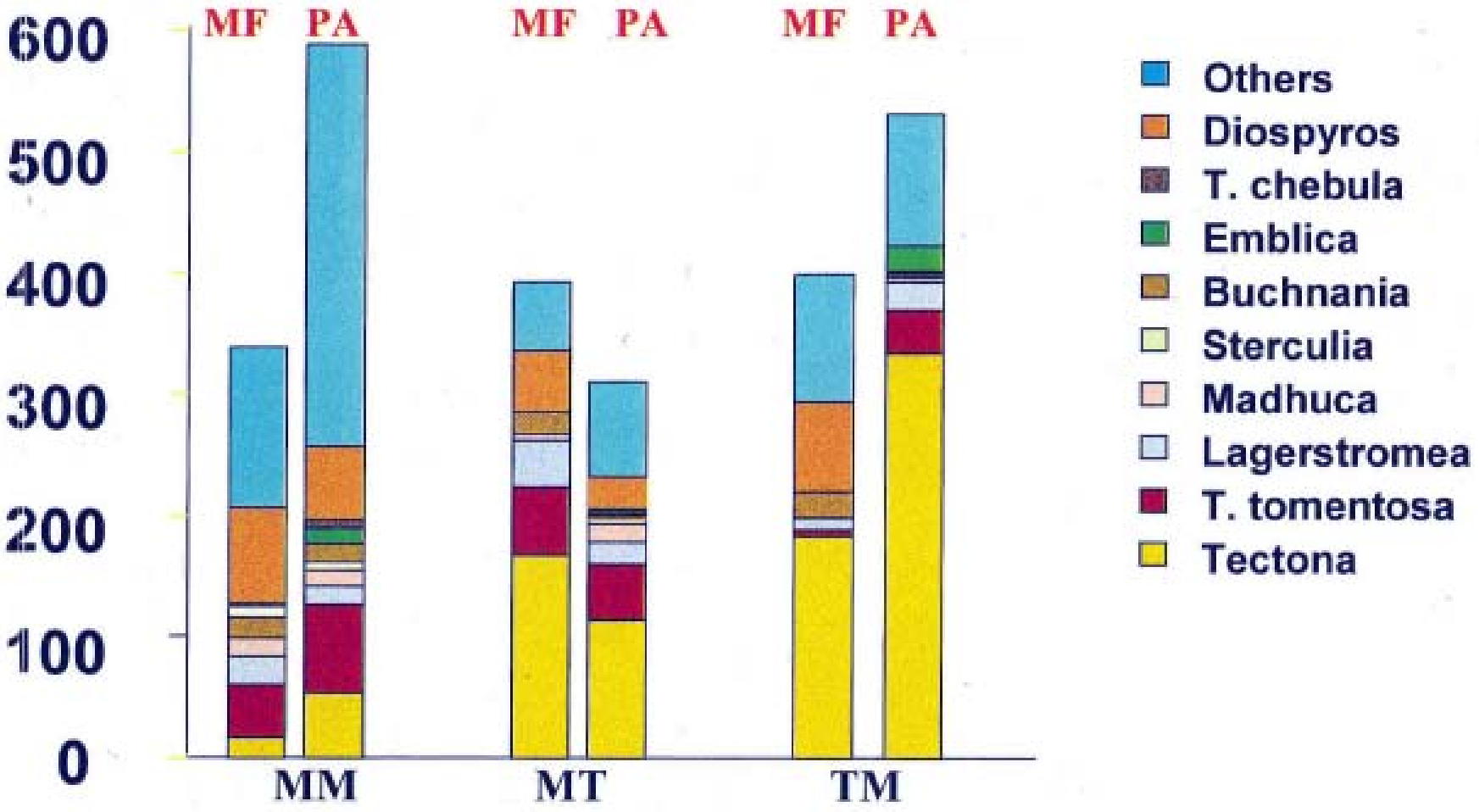
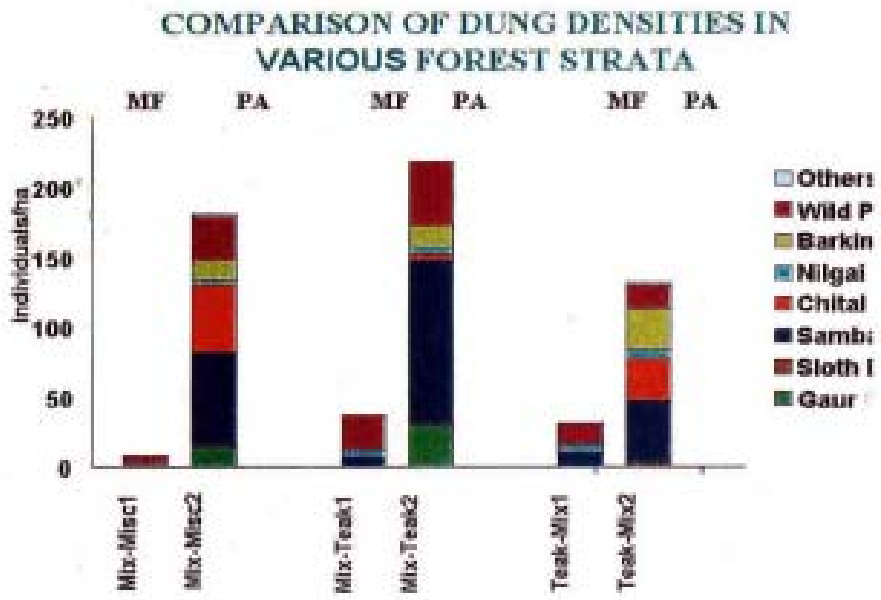


Figure 19


COMPARISON OF DUNG DENSITIES IN VARIOUS FOREST STRATA
MF
PA
MF
PA
MF
PA
250
200
150
100
50
0
Individuals/ha
Other
Wild P
Barkin
Nilgai
Chital
Samb
Sloth I
Gaur
Mix-Misc1
Mix-Misc2
Mix-Teak1
Mix-Teak2
Teak-Mix1
Teak-Mix2

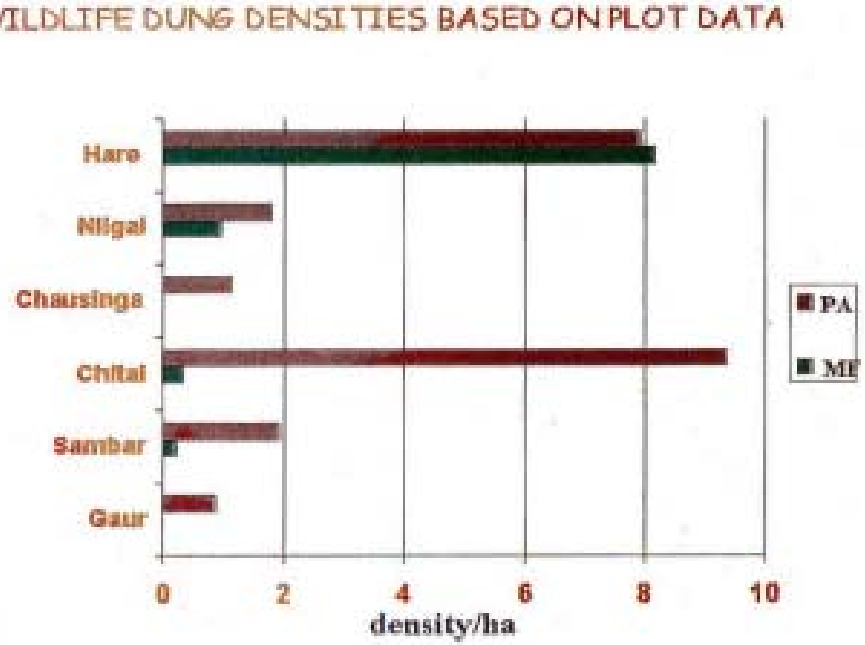

WILDLIFE DUNG DENSITIES BASED ON PLOT DATA
Hare
Nilgai
Chausingha
Chital
Sambar
Gaur
PA
MF
0
2
4
6
8
10
density/ha

Figure 20

Chapter 3 Terrestrial and Aquatic wildlife

3.1 Introduction

The Satpura Conservation Area historically belongs to a single large region of administration, the Central Provinces and Berar (CP & Berar) prior to the reorganization of States during the year 1958 to 1960. The salient features of early natural history of the region are captured by two legendary figures. Captain Forsyth explored the Satpura forests, now in MP during the 1860s and described the wild animals he came across (Forsyth 1871). The most notable record pertains to the herds of swamp deer *Cervus duvauceli branderi* he encountered in the basin of Denwa river and associated streams. Today the only world population of this sub-species of the swamp deer occurs in the Kanha national park, currently standing between 350 to 400 animals.

The disappearance of the species from elsewhere in central India is attributed to the loss of its essential habitat, grasslands and moist areas around streams and water pools in the valleys. These were also the most productive and convenient sites for human settlements and agriculture for people who came into the area much later than the swamp deer. Poaching also must have been a serious decimating factor since among all the larger deer this gregarious species is the easiest to hunt. Though this deer is gone from the central Indian forests with the exception of the Kanha national park there is a lesson in this for the present day wildlife managers to protect whatever patches of grasslands that remain, the so called blanks or otherwise. There are species of animals that are either largely dependent on grasslands/ grassy patches or are obligates to it. A prescription for maintenance of such structural stage is particularly relevant to the managed forests.

During the course of his exploration Forsyth shot many animals and described all he observed. The house that he constructed for his residence is now within the Pachmarhi township. It is called the Bison lodge. Now renovated and enlarged, it houses an interpretation center for the Satpura national park.

Dunbar Brander was a distinguished forest officer of the Imperial Forest Service and served for a period of 21 years in the forests of Central Provinces. He was a keen naturalist and hunter and shot some 200 tigers during his service. Today such records are looked down upon but those were different times and therefore it will be unfair to pass such judgement. He published a book titled 'Wild Animals of Central India' in 1923, an engaging account in some detail of the larger mammals of central India. He even refers to a *mahua* tree in one of the valleys in Melghat that a tiger used regularly as a clawing post.

The credit for providing glimpses of the earliest natural history of this tract of the Central India, however cryptic it may be must go to the ancient people who dwelt in caves, under rock shelter and heavy forest canopy of the vast unbroken tracts of forests of this region several thousand years ago. Ancient people of the world expressed their perceptions of natural environment through pictographs. The earliest painted images on rocks are believed to have been executed some 15000 years ago in the caves of Lascaux in France and Altamira in Spain (Anon 1985). In the conservation area the oldest

iconography on sandstone surface is estimated to have been executed some 10,000 years ago in the Satpura national park and Bori wildlife sanctuary. The paintings appear mainly in shades of brown and maroon with occasional grayish green. The paintings scattered across the sandstone landscape depict tiger, leopard, spotted deer and another with many tines on its antlers that could be the swamp deer, rhinoceros, elephant, a giraffe like creature, wild pig, porcupine, pangolin, horses, hunting parties of men with bows and arrows, men at work etc. Some of these are points of visitor interest but unfortunately there is no interpretive material.

Prior to the 1970s wildlife management in central India had two aspects to it. Protection of wild animals and their habitats in the established protected areas and regulated 'game' hunting elsewhere on license granted by the forest department. There were laws to protect, conserve and for regulated hunting of identified species of wild animals for the purpose. Acts such as the CP and Berar Games Act 1935 and CP and Berar Wild Birds and Animals Protection Act, 1912 were later extended to the newly constituted Madhya Pradesh in 1958. In the Reserved Forests besides these two Acts hunting was controlled by rules framed under the Indian Forest Act 1927.

After the reorganization of States, Melghat in 1960 was included in Maharashtra and the provisions under the comprehensive Bombay Wild Animals Birds Protection Act 1951 was extended to this area. On the ground hunting was regulated by shooting blocks that were mapped and clearly identified by physical features and demarcation. For each shooting block the species that could be hunted was specified. Depending on the species allowed to be hunted the minimum caliber of a firearm that could be used for a species was prescribed. A limit on the number of animals of a species that could be shot in a given year was fixed. When the limits were attained the particular block was closed for hunting. For each licensee a bag limit was prescribed. During each year a certain number of months were declared as closed time. Hunting of all animals during such period was prohibited. A species could be taken off the list of hunting any time for a specified period or banned outright for hunting.

Tiger hunting was unquestionably the greatest attraction. Other large carnivores were next in demand. Between the years 1955-'56 and 1967-'68, 70 tigers and 113 leopards were shot on license in the tract that later became the Melghat tiger reserve in 1973. This and the number of tigers shot by Brander during the early decades of the 20th century provide some indication of the abundance of tigers and leopards in CP and Berar. The SCA is only a small portion of the great tiger country of yore.

The years 1970 to 1973 mark a watershed in wildlife management efforts in India. Prior to 1970 for a period of at least three decades there was regulated licensed hunting of wild animals. Trade in wild animals, trophies and animal parts were generally governed by provisions of legislation that not only were inadequate but they also varied considerably from region to region and State to State. Poachers and smugglers took advantage of this. Thus post 1970 period is probably the most significant in the matter of change in perception of managing wildlife in India. It first witnessed a countrywide moratorium on hunting tigers, the most sought after sport. Following the enactment of the Wildlife (Protection) Act 1973 the ban on hunting was gradually extended to other species.

This Act has a nationwide application, except to the State of Jammu and Kashmir (J&K). The State of J&K has a parallel legislation with some differences. A single Act applicable nationwide removed the anomalies that existed between the disparate provisions and regulations of State Acts. Trade in wild animals, trophies and parts came under stringent

provisions of law and sport hunting came to an end. The Act also ushered formation of Wildlife Wings within the State Forest departments for the express purpose of managing wildlife. Appropriate organizational changes have also been brought about in the Central government for this purpose.

There is at times a debate, within the professional circles as well as outside these groups whether banning hunting of all species is the best way to go about conserving wildlife? The core issue of such discussion is inevitably rooted in damage caused by wild animals to standing agricultural crop, human property, injuries to humans and occasionally loss of human life. History has it otherwise. During British occupation of India between the years 1875 to 1925 a bounty was placed on several 'troublesome' species. The record maintained for the bounty paid for killing such animals reveals that 80,000 tigers, 1,50,000 leopards and at least 2,00,000 wolves were killed. The actual figures are likely to be considerably higher! (Rangarajan 2001). This slaughter did not help in resolving the problems then neither the continued hunting since till the Wildlife (Protection) Act 1973 effectively brought the legal hunting to an end. Illegal hunting was in existence in past and persists today.

In several quarters there is a popular notion that wild animals are government owned animals for whose wellbeing the citizens need not have any responsibility. This inspite of Article 51 A of the Indian Constitution enjoining citizens to protect wild plants and animals. Measures such as widening the base of Protected Areas, and the ban on hunting are seen as an adversity. There might be a little logic in these however main causes for the unfortunate wild animal-human interface issues are very different and are reposed in the various unplanned human activities and land-use. The human and livestock population growth have registered an all time high with serious implications for wild plants, animals and as a consequence to the humans. As stewards of wild-lands the forest and wildlife managers in the present times are standing watch over an extremely testing situation. Given their mandate they are not popular and enjoy little social support.

3.2 Wild Animals of Satpura Conservation Area

The terrestrial and aquatic wild animals of Satpura Conservation Area are described by classes. There is an inventory of species placed at **Appendix** IV, V, VI, VII & VIII. The inventory by no means is complete. The species wise and class wise information level is variable, at times for some it might be very little. The major weakness relates to invertebrates, amphibians and fishes. Though the inventory of reptiles seems better the information on distribution, abundance and habitats for some species at times is not very specific. It was not possible for the single researcher in the project to address these deficiencies. Besides involvement of subject specialists was essential. In spite of some efforts in that direction there was little response to the call. The gaps need to be addressed in future.

The status of a species wherever stated is based on three main references as relevant and applicable. The Schedules to the Wildlife (Protection) Act, 1972 as amended from time to time define the legal status in India. The CITES Appendices I to III indicate how a species is placed in context of international trade. The Red Data Book published by the Zoological Survey of India (Anon 1994) states the conservation status of species in India that qualify inclusion in the Red Data Book categories in India.

For distribution and abundance, whether in text or species profiles the descriptors for mammals in Prater, 1980 with significant updates from literature published later are relied upon. Similar approach is adopted for birds, Salim Ali and Ripley 1983, Grimmett, Inskipp and Inskipp 1999. For reptiles

Daniel, 1983 and for amphibians there is no standard reference. Where specific information on population estimates is available or generated on the Conservation Area during the course of the project it is cited. The class of fishes has not featured in the Wildlife (Protection) Act 1972 except its inclusion in the definition of "wildlife," in article 37 under section 2. It has not featured in habitat management strategies per se in wildlife management. The information is therefore weak. The class of invertebrates likewise is in a similar situation, though a large number of insect species find place in the Schedules of Wildlife (Protection) Act, 1972.

3.3 Invertebrates

There is little information on this class. Between the years 1995 and 2000 there was a severe epidemic of sal borer *Hoplocerambyx spinicornis* in the forests of six districts in Madhya Pradesh. It is a large longicorn beetle belonging to the Order Coleoptera, Family Cerambycidae. It bores into the heartwood of sal *Shorea robusta* the most important timber species in MP after teak. Some 26000 sq. km. of forests were affected by the epidemic. As per record by the year 1998 31,40000 trees were affected and by January 1998, forest department had removed some 7,83000 infected trees. Large and extensive galleries bored by the larvae kill the trees and render the timber useless for any purpose.

The beetle is co-evolved with sal. It is host specific and endemic to these forests. The epidemics appear at an interval of 35 to 45 years and the major attack is on trees in the GBH classes 90cm. and above (Anon 1997, 1998). The severity appears to be more in the vicinity of villages where the forests are under heavy biotic pressures and along riparian patches that are moister and cooler than the surrounding forests.

The beetle breeds during rains in the month of June and July. Persistent rainfall and higher humidity are the required conditions. Eggs are laid in the crannies of the rough bark. Larvae are exposed during a period of 3 to 6 weeks before they bore into the sapwood where the larva chisels winding tunnels. The full larval growth, from 3 mm. to about 75 mm. may take 4 to 7 months. The fully-grown larva then starts to bore into the heartwood and constructs an oval chamber. It remains in a pre-pupal quiescent state for several months. It turns into a pupa by the middle of May. The short pupation period lasts for about 2 to 3 weeks. The imago and then the beetle remains in the chamber till favourable monsoon conditions establish. When this occurs the beetle is ready to emerge and then ready to breed (Thakur, 2000).

The only control strategy is to trap beetles on 'trap trees'. Malformed trees of sal, 2 to 4 per hectare are felled and converted into logs. The bark is beaten so that resin starts oozing that attracts the beetles. Beetles feed on the resin and become sluggish. They can then be picked off mechanically at dusk or dawn and killed in kerosene containers. Labour is paid by the number of beetles collected. During the period of two years 1997 and 1998, 50 million beetles were collected and destroyed. The standard strategy employs a classification system for affected trees that is based on external indicators into severity classes. The classes falling in recruitment categories and snags are harvested and removed. The debris is burnt.

It is interesting to note that sal forests in Kanha national park are located in the center of a vast stretch of sal forests. During the severe epidemic they experienced only a sporadic attack though in comparison the proportion of the higher diameter classes is highest per unit area among all the adjoining forests.

The current thesis is that since Kanha forests have for the past six decades been free of timber operations, NTFP collection, livestock grazing and disturbance that is associated with free human access, they have

maintained the natural ecological attributes and biological forces that maintain populations of the beetle at a very low level thereby reducing the severity of epidemic. In other terms converting the forests into pure stands of sal adversely affect the natural biological forces in the forests that are inimical to the beetle by significantly reducing their habitats. This encourages the severity of the epidemic.

Currently there are no research findings to validate this hypothesis. However at least the woodpeckers and owls among the birds are established predators of such beetles. Other species such as the two civets present in the sal forests, honey badger, wild pig, jackal, shrikes, drongos feed on larvae and adults of the longicorn beetles (Prater1980, Ali and Ripley 1983). It follows that besides the time tested epidemic suppression strategies in the managed forests of sal, maintaining snags, den trees and natural vegetation attributes to the extent possible appear among the most appropriate strategies to reduce the severity of epidemics. The silvicultural marking rules need to be amended to maintain mixed stands. These appear as some of the major lessons emerging from this event.

Sal forests in the SCA occur in a relatively small tract towards the northeast on sand stone formation of the Pachmarhi wildlife sanctuary, and the Satpura national park. The site quality being IV b the sal forests though almost pure on the Pachmarhi plateau. They are biologically old in the sense that they have not been under any felling system since the 1950s. The trees are stunted with the average GBH seldom exceeding 70-80cm. These forests during the period of the epidemic experienced only a sporadic attack of the beetles, more commonly in the dank deep and moist drainage areas.

3.4 Amphibians

These are dry forests though the rainfall per se might not suggest such conditions. The vegetation communities and their distribution however certainly do. Only four species have been listed, not necessarily because the forests are dry, but rather due to lack of a systematic survey. The two species *Rana tigrina* and *Rana cyanophlyctis* occur along the perennial rivers in the northern Satpuras, and otherwise along the perennial pools, margins of the reservoirs and tanks such as Malur and Tarubanda in Melghat. Melghat has a number of mesic groves situated in depressions. The groves are represented by very old, tall and massive trees of *Syzigium cumini, Mangifera indica and Terminalia arjuna.* The percentage canopy closure is 80% to 90%. Large climbers are conspicuous. The upper boles and canopy branches are festooned with moss. The blue orchid *Vanda cerulea* is common. There are one or more springs and the soil is usually clayey. The surrounds of the grove usually have clumps of bamboo. This is in stark contrast to the dry forests in the surrounds. The highest abundance of these frogs occurs in such habitats. During the summer they aestivate.

The slender tree frog *Rhacophorus maculatus* throughout the SCA is not very common and rather rare in Melghat. Occurs mostly along moister localities especially the mesic groves. The common toad is widely distributed.

3.5 Reptiles

There are 21 species of reptiles in the Conservation Area.The Indian crocodile *Crocodilus palustris* is largely confined to the Tawa reservoir occupying portions of Satpura national park and Bori wildlife sanctuary. There is some evidence of its presence in the Denwa, and Sonbhadra rivers. Tapi river describing the boundary between Melghat and the south Betul forest division in MP has crocodiles. There are no estimates of populations although the draw down areas of the Tawa reservoir by the evidence of nesting sites of crocodiles indicates a fairly good population. The evidence in the rivers indicates patchy distribution and low population.

The species is placed in Schedule I of the Wildlife (Protection) Act, 1972 and was considered an endangered species in the early 1970s together with the other two crocodilians in India, the gharial and the Estuarine or the salt water crocodile. However, following the rear and release program under the Crocodile Project that was launched in the mid 1970s, the species staged a remarkable recovery and is now considered out of danger. Fishing in the Tawa reservoir, issues not quite settled along with the controversial seasonal farming in the draw down areas are two activities that militate against the interest of the crocodiles. During the 1990s five adult crocodiles from the rearing center at the Tadoba national park in Maharashtra were introduced in Sidhukund, one of the largest perennial pools in Melghat. Three of these have moved down stream to other pools. The dangerous illegal technique of fishing pools with pesticides is a major threat to these introduced animals in Melghat.

The Indian Pond Terrapin *Melanochelys trijuga* occurs in the Denwa and Sonbhadra rivers. The Peninsular Mud Turtle *Lissemys punctata granosa* is omnivorous and one of the commonest mud turtles in India. It is found in ponds, tanks, and shallow portions of the Tawa reservoir pools and streams. The Deccan Softshell Turtle *Trionyx leithi* is carnivorous and occurs in the rivers of northern Satpura in the MP portion of SCA.

In the forests there are four species of Geckos. The Bark Gecko is common and lives in the crannies of bark on tree trunks. The Rock Gecko is associated with rock formations and caves, feeds on other smaller geckos and insects. The Termite Hill Gecko is attractively coloured and is associated with termite mounds throughout the SCA. The Brook's Gecko is the commonest of the *Hemidactylus geckos* and lives in a variety of habitats such as on trees, rocks, under stones and on buildings.

Among the Agamids the Fan Throated Lizard *Sitana ponticeriana* is ground dwelling, occurs in open shrubby patches, young plantations and is widely distributed. The Common Garden Lizard and the Forest Calotes are widely distributed.

The Indian Chameleon *Chamaeleon zeylanicus* occurs in woodlands and is arboreal. They seem to be patchily distributed and rare. The notion of rarity could also be because of its ability to blend itself against its background and substrate. Interestingly the local forest inhabitants, the Korkus and Gonds believe that the chameleon is extremely poisonous. This could be due to its rather extraordinary appearance, the ability to change colours and the hissing sound it emits when disturbed.

The Common Indian Monitor *Varanus bengalensis* is widely distributed, probably not as common as it is believed to be. It is persecuted and hunted for meat. The oily substance derived from its body is used in traditional medicine to treat rheumatism. It features in trade for skins and is endangered and completely protected under the law. It is diurnal and lives in burrows, crannies in rocks, and tree hollows that are used for escape. It has a powerful grip and there are historical accounts of the animal being used for scaling walls of forts during a battle. It is carnivorous and feeds on small mammals, birds, and eggs of a variety of animals including those of crocodile and turtles, fish, and crabs; insects and arachnids (Auffenberg 1994).

Thirteen species of snakes occur in the Conservation Area. The Indian Python *Python molurus* is the largest of them and occcurs in the forests in low densities. It is an endangered species and has features in illegal trade of snake skins. The Rat Snake is one of the most common while the Tree Snake is mostly seen in Melghat. It is arboreal and feeds largely on lizards and tree frogs. Though it is harmless the locals believe it to be highly poisonous, striking humans on the head while hanging from a branch. The other arboreal snake is the Cat Snake or the Indian Gamma.

The Checkered Keelback *Xenochropis piscator* is a freshwater snake in tanks, paddy fields, pools and rivers. It is extremely active, agile and an excellent diver. It is seen mostly during the monsoon. Feeds almost exclusively on toads, less commonly on other amphibians and lizards. It is harmless to man. The Common Green Whip Snake is mostly seen in the understorey shrubs. It is mildly poisonous and feeds mainly on small mammals, birds, lizards and frogs.

The Common Indian Krait occurs in open forests with shrubs, agricultural fields and near habitations. It mainly feeds on snakes. It is one of the deadliest among the poisonous snakes of the world. The Banded Krait favours moist places and the vicinity of water. It is extremely sluggish and hence seldom bites. Feeds mainly on snakes. It is poisonous but believed to be less virulent than the Common Krait.

The Indian Cobra is widely distributed in almost every kind of habitat. Feeds mainly on rats, frogs and toads, occasionally birds, lizards and snakes. It is a powerful and poisonous snake. It is worshipped during the festival of *Nag Panchami*. There is a shrine at Nagdwari within the Satpura national park where more than 100000 pilgrims gather to offer prayers during this festival. Such sentiments however do not deter people from killing the snake when it is encountered because of an atavistic fear.

The Russell's Viper is widely distributed. Largely nocturnal and slow moving. When provoked it can strike very quickly and is known to hold his bite much longer than other snakes. It can often be fatal to man. The Saw-scaled Viper is a much smaller snake recorded in the open forest and is widely distributed. It feeds largely on centipedes, scorpions, large insects, mice and frogs. It is highly poisonous. The Bamboo Pit Viper mainly occurs in the hilly terrain in the forests. It has a marked preference for bamboo occupied areas. Feeds on small mammals and other smaller vertebrates. It is widely distributed in the extensive bamboo areas of the SCA.

Species distinctions notwithstanding all snakes are considered extremely dangerous and superstitions are many. The greatest threat to snakes in general is a flourishing illegal trade in snake skins (Menon 1998). The forest department is seized of the danger and every attempt is made to curb this trade.

3.6 Birds

The first avifaunal survey in the Melghat tiger reserve was undertaken during the period 1974 to 1979 (Sawarkar 1988). Wildlife managers of the reserve have since continued the activity. Anyone who is in the field is watching birds, checking the previous records and reporting new species from localities where they were seen. These are not automatically listed without confirmation. The process is further helped by bird watchers that visit the reserve. In the Madhya Pradesh portion of the SCA a concerted process began during the year 1986 when the WII chose to site their training programs in all the three PAs. Each of the training programs was of one-month duration for three consecutive years. These however covered only the period of summer. Such programs were also conducted in Melghat. This was followed in 1989 by a four-year duration project of the WII in all the five PAs located in the SCA. A specific component related to the impact of timber felling on bird species (Mehta 1998). Under the WII-USDA Forest Service project the surveys continued and were extended to the remaining areas of the SCA.The surveys have established presence of 259 species belonging to 145 genera and 47 families. The inventory is placed at **Appendix** III. Following is a discussion on distribution and abundance of species that have any of the stated attributes such as restricted distribution, small populations, significant ecological features, those that appear in the endangered and rare category and species that are socially or culturally significant.

Waterfowl habitats include the Tawa reservoir, and the rivers Denwa, Nagdwari, Sonbhadra in the

MP portion. In Melghat there are no perennial rivers but ducks and teals appear seasonally in the Malur and Tarubanda tanks. Waders in the drier Melghat have access to appropriate habitats along the rivers and streams till the rivers and streams dry out by the onset of summer. Thereafter their habitat is restricted around the several scattered perennial pools. The Black Stork *Ciconia nigra* has a very small population and is restricted to the Koktu valley in the core area of the Melghat tiger reserve along the Koktu river. These appear seasonally in winter and were seen for the first time in the early 1990s. Another species that appears rather irregularly during the winters in Melghat is the Demoiselle Crane *Anthropoides virgo* whose flocks have been observed in open muddy patches, near streams and cultivation areas in Dhakna range.

Six species of eagles occur in SCA.The Crested Serpent Eagle and the Crested Hawk Eagle are the two widely distributed eagles. The other four species, the Bonelli's Eagle, Short Toed Eagle, Black Eagle and the Tawny Eagle are rare. The Crested Honey Buzzard is widely but patchily distributed.

Of the four species of vultures in the conservation area three occur in Melghat. The Long Billed vulture is absent. Populations of the other three species are small and patchily distributed. This however is not the case in the MP portion of SCA. All four species are present, with roosting and nesting sites along the sandstone cliffs. These cliffs also have roosting and nesting sites of eagles. The endangered Osprey occurs only along the Tawa reservoir.

The exotic *Lantana camara* especially in Melghat provides excellent cover for the fourteen gallenacious species that occur in the Conservation Area. Patches of tall grasses on plateaux, and in the plain to gently rolling tract of the Kesla Project plantation areas together with the undergrowth of native shrubs provide similar cover functions. The ripe berries of lantana are an excellent source of food for these species.

The Grey Jungle Fowl is associated with teak forests and the Red with the sal forests. The sal forest community is established on the sandstone formations towards the northeastern portion of SCA while teak forests are on the basaltic formations. There is an interesting 'tension belt' between these major communities with no teak or sal trees in a narrow belt that is particularly noticeable between the moist teak forests of Bori and the sal forests of the Satpura national park. The Grey and the Red Jungle Fowl neatly separate along such boundary. Hybrids between these two species are known to occur though none have been observed in areas where the two species geographically intergrade in the SCA.

The two species of sandgrouse were seen only in Melghat from one locality near Dolar in Dhakna Range. The species of doves and pigeons are widely distributed. Among the three species of parakeets the Alexandrine is patchily distributed with a much lower population than the other two species.

Among the species of cuckoos the Eurasian Cuckoo *Cuculus canorus canorus* that principally breeds in the Himalayas between the altitudes of 600-5000 meters, is known to breed in the moist deciduous forests of Chikhaldara, Melghat. It is one of the few sites in peninsular India and the only one in SCA and among other CAs in this project.

During February 1976, Salim Ali and S. Dillon Ripley visited Melghat with the main objective for ascertaining existence of the Forest Spotted Owlet or the Blewitt's owl *Athene blewitti*. The species was described in 1873, and there were less than a dozen specimen in collection. The last of these was collected in 1914 near Mandvi along the Tapi river. The species was stated to have been rare and occurring along the Satpura trend. The survey in 1976 was not successful in fulfilling its chief mission. During November 1997 the species was rediscovered in the Satpuras far west of Melghat in the Taloda region of Dhulia forest

division, Maharashtra (Rasmussen 1998). Later with some persistent efforts of the Bombay Natural History Society the species was also rediscovered in Melghat during March 2001 in the forests of Raipur Range (Melvyaghra 2001). In this early phase of rediscovery there is little information on habitat, distribution and abundance of the species. Ben King and Rasmussen sighted the bird in a degraded patch of forest on a hillock. The plains were heavily forested some thirty years ago but those forests are now gone. The hill forests less inhabited and some very well protected now appear to be the last remnants of the original range of the species.

The Pied Kingfisher occurs only in the MP portion of the CA. The Storkbilled Kingfisher is patchily distributed, and evidently has a small population. The Blackcapped Kingfisher *Halcyon pileata* described principally as a maritime kingfisher is rare. Its distribution is along the western seaboard from Mumbai southward to Sri Lanka; and along the eastern peninsular seaboard northward to Sundarbans and Bangladesh. It is stated to move inland sometimes along the larger rivers. A few individuals of the species occur along the large perennial water pool called Sidhukund and a few associated pools in the Dhakna Range of Melghat. This is the only record in the SCA or probably anywhere in central India. The species is not reported from the other three project sites.

There are two species of hornbills, the Indian Grey and the Malabar Pied. The Malabar Pied Hornbill occurs only in the MP portion of the CA and is patchily distributed. Evidently the population is small. Amongst the woodpeckers, the Black, the Blackbacked and the Browncrowned Pygmy Woodpecker are patchily distributed and not frequently encountered. The first is associated with late structural stage and old growth. It is absent in forests under timber operations. The Indian Pitta is a migrant and is seen in the SCA from about late April to the beginning of June.

The crag martins and swallows are most visible along sheer rock faces of basalt cliffs in Melghat and the sandstone cliffs of the Satpura national park. The large Raquettailed Drongo occurs in mid to late structural stages in the moist deciduous forests.

The Malabar Whistling Thrush occurs along drainages in the riparian zones. The two species of nuthatches are found among large old trees in shady and mesic groves such as Chikhal aam, Teen aam, Ban aam, and Zhunjru aam in Melghat and in the MP portion of the CA.

The Green Munia *Estrilda formosa* among all the Project sites occurs only in the Melghat portion of the SCA. It is endemic to India and is very patchily distributed.

3.7 Mammals

Forty-eight species of mammals occur in the conservation area. The inventory is placed as Appendix VII.

Among the ungulates, Nilgai or the Blue Bull ***Boselaphus tragocamelus*** is the largest antelope in India. It inhabits open forests; scrub interspersed by grassy patches, plains and low hilly tract. In north India it has become a pest to agriculture. There are complaints from farmers in eastern Maharashtra as well. The species lives in small herds principally composed of cows, calves and immature males. The mature bulls usually are on the periphery of such groups. In the SCA the highest densities of 18.7 animals per sq.km. are found in the Kesla project plantation areas in the open forests adjoining the margins of the reservoir and grasslands that seasonally appear in the draw down region in response to the receding waters of the Tawa dam during the summer months. In Melghat they occur in the relatively open forests of the Harisal and Chaurakund and Akot ranges. These populations are small and scattered.

The Gaur is one of the principal prey species of the tiger alongwith the sambar especially in the Melghat portion of the SCA. Tigers often kill mature solitary bulls. Guar is a species that dwells in higher density tree forests. It occurs in plains and hills and exhibits significant seasonal movements. Between February to June the gaur is seen in the valleys and increasingly so as the summer progresses. With the onset of rains the herds move into the hills and on the plateaux with only the solitary bulls being seen occasionally in the valleys. Herd size is variable. A herd is made up of cows, calves and immature males normally 8 to 12 in number. Calves are seen during all months. Leopard frequently takes the straggling calves. The mature bulls are either solitary or in an association of two or more outside the rutting season. The peak rutting falls between March to May. In Melghat composite herds with animals numbering between 30 to 50 have been seen during late April and May. High forests associated with bamboo, interspersed with plantations and grassy openings seem to be the most favored habitat composition.

The Kesla project plantations, with grassy gaps where plantations have failed combined with some excellent growth of bamboo in different stages of growth and small-undisturbed natural stands of trees indicate relatively high densities of gaur in the northeastern portion of SCA in MP. In the three managed forest divisions of Betul gaur occur in very low densities, especially in south Betul there is very little evidence of the species. This demonstrates the sensitivity of the species to high level of disturbance and forest degradation.

Gaur is a browser as well as a grazer. Young bamboo shoots, leaves and twigs are favorites. While browsing the animals frequently break younger culms, which start sprouting again. Thus there appears to be some capability in the species for augmenting browse. This facilitates feeding of other herbivores. The deciduous forests, especially those communities dominated by teak including the teak plantations become completely leafless during the summer. Water becomes scarce, especially in Melghat and fires that sweep over large tracts of forests temporarily burn the grass. This is the pinch period and also the peak-rutting season. Gaur during this period takes to feeding extensively on the bark of teak and there does not seem to be any distinction for the purpose between old trees and saplings. Sambar shares this feeding behavior.

Plantations exhibit extensive debarking. This is particularly noticeable since they are a pure community of teak. Debarking can be in form of patches of various sizes and at times wide strips of bark are peeled off to a height of up to 3 meters. Sambar however is unable to accomplish such bark stripping. There is a widely believed popular notion that such debarking is destructive to young teak plantations. That it promotes malformed growth and is a cause for mortality among older trees due to girdling. This belief was dispelled when during the training exercises of the WII, for three consecutive years, 1987 to 1989 extensive sampling was undertaken to assess damage and mortality. This extended to over some 5000 trees of various age, from saplings to tall mature trees; plantations in different age classes and natural stands. There was little evidence of either malformed growth or mortality (1.5%) due to debarking. The clear cutting system often encourages growth of resilient species of plants besides favoring the species chosen to be planted. Weeds are of particular concern. However in this case a low shrub Petalledium has proved to be significantly useful. The flowers and young shoots of this plant are extensively browsed by gaur, sambar and chital.

During the mid 1960s there was significant mortality of gaur and to a lesser extent of sambar owing to an epidemic of the Foot and Mouth disease (FMD). The population has since steadily recovered. Vaccination of livestock that graze in and around forest

areas, especially the PAs against this disease at an interval of every two years is essential since gaur is particularly sensitive to the disease. There is hardly any poaching pressure on the species. The local inhabitants respect the gaur especially the magnificent bulls with their formidable appearance.

Sambar is one of the three species of deer that occur in SCA. Along with gaur sambar constitutes the principal prey species of the tiger. It also is the favored prey of leopard and dhole. Sambar shares with gaur almost all the requirements of habitat for its survival and maintenance of populations. In Melghat Sambar occur in small groups of 7 to 10 animals, mostly females, yearlings, fawns and immature males. Mature males with the exception of the rutting period occur on peripheries of such groups throughout the year. Sambar is distributed evenly throughout the SCA with the exception of the managed forests of Betul. In the Betul forest divisions the distribution is patchy, with very low densities. In Melghat the mean density of the species is 9.2 per sq. km. The highest densities of 15.6 per sq.km. are attained in the Kesla project plantations and along the margins of the Tawa reservoir in the Bori WLS and the Satpura national park.

Besides browsing and grazing the year round during the summer months sambar extensively feed on bark of teak. A variety of wild fruits and berries such as the fruits of *Terminalia bellerica, T. chebula, Syzigium cuminii, Emblica officinalis, Buchanania lanzan, Bridelia retusa, Zizyphus spp, Gardenia* spp. and undoubtedly of many other species including the very large and hard wood apple, the fruit of *Aegle marmilos* are integral to the diet. The pits/seeds are regurgitated during rumination. Thus sambar performs a key ecological function of dispersal of fruit and seeds to support regeneration of several forest species. It also is the most important prey of the large carnivores and the most sought after animal by local poachers for meat.

Sambar is poached by local inhabitants using snares and hunted with the help of trained village dogs. The villagers often keep track of hunting packs of dhole, and no sooner a kill of a sambar is made, dhole are chased away and the kill is appropriated. Sambar is the only large enough prey of the dhole that affords such appropriation by people. Smaller prey is quickly eaten by dhole precluding an opportunity for people to retrieve any worthwhile quantity of meat. Vicinities of waterholes during summer are usually targeted for snaring sambar.

The spotted deer has a discontinuous distribution. In Melghat it occurs only in few valleys and plains in Harisal, Chaurakund, Sembadoh, portions of the Raipur Ranges, and the Bori, Dhargad, Gullarghat tract in the Akot Range. The largest herd sizes observed seldom exceed 30 animals. The extremely hilly terrain of Melghat is unsuitable to the species that occurs mainly in the plain and rolling country. It is also more water dependent than the other deer species occurring in SCA.

The population estimates in Melghat puts the number between 1000 – 1500 spotted deer in the tiger reserve. In the MP portion the species has a far wider distribution in the Bori and Pachmarhi wildlife sanctuaries, and portions of the Satpura national park south and south west of its high hill features. The highest densities of 32 chital per sq. km. are attained in the Kesla project plantation tract that constitutes plain to gently rolling country with grassland patches amidst a mosaic of plantations and natural stands of trees. Margins of the Tawa reservoir are integral to this habitat. It is an important prey of the leopard and dhole. The tiger generally prefers the larger sambar and gaur.

The barking deer *Muntiacus muntjak* is similar to the sambar in its habitat requirements. It is solitary in habit, at times the male and the female are seen together. It is more of a browser than grazer and an

important prey of the large carnivores. The species is widely distributed in the conservation area.

Besides nilgai the four horned antelope or the chausingha is the only other species of antelope found in the conservation area. The Melghat tiger reserve represents one of the finest four horned antelope habitats in India. The species prefers open woodland and is often found in the ecotone between forest and the scattered agricultural areas of the enclaved villages. Parties upto four animals constituting a male a female and a couple of yearlings or fawns are often encountered. The species occurs in plain to gently rolling country and on the flat extensive plateaux. In the MP portion it is patchily distributed.

The Mouse deer *Tragulus meminna* represents the only species in the family Tragulidae in India. It has been infrequently sighted in the SCA, but probably is much more widely distributed in low densities than the current knowledge of its abundance. The species is shy, small in size and with its obliterative colour it is hard to detect. However in reserves like the Kalakad Mundanthurai tiger reserve in Tamil Nadu the mouse deer can be seen in good numbers at night. The infrequent sightings in SCA therefore could be a function of low densities, inadequately structured surveys as well as scattered habitat conditions.

The wild pig is distributed throughout the conservation area and is considered to be a serious pest of agricultural crops all over India where the pigs naturally occur. Historically various measures have been adopted for its control, some of these go by default since they were not designed for this purpose, such as hunting. Wild pig is one of the more popular meat for pot in urban as well as the rural meat eating societies. It also has been on the list of 'vermin' for long which meant that pig hunting was free for all. Later as a means to curb the possibility of over hunting the species measures were taken so that wild pig could only be shot in the agricultural fields for protection of standing crop. The origins of the crop protection guns in central India can be traced to regulations such as this. With realization of its significance as a prey species of large carnivores it gradually came under greater legal protection afforded by the Wildlife (Protection) Act 1972 as amended from time to time. The species continues to be at the top of the list of problem species for agriculture crops.

Pigs can breed rapidly to build large populations. The populations can also locally decline abruptly due to disease. It is an important prey species of the large carnivores. In Melghat composite sounders exceeding 40 animals have been recorded.

The Indian Pangolin represents the Old World anteaters and is widely distributed in the conservation area. The Pangolin lives in burrows and is nocturnal. It specializes in breaking open termite mounds and feeding on termites. It is also known to climb trees for feeding on tree ants. Since the species is entirely nocturnal there is not much information on its status. One sample of tiger scat in Melghat was found to contain scales of Pangolin.

The family *Leporidae* is represented by a single species in the conservation area by the Blacknaped Hare *Lepus nigricollis nigricollis*. It is common and widely distributed mainly in the open forests, openings in forests and the village environment. The species chiefly breeds during October to February. It is a prey species of smaller carnivores, eagles and large owls. The local inhabitants snare them for pot.

Nine species in the conservation area belong to the order Rodentia. The Bandicoot Rat is mostly encountered in the village environment; the Longtailed Tree Mouse, Whitetailed Wood Rat, the Indian Bush Rat, and the Mole Rat are widely distributed. Other than this there is not much information on their population status.

The Indian porcupine *Hysterix indica* is widely distributed and mainly seen during the dark hours. Its presence is conspicuous by the large burrows in which it lives, and the characteristic droppings. Signs of gnawing tree bark are not so visible as in the semi-arid habitats of the species. It is one of the favourite prey of the leopard that seems to have mastered the technique of killing a porcupine without getting injured by its quills. The tiger on the other hand is frequently injured with quills that get embedded in paws and forearms. Local inhabitants also hunt porcupines for pot. The most popular method involves smoking out the animals from their burrows and then bludgeoning the animal to death as it emerges from its burrow. The quills are said to bring misfortune to the person who possesses them. The population seems to undergo significant change periodically. The reasons are not quite clear. Porcupines live in a system of burrows with several burrows leading to a central chamber that is considerably large. The dhole and hyena frequently enlarge the abandoned porcupine burrows and appropriate them to serve as their denning sites. Most interestedly sometimes pythons are come across using active porcupine dens.

The Five Striped Palm Squirrel *Funambulus pennanti* and the Three Striped Palm Squirrel *Funambulus palmarum* are the two small squirrels in the SCA. While the former is widely distributed and common the latter occurs only in the moist and semi evergreen forests at higher altitudes e.g. the Chikhaldhara and Makhla plateaux in Melghat; the Pachmarhi plateau, the forests on Chauragarh, Dhupgarh and the Mahadeo peaks in MP.

Among the large squirrels the Indian Giant Squirrel (IGS) *Ratufa indica* occurs only in the MP portion of the conservation area, particularly in the three Protected Areas and portions of the Hoshangabad forest division. The population is small and fragmented in the Betul divisions. The Large Brown Flying Squirrel (LBFS) *Petaurista petaurista philippensis* is widely distributed. The IGS is an obligate of the undisturbed riparian forest and old growth. There are only a few scattered and small patches of old growth, the most significant of these is the Preservation Plot of Bori in compartment 52 established in the year 1928. It is 37 ha. in extent. The squirrels are by themselves not difficult to sight, however their characteristic nests provide the most visible indicator of their presence and abundance. The loud chattering call of an alarmed squirrel is an instant give away of its presence in the high canopy. Undisturbed continuous canopy of tall trees is an important habitat attribute to maintain a contiguous population.

The LBFS being nocturnal and shy is difficult to detect and therefore is one of the poorly studied species. Sweeps of tree canopies by searchlights while driving along roads at night reveals their presence. The species is a tree cavity dweller. More than one individual may occupy a bolthole that is used year after year. The standard silvicultural prescription of removal of dead, dying, malformed and hollow trees that are potential dwelling sites of the animal can affect the population very adversely. Further, in timber operation those tree species that have low or little commercial or subsistence value are marked for removal in favour of species that are commercially important. Some species in this category start secreting hollows in the bole at a relatively young age such as *Dalbergia paniculata*, one of the common trees in the dry deciduous forests. Though commercially unimportant it is ecologically significant. Besides the LBFS there are many other species of reptiles, birds and mammals that are tree cavity dwellers. Both the IGS and the LBFS perform an important ecological function of seed and fruit dispersal. Local inhabitants hunt both species.

Nine species of bats occur in the SCA of which the only record of the Leaf Nosed Bat *Rhinolopus luctus* from central India is from around Pachmarhi.

Of these the fruit bats perform an important ecological function of seed and fruit dispersal. The insectivorous bats are important as well. Depending on the species bats dwell in caves, crevasses, among boulders, large rocky outcrops and tree cavities.

The family *Tupaiidae* is represented by a single species in the SCA, the Tree Shrew *Anathana ellioti*. It resembles a squirrel in appearance only. The species is basically an insectivore but also is known to feed on small mammals and birds. Very little is known about its distribution and abundance.

The family *Herpestidae* is represented by two species the Common Mongoose *Herpestes edwardsi* and the Ruddy mongoose *H. smithi*. The former mostly is found in open forests and scrub, also near villages. The latter by far is found only in the forests. The Ruddy mongoose can readily be distinguished from the Common by virtue of a black tassel towards the end of the tail and a peculiar curl in the tail's terminal portion. Mongooses are common throughout the conservation area.

Two species of Viverridae occur in the conservation area. The Common Palm Civet *Paradoxus hermaphroditus* is distributed throughout including the village environs. Sometimes individuals live in the space between the roof and the false ceiling of old buildings. It is arboreal in habit but also comes on the ground. The Small Indian Civet *Viverricula indica* is found mainly in the forest and naturally occurs in low densities. Though it can climb trees it is mainly active on the ground. Both species are omnivorous and nocturnal. They have a role in dispersal of seeds.

Two species the Ratel or the Honey Badger *Mellivora capensis* and the Smooth- coated Otter *Lutra perspicillata* represent the family *Mustelidae*. Ratels are obligates of the riparian zone and are difficult to sight. The local inhabitants are scared of two species, the sloth bear and the ratel. Ratels can be very aggressive at close quarters, especially when surprised by a sudden encounter with humans. They can inflict severe bites. People who have thus been attacked carry deep scars on calves and thighs. The Smooth-coated otter now occurs only along the Denwa and Sonbhadra rivers in the MP portion of the conservation area. The population is fragmented and small. Otters were present in Melghat, especially along the larger perennial pools in the Koktu valley during the 1960s. No otters were found during the surveys conducted in the Melghat tiger reserve during 1973-74 or since. The local extirpation of otter population in Melghat is attributed to the pernicious practice of the local inhabitants of fishing pools by using dangerous pesticides such as Endrin.

The dhole *Cuon alpinus* occurs throughout the conservation area. It is essentially a forest dwelling species. Severely persecuted in past, the populations have recovered during the recent three decades. Along with the tiger and leopard it is a major predator. Dhole hunt in packs. With the exception of gaur and wild pig they hunt all the other potential prey. They are not known to attack livestock. Pack size is variable and unstable. The largest packs observed had >20 animals including pups. The local inhabitants keep track of the movement of dhole packs especially in the vicinity of villages. When a kill is made, the animals are driven off and the kill is appropriated. Dhole is thus compelled to kill in excess of the pack's requirement. In Melghat a monthly record of sightings is maintained. As per this record during February 2001, dhole were sighted on 21 days at 21 places and a total of 138 animals were seen. During May 2001, dholes were sighted on seven days at seven places and a total of 59 animals were seen (Melvyaghra 2001). Dholes are frequently sighted in the Kesla project area of the Bori WLS and the Satpura NP. The highest densities of sambar and spotted deer occur in this tract. Sighting conditions are also very favourable.

The Jackal is common and widely distributed. It is an omnivore and has some role in dispersal of seeds.

The Indian Fox *Vulpus bengalensis* lives in open areas, scrub and near cultivated areas. The species has a discontinuous distribution. In Melghat it occurs in Chikhali and Jhapnadeo localities. In MP it is recorded in portions of west and south Betul divisions. Its food includes rodents and land crabs hence it is popular with cultivators especially since it does not harm poultry.

The hyena is nocturnal and therefore the information on its distribution, status and abundance is weak. It is most certainly distributed throughout the conservation area and there have been opportunistic sightings in locations that are scattered throughout the SCA. Its characteristic footprints that cannot be mistaken for any other animal are found throughout the tract but not frequently. All evidence points to low to very low densities that are probably natural to these forests. The species has no natural enemies including lack of interest in the species among the local inhabitants. In the Harisal, Chaurakund, Sembadoh, Raipur and Dhakna Ranges of Melghat hyena dens have been recorded. Although the sightings are low superstitions however abound!

Among the smaller cats the Jungle Cat Felis chaus is the most common and widely distributed. It can be seen during the day as well as the dark hours. There is no record of the species being a problem for poultry. In recent years unconfirmed sightings of the Rusty Spotted Cat *Felis rubiginosa* have been reported, especially in the tract between Mehriam on the Chikhalda plateau and Sembadoh in Melghat. The third species the Caracal *Felis caracal* in its reported range within India is an uncommon and elusive animal more given to semi arid country and scrub jungle. Central India is part of its natural geographic range. There is very little known about this species in the wild. There is only a single but confirmed record of the animal from near the Dolar village in Melghat (Database of Melghat Tiger Reserve, Prachi Mehta Pers comm.). Both the Rusty Spotted Cat and the Caracal are included in Schedule I of the Wildlife (Protection) Act, 1972. The Red Data Book on Indian Animals records the former as 'data deficient' and the latter is placed in the endangered category (Anon 1994). Intensive surveys are necessary for eliciting better information on both these species.

The Sloth Bear *Melursus ursinus* is distributed throughout the conservation area and is conspicuous by it's characteristic tracks, scats and claw marks leading to the canopy of the tall *Terminalia arjuna* trees in the riparian forests. The outcrops of rocks and boulders along the drainage areas with numerous caves provide an ideal habitat for the species in the conservation area. Termites, beehives of the rock bee *Apis dorsata* and wild fruits constitute favoured food items. During the height of summer bears feed on flowers of mahua *Madhuca indica*, the fruits of wild mango, tendu *Dyospyros melonxylon*, and jaman *Syzigium cumini*. Since the interest of bear and local inhabitants converge on these produce maximum injuries to humans take place during this time.

Cubs are seen during the months of December to March, normally numbering between one to three. They are often hidden in lantana thickets. It is dangerous to walk along footpaths that traverse such vegetation during this period. Among all the wild animals the local inhabitants fear sloth bear the most. Though injuries inflicted by a bear are very severe, human death due to mauling is not common. Typically the injuries mostly are found on skull, around eyes, and on the chest, back and arms. Depending on the severity of attack these can result in grotesque deformities and render a person invalid for life. No crop raiding by sloth bear has ever been reported from the conservation area. Since the bear feeds on a wide variety of fruits it has an important role in dispersal of seeds and fruits including the wild banana *Musa superba* that grows on rocky substrates in the drainages.

Among the big cats, the leopard and the tiger occur throughout the conservation area. Both are included legally in Schedule I as completely protected species and are categorized as 'Vulnerable' in the Red Data Book on Indian Animals (Anon, 1994). While the leopard might still be considered in the vulnerable category the tiger most certainly is critically endangered in India and across its geographic range in the world. In popular and sometimes in professional perception the status of leopard is labeled as 'abundant.' This contradiction is unique to the species. Among the big cats the leopard is without doubt the most versatile and resilient species in context of cover requirement, food habits and adjusting to the local disturbance. During the last decade and a half the leopard has appeared in townships and other human habitation with some regularity. It is reportedly frequently taking toll of livestock. It is said to be causing injury to humans and taking to man-eating with greater frequency than in past are a testimony to its struggle for coming to terms with the rapidly changing habitat conditions. The loss of habitat as well as replacement of the significantly depleted natural prey by livestock is integral to such unfortunate interface with humans and human activities.

India constitutes 2.5% of the world's landmass. The human population of India currently stands at one billion (16% of the world) with a decadal rate of growth of >2%. Going by the census of 1991, and assuming that the proportion is the same 74.3% of the total human population resides in the forest dependent rural areas. The 1987 census had put the figure of livestock population at >445 million (18% of the world). The per capita availability of forest is 0.08 ha. as against the world average of 0.64 ha. (Anon 1999). Against these startling statistics it would be necessary to consider factors that arbiter the naturally low rate of growth and survivorship of a top carnivore like the leopard. Such review would prima facie dismiss the popular notion that leopard population is booming. This is not to deny the existence of a problem but the recognition ought to be for the right reasons. A well-structured study on status and ecology of the leopard is therefore essential for mitigating problems and conservation of the species.

Prior to 1970 when licensed hunting of tiger and leopard together with several other species was allowed, between the years 1955-56 to 1967-68, 113 leopards and 70 tigers were hunted on license in Melghat. All shooting blocks were closed from the year 1968-69 onwards. The crude density of tigers in Melghat currently is approximately one tiger per 20 sq. km. and that of leopard is approx. one leopard per 16 sq.km. The densities are much lower in the MP portion, being approx. one tiger per 40 - 50 sq. km. in the three protected areas and one tiger per 80-100 sq. km.in the Betul forest divisions. The population densities of the leopard are much higher.

Population estimates of tiger and leopard are conducted on annual basis within the PAs in MP and on a cycle of every four years in the managed forests. In the Melghat tiger reserve tigers are monitored on day to day basis. A file is maintained on every identified tiger. Thus mortality, recruitment, appearance of dispersing and transient tigers and the ranging pattern of tigers are effectively tracked. Melghat has a system of recording sightings of tiger and leopard every month. These are published in the quarterly journal of the reserve Melvyaghra. Caves and denning sites used for dropping litter and raising the cubs have been inventoried and protected from disturbance.

For long term conservation of large carnivores like the leopard, tiger and the pack hunting wild dogs it is essential to maintain as large populations of the entire spectrum of natural prey species as is possible across their remaining natural geographical range.

Cubs of tiger are born throughout the year, however March to May appear to constitute the peak

cubbing period. Up to four sub-adult cubs have been seen trailing the mother. Gaur and sambar are the principal prey species of the tiger while the leopard preys on a much wider base of prey including peafowl and jungle fowl. The grazing livestock is widely distributed in the conservation area. Often herds may not be attended. Though much easier to kill than the wild prey the number killed by tiger and leopard is appreciably lower in proportion to the availability. In consideration to habitat use livestock ecologically needs to be regarded a legitimate prey of the tiger. However the ecological reality understandably is in serious conflict with economic and social considerations. This conflict needs to be addressed effectively for long term conservation of the large carnivores and the economic well being of the local inhabitants.

In order to effectively reduce the possibility of tigers being poisoned on the carcass of livestock and killed as retaliation by owners the State governments have since long instituted a system of awarding compensation to the owners of such animals killed by a tiger or a leopard. Safeguards are built into the procedure of settling such compensation. Monitoring the predator concerned is integral to the system. Annually on an average 300 cattle are killed in Melghat. Likewise ex-gratia payment is awarded for injuries sustained by humans or loss of human life as a result of mauling. In case of injury there is a sliding scale of payment for treatment. For loss of life an amount of Rs.50,000 per case is paid. Death of humans due to mauling by tiger or leopard or even injuries is rare. However given the situation only a few such incidents are capable of attracting much greater public ire than the infinitely large number of vehicular or other accidents and criminal activities that routinely cause injuries, loss of human life and property! Although poaching of tiger and leopard has assumed a serious proportion in the country, or elsewhere in Southeast Asia, poaching incidents are very low to negligible in the conservation area. Melghat is one of the first groups of 9 Tiger Reserves commissioned in India under Project Tiger during 1973 and has maintained its reputation as among the best managed reserves in the country.

There are three species of non-human primates in the conservation area. The common langur *Presbytis entellus* a graceful and handsome monkey is distributed across the conservation area. The Rhesus Macaque *Macaca mulatta* occurs north of the Tapi river that describes the political boundary between MP and Maharashtra (northern boundary of Melghat). The other red faced Bonnet Macaque *Macaca radiata* occurs south of the Tapi river in Melghat. The population of the two macaques is small and patchily distributed. The langur is a prey of the leopard and less frequently of the tiger. The macaques however are seldom taken though they spend most of their time on the ground as opposed to the highly agile and arboreal langur. The young of all the three species are encountered throughout the year. An interesting association is observed between the langur and chital. Chital herds frequently are seen feeding under the trees on which langur are seen feeding. The monkeys drop considerable leafy material, flowers and fruit on the ground while they are feeding in the trees, which are eaten by chital. Langurs are excellent sentinels therefore quick to detect the presence of large predators like the tiger, leopard or dhole from their perch atop the trees. There is an excellent study by Paul Newton on this association in the Kanha Tiger Reserve (Newton 1987).

3.8 Species Profile of selected Species

Indian Cuckoo *Cuculus micropterus micropterus* Gould.

Status Resident

Occurs variously as resident Nomadic and visitor during the winters and rains in different parts of lower Himalayas from Kashmir eastward through Nepal,

Sikkim, Bhutan and Southward to the tip of the subcontinent except for the arid portions of Gujarat, Rajasthan, Eastern Pakistan, Ceylon Andaman and Nicobar Islands.

ECOSYSTEM USED:

Affect the Moist Deciduous, Evergreen and Dry deciduous Forest types up to c. 2300m altitudes. Rarely up to 2800m altitudes.

HABITAT REQUIREMENTS:

REARING: Brood parasites mainly on the Drongos of the species *Dicrurus adsimilis* and *D. leucophaeus*. Rarely on species like Paradise flycatcher and Streaked Spider-hunter. The breeding biology needs further studies to know the details. It is found that in this case the incubation period is 12 days. Other details need further study

FEEDING: Insectivorous, feeds on the Hairy caterpillars and various insects and are seen picking it up from the ground sometimes with an awkward hoping gait.

COVER: Cover requirements are similar to that of the host for breeding and they being parasitic are not specific about the cover requirements for breeding. They prefer Evergreen, Moist and Dry Deciduous Forest cover for feeding purposes.

REFERENCES:

Sálim Ali and Sidney Dillon Ripley 1983. "Handbook of the Birds of India and Pakistan" together with those of Bangladesh, Nepal, Bhutan and Sri Lanka (Compact Edition). Oxford University Press, Delhi. Oxford, New York.

Nudfelt, I 1966. Life History of the Indian Cuckoo (*Cuculus micropterus micropterus* Gould.) in Soviet Union, JBNHS 63: 399-419.

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The Cuckoo *Cuculus canorus canorus* Linn.

Status Resident

It is distributed variously in different seasons in different parts of the country. It is seen in extreme south, early in August and mid March. They are local migrants. There are evidences that they are breeding in the Central India.

ECOSYSYTEM USED

They prefer the evergreen and moist deciduous Forests mainly restricting themselves to the thick canopy cover.

HABITAT REQUIREMENTS

REARING: As in the case of most of the Indian parasitic Cuckoos the *Cuculus canorus* also is least studied and needs more detailed studies. They are brood parasitic on a wide range of bird species like Wagtails, Pipits, shrikes, etc. but chiefly on the Babblers, Flycatchers, Warblers and Chats. Breeding season is mainly March to July-August synchronizing locally with the breeding season of the hosts. They adopt various methods to lay the eggs in the nest of host, which are wary of the parasitic brooders. It is observed that in case of nest hole being small they even go to the extent of laying egg outside the nest of the host and then putting it inside the nest with the help of beak. The incubation period is highly variable with the species of the host.

FEEDING: They feed mainly on the insects and their larvae particularly hairy caterpillars, cicadas and other insects.

COVER : They prefer high canopy cover for the feeding purpose and are seen using the ground sometimes but are for sure not comfortable on the ground.

STRUCTURAL STAGES :

They prefer the old and middle successional stages in both the managed and natural forest types.

REFERENCES :

Sálim Ali and Sidney Dillon Ripley 1983. "Handbook of the Birds of India and Pakistan" together with those of Bangladesh, Nepal, Bhutan and Sri Lanka (Compact Edition). Oxford University Press, Delhi. Oxford, New York.

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Bank Myna *Acridotheres ginginianus* (Latham)
Status: Resident

Distributed patchily, plains of central India, foothills of Himalayas, terai and duars, roughly up to the plains of Tamil Nadu in the South locally up to c.800m altitude. Seen mostly in the garbage cans, and railway stations, basically a well adapted bird to live in the vicinity of the human beings.

ECOSYSTEM USED

Usually found near the human habitations, very comfortable with the urban environments irrespective of the vegetation types.

HABITAT REQUIREMENTS

REARING : Breeding season mainly from March till August. They are colonial nesting species and several scores of pairs are seen commonly nesting together. Nest is usually an untidy loose pad of straw, feathers, miscellaneous rubbish and several times bits of snake slough placed in a widened chamber at the end of a horizontal earthen tunnel. The tunnels are drilled in a honeycomb fashion in steep earth banks of rivers, sides of disused brick kilns, wells and the like. Some times shared with the house sparrows and pigeons. Sometimes the nests are in such deep well that needs a vertical rising in the flight, seemingly a hazardous plight for an inexperienced fledgling. Usually 3-5 eggs are laid. The incubation period and other details need study.

FEEDING : They are generalist like other mynas and crows feeds on fruits, grains, insects. Said to be very destructive to crops of Jowar (Sorghum). It is a predator of insect pest larvae on *Ricinus communis* namely *Ophiusa melicerte*.

COVER : They are birds of extremely urban habitats, seen in all kinds of habitats

STRUCTURAL STAGES :

Early successional stages are preferred.

REFERENCES:

Sálim Ali and Sidney Dillon Ripley 1983. "Handbook of the Birds of India and Pakistan" together with those of Bangladesh, Nepal, Bhutan and Sri Lanka (Compact Edition). Oxford University Press, Delhi. Oxford, New York.

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Green Munia *Amandava formosa* (Latham)
Status Resident Endangered

An endemic endangered species having a very patchy distribution, mainly central India along the Aravallis, Gwalior, Jhansi, Surguja south of Mahabaleswar, Utnu and Vishakapattanam Ghats, also recorded from Lucknow and Lahore.

ECOSYSTEM USED

Affects grass and bouldery habitats and shrub jungle. Sugar cane fields and the other cultivated areas along the distribution range are also affected.

HABITAT REQUIREMENTS

REARING: Breeding season is from May and

January, nest is a globular structure made exteriorly of coarse grass, lined with fine fibers inside. Normally attached to sugarcane leaves. They breed in small colonies. Details of the incubation and other breeding biology details need further investigations.

FEEDING: Feeds on the seeds and grains of different species of plants.

COVER: They prefer good thickets as for the escape from predators.

REFERENCES:

Sálim Ali and Sidney Dillon Ripley 1983. "Handbook of the Birds of India and Pakistan" together with those of Bangladesh, Nepal, Bhutan and Sri Lanka (Compact Edition). Oxford University Press, Delhi. Oxford, New York.

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Southern Rufous Woodpecker *Celeus brachyurus* jerdoni (Malherbe)
Status: Resident

Locally common and patchily distributed From the Tapti river in Gujarat to the south through western Maharashtra, Mysore, Western Tamil Nadu, Kerala and Ceylon. Seen in ACA and SCA.

ECOSYSTEM USED

The Moist Deciduous Forests and secondary jungle is preferred.

HABITAT REQUIREMENTS

REARING: Breeding season Chiefly February to April, Nest usually an excavated hollow of live oval shaped carton of tree ants, made of a papier-mâché like substance commonly in trees 4-5 meters from the ground. Usually a lateral entrance hole of 5cm in diameter leads to a spacious interior chamber. Occasionally it is found to make nest like the normal Woodpeckers in the hollowed out tree. The young and the eggs of the bird remain safely among the ants, which are otherwise very ferocious, and sting hard. Both the parents share the incubation and other duties.

FEEDING: Feeds mainly on the ant species like and their pupae. *Cremastogaster* sp. *Phidole malinsi* and *Oceophylla samaragdina* are commonly noted. The fruits, wild figs, flower nectar etc. are taken in occasionally. It is noticed that they puncture banana stem at base of the leaves and drink the sap.

COVER: They are very sensitive to the disturbance and seen suddenly disappearing to the other side of the tree trunk on sighting us. They prefer Dry Deciduous and Moist Deciduous Forests cover and secondary Jungle.

STRUCTURAL STAGES:

Old and Middle successional stages are preferred.

REFERENCES:

Sálim Ali and Sidney Dillon Ripley 1983. "Handbook of the Birds of India and Pakistan" together with those of Bangladesh, Nepal, Bhutan and Sri Lanka (Compact Edition). Oxford University Press, Delhi. Oxford, New York.

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Tickell's Red-breasted Blue Flycatcher *Cyornis tickelliae* jerdoni
Status: Resident

Distributed along the entire subcontinent except for the Northwestern arid and semi arid parts and the Higher Himalayas. A line from Mt. Abu through Mussoorie, Dehradun, Terai grass lands to the northeastern states up to 1500m altitudes.

ECOSYSTEM USED

Generally found in all different habitats with thick undergrowth of Shrubby vegetation.

HABITAT REQUIREMENTS

REARING: Breeding season is from April to August chiefly May to June. Nest placed in crevices on the ledges of rock holes in the trees or in crevices formed by the twisting arial roots of the parasitic ficus trees and orchids. Nest is found in all sorts of odd places like window ledges of disused houses and so on. Nest is usually made of green mosses mixed with grasses and dry leaves lined with fine rootlets. 3-4 eggs are laid in the clutch, other details of the breeding biology is not known.

FEEDING: Feeds on insects chiefly of dipteran.

COVER: They prefer thick undergrowth for both the breeding and feeding activities.

STRUCTURAL STAGE:

Seen in all sort of successional stages in all the vegetation types.

REFERENCES:

Sálim Ali and Sidney Dillon Ripley 1983. "Handbook of the Birds of India and Pakistan" together with those of Bangladesh, Nepal, Bhutan and Sri Lanka (Compact Edition). Oxford University Press, Delhi. Oxford, New York.

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Lesser Whistling Teal. Tree Duck *Dendrocygna javanica* Horsfield.
Status : Resident

Distributed all over the country with local variations and movement with the drought and rains. It is also distributed in Ceylon, Nepal Bhutan, and Pakistan.

ECOSYSTEM USED

Aquatic habitats like lakes, Jheels, ponds, canals are used.

HABITAT REQUIREMENTS

REARING: Season all over June to October varying with the local climatic variation in the climax breeding time. Nest is a rough cup of twigs and grass placed in ancient tree holes and other cavities or crotch at the branching of the trees, sometimes quite far away from water. Old nests of Kites Herons and crows are frequently used. Commonly ten ivory coloured eggs are laid in a clutch. The parents share the duties of incubation and the incubation period is 22-24 days.

FEEDING: Largely vegetarian, aquatic weeds and tender shoots of wild and cultivated grain. They also feed on the fishes, frogs, snails and worms.

COVER: They are birds of the open vast water bodies and are seen using open areas in the interior lakes to rest so that no disturbance is there during the day time and are seen feeding in the paddy fields and other shallow areas of the water body to feed during the night.

STRUCTURAL STAGES:

The Old structural stages are preferred for the breeding purposes.

REFERENCES:

Sálim Ali and Sidney Dillon Ripley 1983. "Handbook of the Birds of India and Pakistan" together with those of Bangladesh, Nepal, Bhutan and Sri Lanka (Compact Edition). Oxford University Press, Delhi. Oxford, New York.

Greater Racket-tailed Drongo Linnaeus
Status: Resident

Widespread except the arid tracts of the country Kumaon eastwards through Nepal, Sikkim, Bhutan and the Northeastern states, up to Surat in Gujarat and extends well in to the extreme tip of the Southern Peninsula. There are two subspecies, which have distinct distribution ranges except in some parts of the distribution ranges where they meet. The Northern and southern subspecies' are not distinguishable when they are in a mixed flock.

ECOSYSTEM USED

Evergreen, Moist deciduous, Dry deciduous and plantations in the forest and out side the forest in some parts like northern Kerala are affected.

HABITAT REQUIREMENTS

REARING: Breeding season is mainly February to June in the species and varies according to the local climatic conditions in subspecies levels. Nest is a cup of twigs, grasses, tendrils, strips if inner bark, mosses lined with finer elements and cobweb, sometimes without a lining as well. The nest is usually placed at the crotch of branches c. 10-15m height from the ground. Nests are found on the same site sometimes even on the same tree year after year. The normal clutch size varies from 3-4. Incubation and other duties are shared by both the parents. Incubation period is undetermined.

FEEDING: Varied food items are eaten by the species, normally seen feeding on the termites (winged), locusts, moths, dragonflies, larvae of different insects picked up from the tree trunks and foliages mostly hawked from the air and carried to a branch, where they are eaten in leisure. Probably also takes lizards and small birds, like the other species of Drongos.

COVER: They are found to prefer Evergreen and Moist deciduous forest types for the Breeding purposes but are seen in dry deciduous and plantations both Silvicultural and agricultural sites neighbouring the forests for the feeding purposes.

STRUCTURAL STAGES:

They prefer the old and middle successional stages in both natural and managed forest types.

REFERENCES:

Sálim Ali and Sidney Dillon Ripley 1983. "Handbook of the Birds of India and Pakistan" together with those of Bangladesh, Nepal, Bhutan and Sri Lanka (Compact Edition). Oxford University Press, Delhi. Oxford, New York.

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Verditer Flycatcher *Eumiyas thalassina thalassina* Swainson
Status: Resident

Distributed well over the country except in the very arid regions, in the winter season and comes to the Himalayas for breeding up to 2700-3000m altitude range. The optimum zone is 1400-1500m.

ECOSYSTEM USED

They are found to avoid the very dense tall trees but generally found in all the vegetation types like evergreen moist deciduous forests with a special preference to the riparian patches.

HABITAT REQUIREMENTS

BREEDING: Breeds in April to May in the upper reaches of the Himalayas, probably double brooded. The nest is a flat thick sided cup placed in banks, crevices of rocks under bridges, sometimes in holes

on walls of buildings, tree trunks up to six meter or so up, made mostly of green moss occasionally mixed with other materials like root-lets and tendrils. Brood usually a clutch of 4 rarely 3 or 5. The incubation and other duties are shared by both the sexes. Incubation period is undetermined.

FEEDING: Food consists of tiny winged insects found mostly in the canopy, caught in the air by sallying.

COVER: They prefer evergreen, riparian and moist deciduous forest types for the feeding purposes.

STRUCTURAL STAGES:

They are found to prefer the middle and old successional stages in the natural forest types.

REFERENCES:

Sálim Ali and Sidney Dillon Ripley 1983. "Handbook of the Birds of India and Pakistan" together with those of Bangladesh, Nepal, Bhutan and Sri Lanka (Compact Edition). Oxford University Press, Delhi. Oxford, New York.

Painted Francolin *Francolinus pictus pictus*
Status: Resident

Distributed south of an arbitrary line drawn along the Southern Gujarat, Uttar Pradesh and Northern MP chiefly along the low countryside and rocky areas with good bush cover.

ECOSYSTEM USED:

They are generally seen in the dry deciduous and thorn forests and seemingly don't prefer the wet vegetation types like evergreen and the moist deciduous forests. They are commonly seen in the semi-moist grassy and scrubby patches and are seemingly most preferred.

HABITAT REQUIREMENTS

REARING: The season mainly starts with the break of the SW monsoon and lasts till September or October. Nest is scrap in a slight hollow in the ground and eggs are laid straight on the ground or sometimes nest are lined with leaves, usually in the standing crops of sugar cane fields. 4-8 eggs are laid in a clutch and the incubation period is not determined.

FEEDING: Food mainly consists of grains of different grasses, berries, tender shoots of grasses and other plants, insects, termites, eggs and larvae of both. A quantity of grit is always present in the stomach.

COVER: They are very shy birds and are seen always under some herb or shrub cover and sulking away at the sight of any human being or other enemies. They prefer thick shrub cover for both breeding and feeding purposes only coming out to open in the transits from one bush to another.

STRUCTURAL STAGES: They are seen mostly in the early successional stages in both the natural and managed forests.

REFERENCES:

Sálim Ali and Sidney Dillon Ripley 1983. "Handbook of the Birds of India and Pakistan" together with those of Bangladesh, Nepal, Bhutan and Sri Lanka (Compact Edition). Oxford University Press, Delhi. Oxford, New York.

Red Jungle fowl *Gallus gallus murghi* Robinson
Status Resident

Distributed along the outer Himalayas, chiefly foothills and Terai locally up to c. 2000m altitude. Southward till the Godavari River excluding the extreme northeastern parts of the country. In some

parts of it's distribution range it mixes with the Grey jungle fowl in the south and the hybrids are common. Its distribution in India is strikingly along with the Sal trees and the Swamp deer, and the distribution of the Grey JF is found to be along with the distribution of the Teak. It can be seen that where mixing of the Teak and Sal occurs the two species are seen together.

ECOSYSTEM USED

They are seen in all the vegetation types within its distribution range generally prefers moist deciduous forests mixed with Bamboo and scrub interspersed with patches of the open grasslands.

HABITAT REQUIREMENTS

REARING: Season mainly March to May but odd clutches can be found in January to October. Nest is a scrap on the ground lined with dry grass and bamboo leaves. Usually 5-6 eggs are laid in a clutch and the female alone looks after the young. The incubation period is 21 days. Precocial young are born and they leave the nest in a day or two after they are hatched, to feed with their mother.

FEEDING: Food mainly consists of a wide range of items including the plant and animal matter. It includes grains of all kinds and crops, tubers, fruits, berries and tender shoots of different plants. Insects especially grass hoppers, termites, grubs maggots, larvae, lizards, small snakes, and human excreta. Bamboo seeds are prized food item when its available and large aggregation can be seen near such areas, and it is noted that they raise more broods in the years where there is availability of the Bamboo seed.

COVER: They are extremely wary of the disturbance and prefer thick shrub cover for breeding and are seen feeding in open only to escape in to the near by bush at the slightest hint of the disturbance/ danger.

STRUCTURAL STAGES:

Prefers early successional stages in the natural and managed forests.

REFERENCES:

Sálim Ali and Sidney Dillon Ripley 1983. "Handbook of the Birds of India and Pakistan" together with those of Bangladesh, Nepal, Bhutan and Sri Lanka (Compact Edition). Oxford University Press, Delhi. Oxford, New York.

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Painted Bush Quail P*erdicula erythrorhyncha erythrorhyncha* Sykes
Status: Resident

Distributed along the Western Ghat strip of the country, South of the Khandala to the tip of the peninsula including all the associated Hill ranges and the Shevaroy Hills of Madras. It is found in ACA and SCA.

ECOSYSTEM USED

Tall grasslands interspersed with the shrubby vegetation and the trees are affected. They are seen along the edge of tall grassland and moist deciduous and dry deciduous forest interface.

HABITAT REQUIREMENTS

REARING: Season is not well defined. It can vary with locality variations and the nest is scrap on the ground sometimes lined with grass. Placed at the root of shrubs or grass tussocks or clump. 4-7 usually and occasionally 10 eggs are laid in single clutch and the parental duties are done by the female alone and the young fledge away very fast. The incubation period is 16-17 days.

FEEDING: Food mainly consists of grass and weed seeds and grains of different crops in the forest cultivations, shoots and small insects, especially termites and a quantity of grit is always eaten with the different food items.

COVER: They are extremely shy birds and are found to prefer thick shrub cover in all habitats, where they are found.

STRUCTURAL STAGES:

They prefer the early successional stages.

REFERENCES:

Sálim Ali and Sidney Dillon Ripley 1983. "Handbook of the Birds of India and Pakistan" together with those of Bangladesh, Nepal, Bhutan and Sri Lanka (Compact Edition). Oxford University Press, Delhi. Oxford, New York.

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Pintail Snipe *Gallinage stenura* Bonaparte
Status: Migratory

Winter visitor to the marshes, jheels, lakes, paddy fields and other aquatic habitats of the Indian subcontinent up to 2500m altitude.

ECOSYSTEM USED

Aquatic habitats

HABITAT REQUIREMENTS

REARING: It is said to breed in Siberia. There are occasional records of the breeding in the North-eastern states, which needs confirmation. Nothing is known about the breeding of the species.

FEEDING: It is found to feed on the worms, larvae and tiny molluscs.

COVER: It is found to use the grass cover or shrub cover and the camouflage to escape being noticed in its feeding grounds.

STRUCTURAL STAGE:

They prefer the early successional stages.

REFERENCES:

Sálim Ali and Sidney Dillon Ripley 1983. "Handbook of the Birds of India and Pakistan" together with those of Bangladesh, Nepal, Bhutan and Sri Lanka (Compact Edition). Oxford University Press, Delhi. Oxford, New York.

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Demoiselle Crane *Grus virgo* Linnaeus.
Status: Migratory

Winter visitor and commonest crane of the Northwestern and North central parts of the continent diffusing eastwards to Bhutan, Assam and Bangladesh. They are found to go up to roughly 16º N latitude, and rare beyond that.

ECOSYSTEM USED

They are found to use the open paddy fields large wet grasslands, sandy riverbeds, lake banks and such habitats.

HABITAT REQUIREMENTS

REARING: Extralimital breeding records show that during the breeding time large congregation of birds come to a common display ground and are said to display for hours to get mates. Breeding season is from May to July. Nest is an untidy heap of decaying vegetation in the middle of wetland or marsh. Two to three eggs are laid in one clutch. The details of the breeding biology of the cranes is yet to be covered.

FEEDING: They usually eat a large quantity of wheat, gram, and paddy. A considerable amount of damage is caused to the cultivation where they land in large numbers.

COVER: They are bird of vast open areas.

STRUCTURAL STAGES: Open wetlands and grasslands thus prefer the early successional stages.

REFERENCES:

Sálim Ali and Sidney Dillon Ripley 1983. "Handbook of the Birds of India and Pakistan" together with those of Bangladesh, Nepal, Bhutan and Sri Lanka (Compact Edition). Oxford University Press, Delhi. Oxford, New York.

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Indian White-backed Vulture *Gyps bengalensis* (Gmelin)
Status: Resident

They are the commonest of the Indian Vultures and are found to be distributed throughout the country in varying degree of presence up to 1500 to 2500m in altitude.

ECOSYSTEM USED

They are found to use almost all sorts of vegetation types except the dense evergreen and moist deciduous forest tracts of the country.

HABITAT REQUIREMENTS

REARING: The breeding season varies from October to March. Nest is a large untidy platform of twigs and branches often with green leaves attached to it, with a shallow depression lined with green leaves usually placed at 10-18m height on a mango tree or large trees of the kind. Usually a colony of nest is found on singletree or in a grove or a patch of forest. Usually single egg is laid and rarely two. The parents share the chores of making nest and rearing the young. The incubation period is about 45 days.

FEEDING: They feed on the carrion.

COVER: They are birds of open sky

STRUCTURAL STAGE: They prefer old and middle successional stages interspersed with early successional stages.

REFERENCES:

Sálim Ali and Sidney Dillon Ripley 1983. "Handbook of the Birds of India and Pakistan" together with those of Bangladesh, Nepal, Bhutan and Sri Lanka (Compact Edition). Oxford University Press, Delhi. Oxford, New York.

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Indian Cliff Swallow *Hirundo fluvicola* Blyth
Status: Resident

Distributed widely with a marked local movement with seasons within and out side the country, needs confirmation. Not recorded in the extreme eastern parts of the country.

ECOSYSTEM USED

They are seen in all the vegetation types and basically are birds of open countryside and sky.

HABITAT REQUIREMENTS

REARING: Season from December to March /April, and July to October. The number of broods a year needs confirmation. Colonial breeders, nests are made like a large agglomeration of mud, reminiscent of a honeycomb, or a cluster of potter wasp nests. Sometimes hundreds of pots fused together, each with a short narrow passage leading out as entrance hole.

Egg chamber is usually lined with grass and feathers comfortably. The whole structure attached to the lower side of the masonry bridges or waterways very close to the water. The same nests are occupied year by year if left unmolested. Breeding biology needs detailed study.

FEEDING: They feed on the midges, gnats and other dipterous insects.

COVER: Open sky.

REFERENCES:

Sálim Ali and Sidney Dillon Ripley 1983. "Handbook of the Birds of India and Pakistan" together with those of Bangladesh, Nepal, Bhutan and Sri Lanka (Compact Edition). Oxford University Press, Delhi. Oxford, New York.

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South Indian Grey Shrike *Lanius meridionalis*
Status : Resident

Distributed along the semiarid and arid tracts of the country in the states like Gujarat, Rajasthan, Parts of MP, UP, Punjab, Maharashtra and Haryana.

ECOSYSTEM USED

Dry thorn forests and scrub Jungle.

HABITAT REQUIREMENTS

REARING: Breeding season is January to October, mainly March to June. Nest is a deep compact cup of thorny twigs and grass intermixed with rags and rubbish like hair, cotton balls, feathers, wool etc hanging untidily from the structure. Size between 15-18cm across and placed in a Babool or *Prosophis juliflora* tree, c. 2-3m from the ground. 3-6 eggs are laid in a clutch. The incubation period and the other details of breeding is not available. Both the parents share the parental duties.

FEEDING: Feeds on the insects, locusts, black ants, and other Hymnoptera, beetle, bugs, small lizards and even small snakes are caught and eaten. Small mammals like mice are also eaten and sickly birds are not spared.

COVER: Dry thorny scrub and dry deciduous vegetation intermingled with grasslands are mostly preferred.

STRUCTURAL STAGES:

They prefer early and middle successional stages in both the natural and managed vegetation types.

REFERENCES:

Sálim Ali and Sidney Dillon Ripley 1983. "Handbook of the Birds of India and Pakistan" together with those of Bangladesh, Nepal, Bhutan and Sri Lanka (Compact Edition). Oxford University Press, Delhi. Oxford, New York.

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Purple Sunbird *Nectarinia asiatica asiatica* Ltham
Status: Resident

Distributed widely throughout the Indian Subcontinent, locally up to 1700m in Himalayas and in the Nilgiris of Western Ghats it is reported from much higher elevations up to 2400m. The local movement is prominent in the species.

HABITAT REQUIREMENTS

REARING: Season varies according to the height and the altitude. Breeding has been reported virtually on every month of the year with local

variations. Nest is an oblong purse of grass and other fibers, draped with rubbish and cobwebs with a lateral entrance along the lateral side with a porch like projection at the entrance, usually 2-3 meters height from the ground.2-3 sometimes even three eggs are laid. The parents share all the chores. Incubation period is 14-15 days.

FEEDING: They are found to feed on the nectar of a wide variety of the plants, like Samalia, Bombax, Madhuca, Borassus etc. and small insects and spiders especially when they are rearing the young.

COVER: They are found in all the vegetation cover in their distribution range and are comfortable even in the urban habitats.

STRUCTURAL STAGES:

They are seen in all the structural stages equally.

REFERENCES:

Sálim Ali and Sidney Dillon Ripley 1983. "Handbook of the Birds of India and Pakistan" together with those of Bangladesh, Nepal, Bhutan and Sri Lanka (Compact Edition). Oxford University Press, Delhi. Oxford, New York.

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Brown Hawk owl *Ninox scutulata* Raffles
Status: Resident

Distributed from outer Himalayas to the southern tip of the country along the forested tracts or well-wooded country.

ECOSYSTEM USED

They are found in the Moist Deciduous, Dry deciduous forests and evergreen forests with riparian intermixing.

HABITAT REQUIREMENTS.

REARING: Curiously nothing is known about the northern race, where as in the southern race the breeding season is January to May normally 2-3 eggs are laid.

FEEDING: Large insects such as locusts, beetles, and grass hoper, occasional bats lizards etc are eaten.

COVER: They are birds of dense forests interspersed with open areas or clearings.

REFERENCES:

Sálim Ali and Sidney Dillon Ripley 1983. "Handbook of the Birds of India and Pakistan" together with those of Bangladesh, Nepal, Bhutan and Sri Lanka (Compact Edition). Oxford University Press, Delhi. Oxford, New York.

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Little scaly bellied green woodpecker *Picus xanthopygeus*
Status: Resident

Distributed along the Peninsular India and Assam, east of line from about Ambala to Mt. Abu, north to the Himalayan terai foothills, from Punjab eastward through UP, UA, Nepal, Sikkim and Bhutan.

ECOSYSTEM USED

The semi-evergreen moist deciduous, and dry deciduous forest types

HABITAT REQUIREMENTS

REARING: Season overall January to June, with variations in the peak season locally. Nest is a circular hole of 5 cm across, cut in to the bole of a tree and up to 50cm long ending in an expanded egg

chamber. The eggs are laid in this chamber not much of lining in the egg chamber. Nest is usually placed at 4-8 meters height from the ground.Eggs usually 3-5, parental duties are shared by both the parents. Incubation period is not determined.

FEEDING: They feed largely on ants, termites, and larvae of other insects picked up from either ground or from tree trunks. Sometimes they are seen pecking on the dry cow dung for beetles and worms.

COVER: They prefer Dry deciduous and Moist deciduous forests intermingled with the open grass lands.

STRUCTURAL STAGES:

Middle and old successional stages are preferred.

REFERENCES:

Sálim Ali and Sidney Dillon Ripley 1983. "Handbook of the Birds of India and Pakistan" together with those of Bangladesh, Nepal, Bhutan and Sri Lanka (Compact Edition). Oxford University Press, Delhi. Oxford, New York.

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Baya Weaver *Ploceus philippinus*
Status: Resident

Distributed all along the Indian subcontinent up to 1200m in the Himalayas. They show clear local migration according to the seasons. It is noted that they migrate to the Himalayas in the summers from the lower plains.

ECOSYSTEM USED

Dry deciduous thorn forests mixed with palms and agricultural lands.

HABITAT REQUIREMENTS

REARING: Season over all is April to October depending mainly on the SW and NE monsoon. Nest is a pencil retort-shaped with a long down hanging entrance tube, measuring 40-50cm in length. Composed of finely woven strips of sugar cane leaves or rice blades or coarse grass blades. A colony of nests can be seen commonly on a single tree, usually suspended from the pinnae of palm fronds. The males practice Polygyny and male alone builds the nest and invites a female to mate and lay eggs. Once eggs are laid he moves on to make a new nest and finds a new mate. 3-4 eggs are laid in single clutch and the female alone looks after the young. Incubation period is 14-15 days, and chicks fledge in 17 days in normal cases.

FEEDING: They feed mainly on the grains of grass and cropsinsects, grasshoppers, beetles, caterpillars, spiders and nectar. Nestlings are fed on caterpillars and insects.

COVER: They prefer the dry deciduous and thorn scrub cover. They also use tall grass cover to breed along the water tanks and canals.

STRCTURAL STAGES:

Early and middle successional stages are preferred.

REFERENCES:

Sálim Ali and Sidney Dillon Ripley 1983. "Handbook of the Birds of India and Pakistan" together with those of Bangladesh, Nepal, Bhutan and Sri Lanka (Compact Edition). Oxford University Press, Delhi. Oxford, New York.

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White throated Fantail *Rhipidura albicollis canescens* Koelz
Status: Resident

Common resident subject to local movements, breeding at 1500 m in Himalayas and spreading to the plains and lower areas in the winter.

ECOSYSTEM USED

Pine, Moist & dry deciduous and evergreen forests.

HABITAT REQUIREMENTS

REARING: Season March to August, double brooded. Nest is a neat cup shaped, rather like an inverted cone, of fine grass stems bound together by a thick external coating of cobwebs; usually without any special lining and with an untidy tail of strips of neat material dangling below. Eggs usually 3 and incubation period is 12-13 days. The Young ones leave the nest on 13th or 15th day. Parental duties are shared by both the sexes.

FEEDING: Insects, gnats, flies, caterpillars and small larvae of different animals collected from the canopy and other parts of the plant.

COVER: Evergreen, Moist Deciduous forest covers are preferred.

STRUCTURAL STAGES:

Middle and late successional stages in both natural and managed forest.

REFERENCES:

Sálim Ali and Sidney Dillon Ripley 1983. "Handbook of the Birds of India and Pakistan" together with those of Bangladesh, Nepal, Bhutan and Sri Lanka (Compact Edition). Oxford University Press, Delhi. Oxford, New York.

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Redheaded Vulture *Sarcogyps calvus* Scopoli
Status: Resident

Distributed patchily, breeding in the high mountain temperate forests of Himalayas. Rare and sparse winter visitor to NW India, North India, central India and south to a latitude Dhulia in Khandesh (21^{o}N)

ECOSYSTEM USED

The dry deciduous, open Savannah and semi-arid tracts

HABITAT REQUIREMENTS

REARING: Within continental limits only recorded from the Baluchistan between c.2400 and 3000 m elevation. Season apparently between March and April. The season is variable along with the local climatic conditions. Nest is an enormous platform of sticks and twigs year after year, usually at about 8-10m above the ground. Singleton egg is laid. Incubation period needs to be studied. The chores of the parental caring are done by both the sexes together.

FEEDING: Feeds on the carrion. Rare reports of feeding on some turtles are there.

STRUCTURAL STAGES:

Early successional stages are preferred.

REFERENCES:

Sálim Ali and Sidney Dillon Ripley 1983. "Handbook of the Birds of India and Pakistan" together with those of Bangladesh, Nepal, Bhutan and Sri Lanka (Compact Edition). Oxford University Press, Delhi. Oxford, New York.

Asian Paradise Flycatcher *Terpsiphone paradisi paradisi* Linnaeus
Status: Resident

Common but unevenly distributed along the southern parts, east up to the lower West Bengal and low lands of Bangladesh. They are partly migratory and are seen in some parts of the country only during the winter where as they are seen throughout the year in some parts of the country. They presumably breed in the Himalayas and the Peninsular Hills.

ECOSYSTEM USED

Evergreen and moist deciduous forest type and orchards.

HABITAT REQUIREMENTS

REARING: Breeding season is mainly May to June. Nest is neat deep cup of fine grass, roots, bast fibers and few leaves, compactly bound together with cobweb and thickly plastered on the outside with several cobweb and several tidbits of egg cases of the spiders and other items. The incubation period is 15-16 days.

FEEDING: They feed on the insects. The recorded items include different items like flies, beetles, dragonflies, bugs, butterflies and moths.

COVER: They are extremely shy type of bird and during breeding season won't tolerate the presence of any intruders near the nest

STRUCTURAL STAGES:

Middle and late successional stages are preferred

REFERENCES:

Sálim Ali and Sidney Dillon Ripley 1983. "Handbook of the Birds of India and Pakistan" together with those of Bangladesh, Nepal, Bhutan and Sri Lanka (Compact Edition). Oxford University Press, Delhi. Oxford, New York.

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Green Sandpiper *Tringa ochropus* Linnaeus
Status: Winter visitor

Distributed throughout the country in the winter season, along the jheels, lakes, irrigation tanks, riverbanks and agricultural lands, in the Plains and mountains of the peninsular hills up to 2300m.

ECOSYSTEM USED

Aquatic habitats.

HABITAT REQUIREMENTS

REARING: Breeds in the northern Europe and Asia north to Arctic Circle.

FEEDING: They feed on the Molluscs, crustaceans, aquatic insects, worms and mosquito larvae.

COVER: They prefer grassy or bouldery banks interspersed with light vegetation for the feeding purpose.

STRUCTURAL STAGES:

Early successional stages are preferred.

REFERENCES:

Sálim Ali and Sidney Dillon Ripley 1983. "Handbook of the Birds of India and Pakistan" together with those of Bangladesh, Nepal, Bhutan and Sri Lanka (Compact Edition). Oxford University Press, Delhi. Oxford, New York.

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Peninsular Crested Serpent Eagle *Spilornis cheela melanotis* (Jerdon)
Status : Endangered Schedule I, Resident

Widely distributed south of Gangetic plain in the peninsula along the Dry and Moist Deciduous forests, Semi-Evergreen and broadleaf Evergreen forests; plains and hills. The presence is readily discerned by its characteristic high-pitched calls while soaring and sometimes from a perch. The calls can readily be distinguished from those of the somewhat similar whistles of the crested hawk eagle. Occurs in ACA and SCA. The GCA and TCA have another sub-species S.c.cheela (Latham), with similar habitat orientation.

ECOSYSTEMS USED

The Dry, Moist, Semi-evergreen and Evergreen broad leaf forests. Partial to riparian forests.

HABITAT REQUIREMENTS

REARING: The breeding season is between March to May. The nest is built high up in the crown of tall and large old trees, near a clearing. Partial to riparian forests along streams in the vicinity of a swamp or a reservoir. The nest is a large structure of sticks and twigs often lined with green leaves. The nest may be used year after year with material being added each time. Both sexes participate in nest building but only the female incubates. The clutch size is of one egg.

FEEDING : Snakes, frogs, crabs, lizards, rats and mice, injured or sick birds.

COVER : Well-wooded forests.

STRUCTURAL STAGES :

A mosaic of early to late successional stages, favoring middle to late, especially riparian vegetation, late and old growth.

REFERENCES :

Ali and Ripley 1983; Grimmett, Inskipp and Inskipp 1999.

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Bonelli's Hawk- Eagle *Hieraaetus fasciatus fasciatus* (Vieillot)
Status : Endangered, Schedule I, Part III,

Resident, widely distributed but not common, all India, from about 2400 m. in the Himalayas. Hills and plains. Ranges from dry deciduous forests to the rain forests in well-wooded tracts. It is essentially a forest dependent species. Extremely agile and dexterous while hunting. Occurs in ACA, GCA, SCA, TCA.

ECOSYSTEMS USED

The dry deciduous to rain forests, plains and hills.

HABITAT REQUIREMENTS

REARING : Courtship display is spectacular with sorties of soaring and diving in all manners of loops and tumble. Breeds between December to March with local variations. The huge nest of sticks and twigs lined with green leaves is located in the crown of old, large and tall trees. The pair tends to use the same nest year after year by adding fresh nest material each time. Thus the nests attain huge size. In hills, cliff ledges are also used for the purpose. Both sexes share nest building and incubation. The male mainly brings food.

FEEDING : Mainly large birds and mammals like hare. Prey recorded include myna, crow, green pigeon, coucal, partridge, spur fowl, jungle fowl, pea fowl, painted stork, kite and other raptors. It uses both ambush and pursuit. Frequently the pair may hunt in tandem. The larger birds are hit and caught

from below. A truly great hunter often killing prey that is larger and heavier than itself.

COVER : Leafy tree crowns for ambush.

STRUCTURAL STAGES:

A combination of early to late succession and old growth in a well-wooded forest.

REFERENCES :

Baker EC Stuart 1922-'31, Vol 7: 114; Ali and Ripley 1983; Grimmett, Inskipp and Inskipp 1999.

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Greyheaded Fishing Eagle *Icthyophaga icthyaetus icthyaetus* (Horsfield)
Status : Endangered, Schedule I, Part III

A resident, widely though patchily distributed eagle. From the northern terai through the peninsula along well-watered, well wooded forests. Mainly plains but also rolling country. It is readily identified by its weird sounding repetitive calls. Especially noisy during courtship. Occurs in TCA and SCA. In the latter it is becoming rare with heavily used perennial pools by cattle, streamside village communities, and the practice of fishing pools by using pesticides.

ECOSYSTEMS USED

The dry, moist, semi-evergreen and evergreen forests with large pools of water, sluggishly flowing streams, tanks and swamps.

HABITAT REQUIREMENT

REARING : Breeds between November to January. An enormous nest of sticks and twigs is placed high up in an old tall tree along the margin of water. If large branches are hanging over water, the nest could be as low as 10 to 15 m. above ground, otherwise 30 or >30 m. high into the tree. Large, tall, old trees in the riparian forest near water are important. A pair may maintain two or more nest sites that may be used alternately in successive years. The nests are repaired, added to year after year by both sexes. If not by the pair but at least one of them will use a nest throughout the year for roosting. The clutch size is of 2-3 eggs. Both sexes participate in incubation and later feeding the young. The period of incubation is 28-30 days. The young remain in the nest for 10 weeks.

FEEDING : Food consists almost exclusively of fish. Fish is commonly caught from a lookout perch near the water, less commonly by quartering and swooping over water in the manner of an Osprey unless a stretch is known for abundance of fish. Rarely seen soaring like other eagles. Often fish of very large size is caught and as the eagle is unable to fly with a struggling fish of enormous size, the eagle will drag it through water while appearing to be swimming. Large woody debris such as fallen big branches or fallen tree near the edge of water is used as a feeding post/site. The heavy fish is dragged to such platform and then quartered and eaten. Accumulation of large fish bones and scales at such sites are an evidence of frequent use of such structures. During nesting birds and smaller mammals are hunted in addition to fish.

COVER : Varied as above. Old riparian forest patches along the edge of water is important with overhanging branches and crowns.

STRUCTURAL STAGES :

Old riparian forests.

REFERENCES :

Baker E.C. Stuart 1922-'31, Vol 5:7; Ali and Ripley 1983; Grimmett, Inskipp and Inskipp 1999.

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Osprey *Pandion haliaetus haliaetus* (Linnaeus)
Status : Endangered, Schedule I, Part III

Mainly winter visitor, September to March throughout India. No breeding sites within the Project areas. Singly or in pairs, widely scattered but very patchily distributed along large bodies of water, large rivers and inland lagoons and dammed reservoirs. Occurs in localities of the Tawa reservoir, SCA and Aliyar dams in the ACA.

ECOSYSTEMS USED

As above.

HABITAT REQUIREMENTS

REARING : Not applicable

FEEDING : Uses snags near the margins of water or in water, also isolated rocks well within the water to perch. From such perch it launches sorties and reconnoiters stretch of water, at places it will hang still over a spot in the manner of a kestrel and dive into the water, completely submerging and then emerging with fish caught in its talons. The catch is then taken to the favorite/convenient perch, usually a snag, the prey is quartered and eaten. Will often strike Mahseer. Heavy fish is dragged in water and beached on the nearest shore to be eaten.

COVER : As above.

STRUCTURAL STAGES :

Not applicable.

REFERENCES :

Ali and Ripley 1983; Baker E.C.Stuart 1922-'31, Vol 5: 3; Grimmett, Inskipp and Inskipp 1999

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Grey Junglefowl *Gallus sonneratti* Temminck
Status : Schedule IV

The distribution mainly covers the peninsular India, roughly south of a line connecting Mount Abu, south Rajasthan in the west, eastward to Pachmarhi(MP), Polavaram(Andhra Pradesh) to the mouth of Godavari. It is an associate of teak forest and is said to frequently hybridize with the Red Junglefowl at the interface of their respective range of distribution. In the SCA both species occur. The Grey is confined to the Melghat forests and the teak forests of Hoshangabad, and all three divisions of Betul in MP. While the Red occurs in the sal forests of the Pachmarhi WLS and the Satpura national park. The two species can easily be distinguished by sight and by their separate distinctive calls heard during the early morning hours and dusk. The Grey occurs in ACA and SCA.

ECOSYSTEMS USED

The species has a wide range of habitat orientation from open secondary Dry Deciduous forest to Wet Evergreen forests. It occurs in plains as well as in hills upto an elevation of 2400m. in the Nilgiris. Favours bamboo and shrubby undergrowth, forest clearings, neglected tea, coffee and rubber plantations, lantana thickets. Shrubby undergrowth is an essential element of habitat of all gallenacious birds.

HABITAT REQUIREMENTS

REARING: The peak breeding is recorded between the months of February to May, but young are seen almost throughout the year. The nest is a scrape on the ground lined with grass, and leaves in dense shrubby thicket, sometimes against the bole of a tree. Clutch size varies between 3 to 6. The incubation period is 20-21 days.

FEEDING: Seeds and shoots of grass, and cultivated crops, tubers, berries such as Zizyphus and Lantana, seeds of bamboo and Strobilanthes, seeds from fallen fruit like wild figs, termites, other small insects, maggots, grasshoppers and small lizards. Food items are plucked from low bushes, scrached from among leaves and grass. Large parties can be seen when bamboo is flowering. During early mornings, late afternoons and evenings the birds can be seen near waterholes. The popular method of poaching by locals involves placing a long line of noosed snares just above ground level hidden along bushes surrounding the waterholes.

COVER: As above. Shrubby undergrowth is very important for the species as breeding, rearing, feeding and persistence depends on such attribute. The birds however roost in trees or bamboo clumps.

KEY CULTURAL FUNCTIONS:

The local forest dwellers capture the birds for food. The city dwelling poacher in quest of a wild table bird does the same. The neck hackles of the cock are speckled and in recent past these were in much demand for making artificial flies for fishing of trout in the USA. Large scale smuggling of these feathers reportedly had caused serious decline of its population in South India till protection measures were significantly stepped up.

REFERENCES:

Ali and Ripley 1983; Baker 1922-'31 Vol. 5-298; Grimmett, Inskipp and Inskipp 1999.

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Malabar Pied Hornbill *Anthracoceros coronatus coronatus* (Boddaert)
Status : Resident

Distributed along the extreme western tract of West Bengal bordering Orissa; Andhra and Madhya Pradesh. Along the foot of the Western Ghats from about Ratnagiri, south through Goa, western Karnataka , west Tamil Nadu and Kerala, chiefly the well wooded country. Occurs in plains and foothills. Occurs in ACA and in the SCA. only north of the Tapi river in the well watered tracts.

ECOSYSTEMS USED

Open evergreen and moist deciduous forest communities with wild fruit bearing trees, partial to groves of old large fruit bearing trees such as ficus and mango.

HABITAT REQUIREMENTS

REARING : Breeding season principally April and May. Nests in a natural hollow in a trunk of a large tree (90 cm. dia.) located at a height of about > 10m. above ground, sometimes enlarged to suit its requirement. After the female occupies the hollow, it is walled up by a mixture of mud and excreta of the bird. A slit is left open for the male to feed the sequestered female throughout the incubation period of the eggs. A few days after the eggs are hatched, the female exits after breaking the wall. The wall is then rebuilt and the parents feed the chicks till they are fully fledged.

FEEDING : Wild figs, drupes and berries, will catch and eat fish from shallow pools, nestlings of other cavity nesting birds, lizards, snakes, even at times termites are taken from their mounds and eaten.

COVER : Well wooded open evergreen and moist deciduous forest communities.

SRUCTURAL STAGES:

Mid successional stages to old growth stands, isolated groves of large old fruit bearing trees.

REFERENCES

Ali Salim and Dillon Ripley 1970, Baker 1922-'30, Grimmett, Inskipp and Inskipp, 1998, Mehta 1998, Primrose 1921, Sawarkar 1987, Waite1931.

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Great Stone Plover *Esacus magnirostris recurvirostris* (Cuvier)
Status : Resident

Distributed throughout India. Oriented to riverain tracts, rocky beds of larger rivers and their barren surroundings, sandy spits and rocky areas amidst the deciduous forests and such vegetation.

ECOSYSTEMS USED

As above.

HABITAT REQUIREMENTS

REARING: Breeding season extends from February to June, peak during April. The nest is a shallow scrape on a sandbank, unsheltered by vegetation. Uses the same nesting site year after year if not disturbed.

FEEDING : Chiefly crabs , the bird gets at them by lifting stones with its beak underneath which the crustaceans hide. Known to feed on frogs, molluscs, insects and other small animals, may rob nests of other plovers.

COVER : Open , sandy, rocky or such barren areas. Though mainly crepuscular and nocturnal, it is frequently seen during the day at all hours resting even on hot sheet rocks under a blazing sun. Exhibits strong fidelity to the same sites it occupies year after year avoiding other sites of similar attributes.

STRUCTURAL STAGES :

Only the earliest. Bare open country.

REFERENCES

Ali Salim, S. Dillon Ripley 1969, Baker 1922-'30, Biddulph 1938, Dharmakumarsinhji 1949, Grimmett,Inskipp and Inskipp 1998, Higgins 1934, Sawarkar 1987, Whistler 1912.

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Yellow Legged or the Southern Green Pigeon *Treron phoenicoptera chlorigaster* (Blyth)
Status : Resident

Occurs across the peninsular India, south of the Gangetic Plain. The boundary separating the race T. p. phoenicoptera is uncertain. Occurs in ACA and SCA.

ECOSYSTEMS USED

Dry and the moist deciduous forest communities with scattered Ficus and other fruit bearing trees and groves of such large trees, isolated or otherwise.

HABITAT REQUIREMENTS

REARING : Breeds between March to June, a flimsy nest concealed among leaves in a medium sized tree, prefers forest or stand edges for the purpose, often in a tree that holds a nest of the black drongo as the latter is vigilant against nest robbing birds.

FEEDING : It is essentially a frugivore. Feeds on drupes, berries, and wild figs of various kinds, is partial to *Ficus bengalensis , F. religiosa, F. glomerata, F. benjamina*. Other favorites are, *Zizyphus jujuba, Z. xylopyra, Syzygium cumini, Terminalia bellerica, T. chebula, Buchanania lanzan, Bridelia retusa, Lantana camara*.

COVER : Dry and moist deciduous forest communities with a diversity of fruit bearing tree species, isolated groves of large old trees.

STRUCTURAL STAGES :

Mid succession to old growth stands.

REFERENCES

Ali and Ripley 1969, Baker 1922-30, Grimmett, Inskipp and Inskipp 1998, Sawarkar 1987, Whistler 1912.

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Indian Great Horned or Eagle Owl *Bubo bubo bengalensis* (Franklin)
Status : Resident

ECOSYSTEMS USED

Amongst the dry and moist deciduous forest communities the species is oriented to shrub covered rocky hills with interspersed tree stands, ravines, groves / stands of large old trees, partial to steep earth banks, clay cliffs along dry washes and rivers that have characteristic isolated pools of water. Avoids evergreen forest.

HABITAT REQUIREMENTS

REARING : Breeds between October to May, peak during February to April. No nest. Eggs are laid on sheltered ledges of rocks, shelves along clay cliffs, sometimes on the ground hidden by vegetation in a scrape.

FEEDING : Field rats and mice are the chief components, also feeds on birds, reptiles, frogs,crabs, large insects, both hard and soft bodied.

Cover : As in 'ECOSYSTEMS USED', and thickly foliaged bough, fissured rock or a sheltered ledge to hide and roost during the day. Between the sunset and the sunrise an exposed pinnacle to perch and look for a prey.

STRUCTURAL STAGES :

Early to late successional stages, groves of old growth forest, semi arid thorny vegetation.

REFERENCES

Ali Salim and Dillon Ripley 1969, Baker 1922-'30, Grimmett, Inskipp and Inskipp 1998, Sawarkar 1987.

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Dusky Horned Owl *Bubo coromandus coromandus* (Latham)
Status : Resident

Widely distributed in forests with perennial streams,or year round well scattered pools of water south of the Himalayas throughout the subcontinent. Occurs in ACA, GCA, SCA, TCA.

ECOSYSTEMS USED

Old growth stands, tall tree riparian forests, groves of ancient large trees such as the association of mango, jamun tamarind etc., in the well watered tracts. Prefers valleys and plains. Dry deciduous, moist deciduous, and evergreen forest communities.

HABITAT REQUIREMENTS

REARING : Breeds between November to April, peak during December to January. Nest is made of sticks in supporting branches. Usually an old tall tree with large spreading crown near water is the location of choice. Frequently the riparian forests. Old nests of kites, vultures, eagles may be appropriated.

FEEDING : Small mammals, a variety of birds including at times smaller raptors,crows, reptiles, frogs and fish, large insects including water beetles.

COVER : As described under 'ECOSYSTEMS USED'and 'REARING'.

STRUCTURAL STAGES :

Late succession stages and old growth preferred.

REFERENCES

Ali and Ripley 1969; Baker 1922-'30; Grimmett,Inskipp and Inskipp 1998; Sawarkar 1987; Ticehurst 1924; Whistler 1935.

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Barred Jungle Owlet *Glaucidium radiatum radiatum* (Tickell)

Status : Resident

Distributed from Himachal Pradesh in the west and then eastward to Sikkim and Bhutan, up to about 2000m.in the hills and south throughout the Peninsula except the Malabar coastal strip and Kerala. Occurs in ACA, GCA, SCA and TCA.

ECOSYSTEMS USED

Dry and moist mixed deciduous primary and secondary forest communities,favours teak and bamboo mainly in the foothills.

HABITAT REQUIREMENTS

REARING : Breeds between March to May.Nests in a natural tree cavity or in an abandoned excavated cavity of a barbet or woodpecker,in the trunk or branch of a tree located in an open stand,3 to 8m.above ground.

FEEDING: Locusts,grasshoppers, cicadas, other large insects such as from the group Coleoptera; molluscs, lizards, small birds and mice.

COVER : Needs leafy branches or tree hollows to hide during the day time.Rest as in 'ECOSYSTEMS USED'.

STRUTURAL STAGES : Mid to late succession stages, groves of old trees,riparian vegetation and old growth stands.

REFERENCES

Ali and Ripley 1969;Baker 1922-'30;Grimmett,Inskipp and Inskipp 1998;Sawarkar 1987; Tickell 1833.

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Southern Mottled Wood Owl *Strix ocellata ocellata* (Lesson)

Status : Resident

Widely distributed throughout the peninsula, plains and hills, occurs in the ACA, and the SCA.

ECOSYSTMES USED

Dry and the moist deciduous forests communities; favors groves of large ancient trees with snags and den tree elements; old growth stands amidst low density forest vegetation. Riparian forests and large trees dominated mesic sites.

HABITAT REQUIREMENTS

REARING : Breeds between November to April. Eggs are laid in natural cavity ofa large diameter (> 150cm. dbh) den tree,or of a snag surrounded by large crowned leafy trees, within a grove of large ancient trees such as mango and jamun; or an old growth stand.

FEEDING : Rats mice other rodents, birds, lizards, crabs, large hard and soft bodied insects.

COVER : As in the 'ECOSYSTEMS USED' and 'REARING', Roosts during the day time within dense foliage, will often use a large tree cavity for the purpose.

STRUCTURAL STAGES :

Mid succession to old growth.

REFERENCES

Ali and Ripley 1969; Baker 1922-'30; Grimmett, Inskipp and Inskipp 1998; Sawarkar 1987.

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Brownheaded Storkbilled Kingfisher *Pelargopsis capensis capensis* (Linnaeus)
Status : Resident

Has an all India distribution, but is localized on scattered sites.Plains to about 1200m.above msl. Occurs in ACA, SCA and TCA. In SCA, along the perennial rivers like the Denwa, Sonbhadra, along the margins of the Tawa reservoir, Kakdi nala, and in Melghat along the large perennial pools in river Sipna.

ECOSYSTEMS USED

Dry deciduous to broad-leaved evergreen forest communities, along the heavily wooded forests, riparian forest along streams, large pools, lakes and reservoirs.

HABITAT REQUIREMENTS

REARING : Breeds between January to September, peak during April and May in TCA, February and March in ACA. As with all kingfishers it bores a horizontal tunnel in a steep earthen bank of a stream, about a meter in length and a diameter of about 10cm.

FEEDING : Fish, frogs, crabs, lizards, mice, young birds, water insects

COVER : Dense forest along the streams and water bodies, hence preference for the riparian forest.

STRUCTURAL STAGES : Mid succession to old growth.

REFERENCES

Ali and Ripley 1970; Baker 1922-'1930; Grimmett, Inskipp and Inskipp 1998; Neelakantan 1950, JBNHS 49(3): 553-4; Sawarkar 1987.

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Northern Green Barbet *Megalaima zeylanica* caniceps (Franklin)
Status : Resident

Distributed along the lower western Himalayas from Kangra (H.P.) to Kumaon(U.P.).In continental India Mt. Abu and Gujrat, through M.P., northern Maharashtra, Bihar, West Bengal, Orissa, south to Godavari. Occurs in moist and dry deciduous forest, wooded avenues and gardens.Occurs in the SCA and TCA.

ECOSYSTEMS USED

Dry and Moist deciduous forest communities with a variety of fruit bearing trees.

HABITAT REQUIREMENTS

REARING: Breeding season between February to June with peak during March to May.A cavity is excavated by the bird in a vertical branch or the bole of a tree, softened by rot or a tree species offering a relatively soft wood substrate suitable for excavating a cavity.The cavity is generally located at a height between 3 and 15 meters from the base of the tree.The eggs are laid on the unlined base of the excavated shaft.

FEEDING: An eminently frugivorous species,feeding on wild figs, a large variety of drupes

and berries, flower petals, and the nectar from flowers such as Erythrina,Bombax etc. Feeds on insects such as beetles, other flying insects, and occasionally small lizards.

COVER: Well-wooded dry and moist deciduous forest communities.

STRUCTURAL STAGES :

Mid succession to old growth, and groves of fruit bearing trees

REFERENCES

Ali Salim and Dillon Ripley 1970, Baker 1922-'30, Franklin 1831, Grimmett,Inskipp and Inskipp,Mehta 1998, Sawarkar 1987,Whistler H. and Kinnear, 1934.

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Spotted Deer or Chital *Axis axis axis* (Erxleben)
Status : Common, Schedule III

Distributed along the Himalayan foothills and southward almost throughout the peninsula, plains or rolling country.Does not occur in hilly terrain but may occupy the valleys, from semi arid country to the coastal mangrove system, the terai in the north and the northeast. Does not occur in the arid plains. Occurs in ACA, SCA, TCA.

ECOSYSTEMS USED

Known to occur across a wide range of forest types from semi arid forested tracts to the coastal mangroves of the Sunderbans, where it is one of the principal prey of the tiger. It is found in the terai, the dry, the moist deciduous, and the semi evergreen forest. Avoids the rain forests, and natural scrub. While it is dependent on grasslands, these must occur interspersed within forests. It is variously described as a species associated with forested edges and ecotones, and a mosaic of forests and grasslands in well watered tracts. Notwithstanding the presence of the required vegetation and terrain features, if water is limiting, the population appears scattered in distribution, in low densities, and small herds or parties, though under ideal conditions it may form very large herds, and significantly high densities. As such it is an important prey of the tiger, leopard and the wild dog. It does best under an interspersion of the early to mid succession stages, considered together with other essential habitat features.

HABITAT REQUIREMENTS

REARING: Chital breed throughout the year. Peak fawning is observed during November to March and June to August. Usually a single fawn is born. Scattered patches of tall grass, and shrubs in grassland or woodlands are essential for dropping and hiding the fawns for a period of 4to 5 weeks till they develop the capability of being able to successfully trail the mother. This means that such mosaics need to be maintained throughout the year.

FEEDING: It is primarily a grazer. Diversity of grasses and herbs is therefore important. The perennials become significant in relation to the ephemerals. The grazing intensity (domestic stock or high-density wild ungulates) and frequency and intensity of fires arbiter the structure and composition of vegetation communities. Fresh sprouts are preferred. Following the seasonality of phenology and its relationship to nutrient contents of the diet, together with availability of food items, grazing is supplemented by browsing on a variety of plants, and parts such as leaves, flowers and fruits. Among the fruits, *ficus* spp., *Cordia* spp., *Grewia* spp., *Hollarrhana antidysentrica, Helecteris isora*, mature Lantana berries,*Zizyphus* spp., *Terminalia bellerica*, *T. chebula*, etc are eaten. Depending on the vegetation composition and chital densities a clear browselines

may be seen. Chital are frequently seen feeding in association with langur *Presbytis entellus*, who while feeding on leaves in the trees drop leaves, twigs, fruits on the ground as incidental to their feeding activities. The cruising radius with respect to a source of water is approximately 2 km.

COVER: Components as described above.

STRUCTURAL STAGES:

Early to mid succession, In older succession stages the stands need to be relatively open (0.5 to 0.6 canopy density) with interspersed grassy openings.

REFERENCES:

Prater 1980, Putman 1988, Seidensticker, Christie and Jackson (Ed) 1999,Schaller 1967, Sankar 1994, Sankhla 1978, Wemmer (Ed) 1987, Whitehead 1972

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The Sambar *Cervus unicolor* (Kerr).
Status : Common , Schedule III

The largest of all the Indian deer, is a typically forest associated species of the southeast Asia. From about the middle lower altitudes of the Himalayas southward occurs practically throughout India, within the well-wooded forests. Occurs in ACA, GCA, SCA and the TCA. Along side the gaur it is the most important prey of the tiger.

ECOSYSTEMS USED

Semi arid to broad leaf evergreen forests, across their range of forest types. Absent in coastal mangroves, grasslands without forested mosaic, scrub and desert. Presence of forests with grassy openings is essential for its existence. Occurs in plains, rolling and hilly terrain. The last two are ideal habitat features.

HABITAT REQUIREMENTS

REARING : Fawning generally peaks in May and June. In the northeast during March – April. Tall grass patches, patches of dense shrubs are needed for the females to drop their fawns and subsequently for hiding them for about 4 weeks till they are able to trail the mothers.

FEEDING : It will graze but is mainly a browser, feeding on leaves, twigs, flowers and fruits of a variety of species, including the large and hard fruits of *Aegle marmilos*.The other favored fruits are those of *Terminalia bellarica* and *T. chebula, Ficus* spp.*, Zizyphus* spp. *Diospyros melanoxylon, Syzigium cumini, Emblica officinalis, Cordia spp*. The inventory is fairly large. During summer when food resources decline, it will feed on the bark of trees such as *Tectona grandis, Mitragyna parviflora*. Young teak plantations display extensive feeding on the bark. It is also observed feeding on the dry fallen leaves of teak and *Anogeissus pendula* during the summer. This seldom causes mortality in teak. All fruit bearing tree species ought to be considered important. In shallow tanks and swamps it will get into the water and feed on aquatic plants reminiscent of the swamp deer. It will also swim freely. Since the sambar regurgitates seeds of the fruits eaten, it makes a valuable contribution to the process of forest regeneration.

COVER : Dense stands of trees, and shrubs, patches of tall grass are used as hiding and escape cover. It also uses rugged terrain features for the purpose. Often when chased by wild dogs it enters water to escape from being attacked. The cover requirement for dropping and rearing fawns has been described above.

STRUCTURAL STAGES :

Mid succession to old growth. The ideal is a mosaic of early succession stage to old growth, with

early succession stages represented as small openings, upto 40-hectare extent. Extensive grasslands are used only partially. Within the old growth stands of rain forests and Dipterocarps like *Shorea robusta* the density of sambar declines.

REFERENCES :

Prater 1980, Putman 1988, Seidensticker, Christie and Jackson (Ed.) 1999, Schaller 1967, Sankar 1994, Sankhla 1978, Wemmer (Ed) 1987, Whitehead 1972.

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The Indian Chevrotain, or the Mouse Deer *Tragulus meminna* (Erxleben)

Satus : Endangered, Schedule I

It is essentially a forest-associated species, occurring in rolling and hilly terrain, upto about 1850 meters elevation above the MSL. A single species representing the family Tragulidae in India, it is probably much more widely distributed than the described approximate range south of the 24 degrees North latitude in the Indian peninsula. It is tiny, solitary, cryptic in behavior, and has obliterative colours. It can thus escape detection. Occurs in ACA and SCA.

ECOSYSTEMS USED

Rain forests, semi evergreen and moist deciduous forests.

HABITAT REQUIREMENTS

REARING: Fawns are born towards the end of rains, i.e. December - January in south India, October – November in central India. Twinning is common. The female chooses suitable crevices among large bouldery outcrops to drop and hide the fawns till they are old enough to move on their own.

FEEDING: Feeds on grass and a variety of fruits. A diversity of fruit bearing trees and shrubs are therefore important. Grassy openings and such mosaic are necessary.

COVER: Grassy hill slopes with large boulders secreting crevices are essential as breeding, hiding and escape cover. Atleast 2 to 3 (?) den trees per hectare with hollows going up from the base into the bole are necessary. When chased by an enemy, the mouse deer has the ability for climbing up the insides of such hollows to escape from harm.

STRUCTURAL STAGES:

Mid to late successional stages interspersed with grassy openings.

REFERENCES:

Champion 1927, Gee 1955, Krishnan 1972, Prater 1980.

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The Four Horned Antelope, or Chowsingha *Tetracerus quadricornis* (Blainville)

Status : Endangered, Schedule I

Along with the nilgai *Boselaphus tragocamelus*, the chowsingha is grouped under a separate sub-family Boselaphinae to distinguish it from the true antelopes. It is the only member of this group with two pairs of horns. It occurs in peninsular India south of the Siwaliks and the Gangetic plains. Absent in the Western Ghats and associated mountain ranges. It is a forest dwelling species in the rolling and hilly terrain. Present only in the SCA.

ECOSYSTEMS USED

Dry and moist deciduous forests along the Satpuras and the Vindhyan hill ranges, the semi arid forests in the Aravallis are its better known habitats.

HABITAT REQUIREMENTS

REARING: Fawns are dropped towards the beginning of rains i.e. during the month of June. Tall clumps of grasses, bushy patches are used to hide the newly born fawns till they are old enough to accompany the mother; usually three weeks. Twins are not uncommon.

FEEDING: Mainly grasses and leaves. Usually stay in the proximity of a source of water i.e. the cruising radius is short, approximately 1.5 km. Often found near small cultivation patches of forest dwelling villagers and village tanks.

COVER: Uses tall grass patches and bushy thickets as hiding, escape. Breeding cover as above.

STRUCTURAL STAGES:

A combination of early to mid successional stages with open canopy (0.4 to 0.6). May also occur in late successional stage under such canopy conditions. Tracts adjoining habitations are important.

REFERENCES:

Prater 1980, Krishnan 1972, Shaikh and Sawarkar 1973.

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The Gaur, or Indian Bison *Bos gaurus gaurus* H.Smith
Status : Endangered, Schedule I

The seven north eastern states, forests of Bihar, Madhya Pradesh, Maharashtra and south to Kerala and Tamil Nadu. Has been recorded at elevation upto 1850 metres in the Western Ghats. In eastern Himalayas confined to the hills. Essentially a forest dwelling species in rolling and hilly terrain. Along with the sambar it is the principal prey of the tiger.

ECOSYSTEMS USED

Dry and moist deciduous forests, semi evergreen and evergreen forests, especially those associated with bamboos, bogs.

HABITAT REQUIREMENTS

REARING: Tall grass patches, clumps of bamboo are used as cover for dropping and rearing calves. Peak calving months are December – January, though calves might be seen in other months of summer and winter.

FEEDING: Gaur is both a grazer and a browser. And therefore feeds on a variety of grasses, including those in a coarse condition. Bamboo leaves, twigs, young shoots are favorite. Will browse on leaves, twigs, flowers and fruits of a large variety of trees, shrubs, and climbers. When the food resources decline in summer, it will extensively feed on the bark of trees like the teak and *Mitragyna parviflora* which are of choice. The herd size varies from 5 to 10 animals. However sometimes composite herds of as many as 30 to 40 animals may be seen. A distinct seasonal movement is observed. Valleys and lower slopes are used during late winter and summer. During the rains and early winter the animals move extensively and use the upper slopes and plateaux. Thus extensive habitats and a variety of landforms are essential.

COVER: As above and a combination of forest conditions.

STRUCTURAL STAGES:

A combination of early to late succession stages. The early succession stages, and old growth interspersed in patches of smaller size in large areas of middle to late succession. Grassy openings of the size 5 to 15 hectares in a mosaic constitute an ideal habitat.

REFERENCES:

Bhattacharya et.al 1997, Conry 1989, Krishnan 1972, Lad and Rajesh Gopal 1992, Prater 1980, Sahai 1972, Schaller 1967.

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The Flying Fox *Pteropus gigantius(Brunnich)*
Status : Common, Schedule V

The largest fruit bat in India, usually seen flying with slow wing beats in the evenings. Common and widely distributed. They are crepuscular and nocturnal. They are gregarious and roost during the day in large tall trees as noisy colonies, which can at times include hundreds of animals. They are considered as a pest in orchards. Occurs in ACA, GCA, SCA and TCA

ECOSYSTEMS USED

Dry deciduous forests to evergreen forests. The most favoured are the dry and the moist deciduous forests Rare in semi-arid and arid country and absent in the temperate region. Often found amidst busy towns and cities

HABITAT REQUIREMENTS

REARING: The flying foxes mate between October to December during this period the gathering at the roosting site is particularly large as compared to the non breeding period. At times hundreds or even thousands may gather. After the period of gestation between 140 to 150 days a single young is produced between March and May. The young is carried by the mother from roosting site to the feeding sites till it is able to fly. There does not seem to be any separate roosting place/colony for females with young. However outside the breeding period colonies composed entirely of males have been seen.

FEEDING: Food is chiefly of a variety of fruits. The bat feeds on the fruit juice by chewing on it and the pulp and seeds are then spat out. If the seeds are small and the pulp soft then the pulp may be swallowed. The bat may carry fruit from feeding to the roosting site. Since the bat is dependent on cycles of fruiting they may seasonally shift their foci of feeding sites. The flying fox thus is an important agent of dispersal of seed like all other species categorized as fruit bats.

COVER: The bats roost in tall trees. The colonies are observed in large trees with spreading crowns like tamarind, several species of ficus, *Adina cordifolia* etc. but also in stands of eucalyptus which have narrow crowns. Bats exhibit strong roost fidelity and will return to the same roost tree from year to year. The roosting sites can be several kilometers away from the feeding site.

STRUCTURAL STAGES:

A combination of early to late succession stages, groves and riparian forests.

REFERENCES:

Bates J.J. and D.L.Harrison 1997, Prater 1980, Walker 1975.

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The Fulvous Fruit Bat *Rousettus leschenaulti* Desmarest
Status : Common, Schedule V

A medium sized bat, uniformly light brown, occasionally yellowish in colour. Their presence is characterized by odour like fermented fruit. They are readily distinguished from colonies of insectivorous bats by their large brilliant eyes. The species has an all India distribution. Occurs in ACA, GCA, SCA and TCA.

ECOSYSTEMS USED

Dry deciduous to tropical evergreen rain forests. The density and distribution in the latter is somewhat

limited as compared to other vegetation types. Not common in semi-arid and arid ecosystems. Occurs also amidst human habitations in suitable habitat.

HABITAT REQUIREMENTS

REARING: Mating season reported between November and March, and is probably governed by the distribution and availability of food for the adults in breeding age class. Two discrete birth seasons are observed, one in March and the other in August. The bats roost gregariously in large colonies and there is no sexual segregation till the females are gravid. In the forests the colonies are established in caves, manmade tunnels, wells, rooms in old ruins. Gravid females live in maternity colonies and leave the cave soon after arrival of monsoon. Normally a single young is born but twins are not unknown. The young are carried by the mother until they are able to fly, normally a period of two months. Once the juveniles become independent of the mother they live separately in colonies of their own.

FEEDING: The Rosette fruit bats are crepuscular and nocturnal. They feed on fruit juice and nectars from flowers. After having consumed the fruit juice they spit out the pulp and seeds. Thus they are agents of seed dispersal and regeneration of several species of plants. While feeding on nectar they carry pollen and thus perform the function of pollinators. The colonies may move from one locality to the other depending upon the phenology of fruiting trees.

COVER: The bat needs caves, manmade tunnels, old ruins, wells for shelter, roosting and breeding including separate caves for the gravid females who would continue to occupy the maternity caves as long as they are encumbered by the young and separate roosting caves exclusively for the juveniles. The bats are sensitive to disturbance and in such event may abandon a roosting site.

STRUCTURAL STAGES:

Nothing specific, presumably mid- succession to old growth, groves and riparian forests.

REFERENCES:

Bates J.J. and D.L. Harrison 1997, Prater 1980, Walker 1975

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Short–Nosed Fruit Bat *Cynopterus sphinx* Vahl
Status : Common, Schedule V

The species has an all India distribution. The fur is dense and the colour can be variable in some shade of olive brown. The white margined nearly naked ears, prominent almost tubular nostrils and distinctively grooved upper lip are pointers to identity. Males often have a bright rusty brown collar. This bat is not as commonly seen as the Flying Fox or the Fulvous Fruit bat. Roosts in small colonies of three to four individuals. Occurs in ACA, GCA, SCA and TCA

ECOSYSTEMS USED

Dry deciduous to tropical evergreen rain forests. Also amidst human settlements and partial to roosting in palm trees. Occurs in Rural and Urban areas outside the forests.

HABITAT REQUIREMENTS

REARING: Breeding period is variable by geographic location. In Central India sexual activity is observed during September- October, pups appear between December-January. The second period of sexual activity falls between February-March with the pups appearing between May and June. In south the well defined period commences in December-January and ends in August. Gestation period is estimated

between 115 to 125 days. Usually a single pup is born. Outside the breeding period the males and females roost separately.

FEEDING: The bat feeds on a variety of wild fruits in addition to those cultivated. It mainly feeds on the juice, spitting out the pulp and seeds. This may be done while in flight It also very often plucks the fruit and carry it to a convenient point from where to hang and feed. If the seeds are small they pass through the feces. It also visits flowers to feed on nectar, or petals. Thus the species has a role to play in pollination and dispersal of seeds of several fruit bearing plants and their regeneration.

COVER: The diurnal roosting sites include crevices in the bole of Ficus species, palm or coconut trees, the underside of palm leaves. Snags and den trees seem important for the purpose.

STRUCTURAL STAGES:

Nothing specific, apparently a mosaic of successional stages with the middle to late succession stages being important in context of fruit production and diversity of such fruit bearing tree and shrub species. Also higher incidence of occurrence of large trees capable of secreting hollows and crevices.

REFERENCES:

Bates J.J. and D.L.Harrison, Prater 1980, Walker 1975.

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Indian False Vampire *Megaderma lyra* Geoffroy

Status : Common, Does not appear in any Schedule.

Geographically widely distributed with altitudinal range between about 1000m. to sea level. Probably common. Recent surveys in the Western Ghats indicate that the population has declined significantly. This could be due to disturbance to the roosting sites. No endemic sub-species. Its flapping and dipping flight allows ready identification.

ECOSYSTEMS USED

Adapted to a wide range of biotopes, rainforests to semi-arid forest types, in plains and hills.

HABITAT REQUIREMENTS

REARING: There is a single breeding period in a year and varies slightly between the north and south. In southern India mating takes place sometime in November with births during April. In the north it is about mid December and May respectively. The period of gestation is 145-150 days. A single pup is born, twins are rare. Young are carried by the mother for a month. Suckling may continue for another 3 weeks or so.

FEEDING: Leaves the roosting site late after sunset. It hunts close to the ground usually within a radius of 2km off its roosting/resting sites where it returns to feed on its prey. Its range of food includes mainly vertebrates such as wall and other lizards, fishes, frogs, toads and birds such as White- eyes, Sunbirds, Sparrows, Crag Martins.It also preys on other bats such as Rhinopoma, Tapozous, Pipistrellus spp. Among mammals the prey includes rats, mice, gerbils, and shrews. Among the insects it is partial to the group coleoptera, mainly scarabids, curculionids and carabids. Some of them being wood boring insects. During the rains the proportion of intake of beetles goes up significantly and will also feed on termites, ants and swarming wasps.

COVER: In the forest it roosts in caves, large crevasses in rocks, temples, forts, etc. Colony size may vary from a single individual to several hundred. Sexes mostly do not form separate colonies.

STRUCTURAL STAGES:

In consideration to the range of food items a mosaic of early to late succession stages, old growth and riparian forests is necessary.

REFERENCES:

Bates J.J. and D.L.Harrison 1997, Prater 1980, Walker 1975.

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Horseshoe Bat *Rhinolopus luctus* Temminck, 1835
Status : Indeterminate. Does not appear in any Schedule

It is a forest dwelling species little studied on the Indian sub-continent. Occurs in mountainous region. The only record in Central India is from the Pachmarhi WLS within the SCA. The location is between the *R. luctus* population in Nepal and *R. beddomi* in the Western Ghats. The geographical distribution may have significance for the Satpura Hypothesis. Occurs only in SCA.

ECOSYSTEMS USED

Dry and Moist Deciduous forests, Montane Hill forests on and around the Pachmarhi plateau and peaks.

HABITAT REQUIREMENTS

REARING: Nothing is known.

FEEDING: Flight is low, about 6 to 9 metres above ground around large trees. Recorded to be feeding on small beetles and insects.

COVER: Never found in colonies but roosts in pairs. A number of pairs may roost separately in a cave if it is large enough to allow this. Besides caves also roosts in tree hollows of snags and den trees.

STRUCTURAL STAGES:

Nothing is known. Presumably a mosaic of succession stages.

REFERENCES:

Bates J.J. and D.L.Harris 1997, Blandford 1888-91, Prater 1980, Walker 1975.

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Leaf-Nosed Bat *Hipposideros galeritus* Cantor, 1846
Status : Rare. Does not appear in any Schedule

A rare bat in India, only isolated individuals or very small colonies of few individuals have been encountered. Known to hang in a family group, adult male, female and a pup. Tends to avoid contact with other bat species. Among the four Project sites reported only from the SCA, the Chikalda ridge of the Melghat Tiger Reserve.

ECOSYSTEMS USED

Semi evergreen, Dry and the Moist Deciduous forests, in hilly terrain up to an altitude of 1100 metres.

HABITAT REQUIREMENTS

REARING: Little is known in India. In Sri Lanka pups were seen in the month of May.

FEEDING: Becomes active in the evening. Flies low around bushes and hunts its prey along edges and ecotones. Feeds on beetles and insects

COVER: In the forest the roosting sites include small caves, crevasses in rocks, rocky overhangs, spaces between aggregates of large boulders, dungeons in old forts, underneath large culverts.

STRUCTURAL STAGES:

The edges and ecotones in a mix of succession stages and rocky outcrops. Interspersed shrubby growth is important.

REFERENCES:

Bates J.J. and D.L. Harris 1997, Brosset 1962, Khajuria 1980, Prater 1980, Walker 1975.

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The Ratel, or Honey Badger *Mellivora capensis* (Schreber)
Status : Endangered, Schedule I

It is a single species representing the sub-family Mellivoranae. Though widely distributed, it is nowhere common and easily sighted as the records of the 1930s may suggest. With the exception of the Northeast region of the country where records are not clear, and where the Hog Badger *Arctonyx collaris* is better known, the species range extends from the foot-hills of the Himalayas southward through the peninsula. Occurs in ACA, SCA, and TCA.

ECOSYSTEMS USED

Semi-arid tracts to the Dry and the Moist deciduous forests. Also recorded in the Terai but in the upland forests and less wet grasslands. Avoids the higher rainfall areas of semi-evergreen and the rain forests. Prefers the rolling, broken and hilly country. Does not seem to exist outside the forested tracts anymore due to the presence of human habitations and the immense pressure of grazing of livestock, and other biotic pressures to which the species is very sensitive.

HABITAT REQUIREMENTS

REARING: Little is known of the breeding. By accounts of the well studied badgers in Europe, north Asia, and the US, peak cubbing seems to take place in India just before the onset of monsoon. C1 they are a repository of fungi and insects, which in turn attract birds, reptiles, and rodents.

COVER: Most requirements have already been cited. To sum up the cardinal requirements, the riparian zones are critically important. Large boulders, hollow down logs of large size are significant as hiding cover and temporary shelter. Such areas need to be free of human and cattle related disturbance.

STRUCTURAL STAGES:

A combination of early to late succession stages and undisturbed riparian forests.

REFERENCES:

Champion 1927, Prater 1980, Neal 1977, Schaller 1967

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The Sloth Bear *Melursus ursinus ursinus* (Shaw)
Status : Endangered, Schedule I

Widely distributed across the forested landscapes from the foot – hills of the Himalayas and south throughout the peninsula, except the semi – arid and arid tracts of Punjab, Haryana and Rajasthan. In the northeast to West Bengal and Assam. Prefers rolling, broken hilly country but also occurs in plains. Currently under great pressure of poaching and conflicts with people, because of the rapidly growing human population and extension of its activities in the habitat of the bears. In places the bears have been tragically marooned amidst encroaching cultivation and habitations leading to serious situation, both for the bears and the people. Occurs in ACA, SCA and TCA.

EOSYSTEMS USED

Dry and moist deciduous forests, semi – evergreen and broadleaf evergreen forests.

HABITAT REQUIREMENTS

REARING: Cubs are met with in the winter as well as the summer. Two to three cubs may be seen. Cubs are dropped in secluded places, in depressions surrounded by thick vegetation. Caves are preferred. Thus drainages with large boulders are important. When very small the cubs sit tight on the mother's back, as she goes about searching for food. Females with cubs are extremely protective, and liable to attack an intruder on sight. Thickets constitute a significant hiding cover while the cubs are growing.

FEEDING: The sloth bear is an omnivore and feeds on a variety of insects. Termites are favorite, and the bear will break open and raid a termatorium, or dig deep into the ground looking for other ants which build sub-terranian chambers. Such craters will often be found on the dirt roads. A bear will dig for tubers, rhizomes, roots, and grubs. It feeds on a large variety of fruits and berries seasonally come across, and include the ripe berries of *Lantana camara*. It will climb trees to feed on figs Ficus spp., fruits of wild mango *Mangifera indica*, *Syzigium cumini, Dyospyros melanoxylon, Cassia fistula,Bridelia retusa, Buchanania lanzan* just to mention a few. It will pull down the wild banana *Musa superba*, feed on the fruit as well as the bast. The most attractive item is the flowers of *Madhuca latifolia* and these are sites of serious conflict with the local tribals who extensively collect the flower to derive food items and some excellent and potent liquor. People are liable to be seriously injured. A bear will climb into a mango or a Arjuna *Terminalia arjuna* tree which occur in the riparian forests in central India to get at the large hives of the rock bees. Opportunistically bears will raid agricultural crops such as maize. This particularly happens when bears are isolated in rapidly degrading habitats. Occasionally will feed on a carcass.

COVER: Caves for shelter and breeding. Woodland with thickets of shrubs as escape cover and shelter. Lantana thickets are often used for all such purpose. Broken hilly country, with large size bouldery drainages.

STUCTURAL STAGES:

A combination of mid to late succession stages with grassy openings. Riparian zones.

REFERENCES:

Champion 1927, Desai et.al 1997, Laurie and Seidensticker 1977, Krishnan 1972, 1985,Prater 1980,

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The Tiger *Panthera tigris tigris* (Linnaeus)
Status : Endangered, Schedule I

Once distributed widely in India from the Himalayas (approximately 3050 m. above MSL) through to the tip of the peninsula, except the deserts, the tiger population is now locally extirpated over large tracts. Very few tigers are now left in the Himalayas.It is absent in Jammu and Kashmir, Himachal Pradesh, Nagaland, Manipur, Tripura, Punjab, Haryana, and Gujarat. Wherever the tigers exist they occur mostly in low to very low densities with the exception of several well managed tiger reserves, national parks and wildlife sanctuaries. Currently there are 25 Tiger Reserves, aggregating 32,995 sq.km. enjoying partly or wholly the substantive status of a PA. The threats confronting the species are many. Habitat fragmentation, a rapid decline of prey species and their densities, high human and cattle population, and a combination of a variety of factors of disturbance associated with these are among those that are serious. During the past decade and a half some very serious

pressure of poaching for the illegal international trade in tiger bone has created a situation of great adversity for the survival of the species. Currently the population estimates vary between 3500 to 3750, which is between 60 – 70% of the world population of all the existing five sub-species put together. Tiger is present on all the four Project sites, ACA, GCA, SCA and the TCA.

ECOSYSTEMS USED

Semi arid; Dry and Moist Deciduous forests; Semi Evergreen and broadleaf Evergreen or the Rain forests; coastal mangroves and the terai tall wet grasslands. Plains and hills.

HABITAT REQUIREMENTS

REARING: The tigers breed throughout the year. Peak cubbing in the north appears to be in winter, while along the humid coast, and in central and south India it appears to be in summer. A tigress will seek secluded and safe sites such as a cave, a sheltered place among large boulders preferably well concealed by vegetation, an enormous size hollow at the base of a tree, or a hollow of appropriate size in a large fallen tree or a log to drop, hide and rear the cubs. The cubs may also be moved from place to place, especially in areas with some disturbance and insecurity. A tigress may leave the cubs for several hours at a time in search of a prey and during such times the cubs are most vulnerable to danger to their lives. Complete protection of such sites at all times is critically important. Upto five cubs may be born but fewer, 1 or 2 may survive to reach adulthood. The success is much higher in areas with favourably high densities of natural prey, which can happen only in well managed habitats. In prime habitats the percentage of females with cubs is recorded to vary between 40 to 87% and the interbirth interval could be as less as 20 months. The reproductive output can be significantly high if litters are large and survivorship is high. If a litter is lost early the interval between litters can be as short as 7 to 8 months. Thus given a good status of the prey, and large intact habitats the tiger population can recover rapidly from impacts of hunting and poaching. The mother – cub association is strong and may last for about 16 to 18 months in case of a male cub and 20 to 22 months in case of a female. The male leaves the natal area to establish a home range of his own at a distant location while female does so closer to the mother's home range. The study in Chitwan revealed the average distance of dispersal to be 33 km. with the maximum being 65km for the male. For the female it was a little less than 10 km. and 33km. respectively. However tigers are known to cover much greater distances. Little is known how the dispersing tigers move, especially through fragmented forests. Dispersal is male biased and therefore it is expected that mortality among males would be higher.

FEEDING: Across the spectrum, a wide range of species has been recorded in the diet of the tiger that differ enormously in size and weight. These include small size mammals like the porcupine, pangolin, a small deer like the muntjak to a fully-grown bull gaur, elephant and rhino calves. Fish and crabs in the Sunderbans. However the large cervids and bovids are critical for the long-term survival. These make up approximately 75% of the contribution to the diet of the tiger over the greater part of its geographic range. The tiger has the ability to adjust to the changing landscapes provided the large forest ungulates persist. Various estimates have placed the annual dietary requirement of an adult tiger between 2500 to 3500 kg. of prey on the hoof. It is also estimated that a tiger is unable to crop more than 10 to 15% of the standing biomass of prey. Though domestic cattle may have a significant presence in the Indian forests and are preyed upon, it is not the same as the presence of large forest ungulates associated with the vital habitat attributes of the tiger. Predation on cattle has also led to the tragic consequences of tigers now popularly being poached on poisoned kills.

COVER: Well-wooded and well-watered forest with patches of dense cover provided by scrub level thickets and bamboo under tree canopy or tall grass patches. Riparian forests are important The breeding and rearing cover requirement is as above. As the tiger hunts by stalking the prey with the vital associated element of surprise, thickets, bouldery or topographical features that provide concealment are necessary. The tiger is adept at using the available cover in a strategic manner to its advantage.

STRUCTURAL STAGES:

A mosaic of early to late succession stages and old growth. Extensive late succession stages normally have lower densities of large forest ungulates which results in low tiger densities, especially in the primary rain forests.

REFERENCES:

McDougal Charles 1977; Sankhala Kailash 1978; Schaller George B 1967; Seidensticker John, Sarah Christie and Peter Jackson 1999; Tilson Ronald, Ulysses Seal 1987.

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The Leopard *Panthera pardus* (Linnaeus)
Status : Endangered

The leopard has an all India distribution, across the range of the tiger and the lion, in plains and hills (3000 meters msl) except in the desert and the coastal mangrove forests. It is rare in the tall wet grasslands of terai. The highest known density of the species appears in the Gir forests of Gujarat that includes the only remaining habitat of the Asiatic lion in the world, the Gir national park and wildlife sanctuary along with the surrounding forests, in all 1882 sq.km. with a lion density of one per 6.3 sq.km. and a leopard per 7 sq.km. Although the leopard is a forest-associated species, it has an extraordinary capability to adapt to changing landscapes, landuses, habitat fragmentation and decline or loss of its natural prey. It can use minimal cover of any character for its survival and dispersal. Prey size varies from that of a small size domestic buffalo to a rodent. On virtue of such range of adjustments leopards are occasionally reported within metropolitan areas, cities and townships. It is under greatest conflict with humans among all the wild carnivores. Child lifting, mankillig, causing injury to humans and depredation of livestock are some of the issues attributed to the leopard. Even sighting of a leopard near habitations within the legitimate range of the species is now being flagged as a life threatening situation resulting in " capture and release" operations being carried out in several areas of local protests. Large amounts of ex-gratia payments are made by the Forest Department to people for loss of livestock, injuries to and and loss of human life. This has created a general unsubstantiated impression that the leopard population is growing at an alarming rate. Thus though the leopard is still being reported from its known geographic range, it is under serious danger.

Four races are recognized from the Indian sub-continent. *P.p. fusca* (Meyer 1794) the Indian leopard; *P.p.pernigra* Gray 1863, the leopard of Sikkim and Nepal; *P.p.sindica* Pocock 1930, Sind leopard; P.p.millardi Pocock 1930, the Kashmir leopard.The leopard occurs in ACA, GCA,SCA and TCA.

ECOSYSTEMS USED

Semiarid forest types to evergreen coniferous and broad-leaved rainforests. Highest densities are attained in semiarid, dry and moist deciduous forests. Absent in coastal mangroves, rare in the tall wet grasslands.

HABITAT REQUIREMENTS

REARING: Leopard breeds throughout the year, with no discernible peak cubbing period. Females

attain sexual maturity around 2.5 to 3 years of age. 2 to 4 cubs may be born after a short gestation period of 3 months. The rearing cover requirement is same as that for the tiger. However unlike the tiger the leopard is more versatile in accepting small sites offering concealment amidst otherwise disturbed tracts with limited cover. It may use spaces in a box culvert or a Hume pipe along roads. There is not enough information on the duration of the mother cub association, and the dispersal of the grownup cubs.

FEEDING: The versatility in terms of using cover types is matched by its catholic food habits. In the forest, hare, porcupine (favorite), other rodents, birds especially peafowl, all deers except sambar stags, wild pig, primates (favorite), and gaur calves etc. Among domestic stock, cattle of medium size, goat and sheep, poultry, and dogs (favorite). Often leopards are found fallen in village wells that have either very low or no parapet walls while chasing dogs. Occasionally it may opportunistically lift an unattended child, or those emboldened may take to man eating. Most such events are accidental or under provocation. Leopard is adept at climbing trees and will often carry a kill into a tree and wedge it between branches, concealed under leaf cover for safety against vultures and other larger carnivores and solitary boars.

COVER : As above.

STRUCTURAL STAGES:

Early in some combination with mid to late succession stages. Mid to late succession stages either individually themselves or as a mosaic.

REFERENCES:

Champion 1927, Daniel J.C. 1996; Krishnan 1985, Prater S.H. 1980; Schaller 1967, Singh H.S. and R. D. Kumbhoj 1996.

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The Dhole or Indian Wild Dog *Cuon alpinus* (Pallas)

Status : Vulnerable

The species was once widely distributed from the Trans-Himalayas and Himalayas, through the peninsula, in mountains and plains except the hot deserts. Three races are recognized in India, primaevus(Hodgson), laniger Pocock, and dukhunensis (Sykes), respectively from the Trans-Himalayas, Himalayas and rest of the country. Wild dogs no longer occur in the Himalayas or the Siwaliks and seem to have disappeared from the semi-arid habitats of western India and the terai as well. The highest densities are attained in the dry and moist deciduous forests of peninsular India where deer occur. Like the tiger it essentially is a forest dwelling species with the exception of the Trans-Himalayan cold desert. They have been persecuted for long by hunters due to a misplaced belief that their presence disturbed game and they were destructive predators! During the period of licensed hunting they carried a bounty on their head. Like the African Cape hunting dog, dholes are social and hunt in packs, chasing and running down their prey. Pack size may vary from a few to > 20 animals under the leadership of an older female. Mortality, emigration of a few members from a pack before the arrival of pups and a loosely displayed territoriality seem to be the mechanism controlling pack size. Dhole occurs in ACA, GCA, and SCA.

ECOSYSTEMS USED

Trans-Himalayan cold deserts, semi-arid forest types, dry and moist deciduous forests, semi-evergreen forest types.

HABITAT REQUIREMENTS

REARING: Pups are come across during all months, but there seems to be a peak during the months of January and February in the peninsular

India. Pups are born in a den burrowed by the dogs. Sometimes porcupine burrows not in use are appropriated and enlarged to suit the requirement, or concealed sites under rocks may be used. Several females at times may establish a breeding colony. Four to six pups may be born which are nursed and reared in the den. Denning sites if left undisturbed may be used year after year. If there is disturbance pups may be shifted from one den site to another. The pups remain in the den till they are about 70 to 80 days old. The pups are looked after with special attention by the pack till they are 4 to 5 months old and are weaned on regurgitated meat. During this period the pack usually hunts during the early hours or late in the day to provide security to the pups. During such hunting the pups are kept in hiding. When they start following the hunts, some adults are in attendance to round up the stragglers. The pups are allowed to monopolize small kills, and when the food is insufficient, adults who might have eaten earlier will regurgitate meat for the pups. This activity seems to taper off when the cubs are between 7to8 months old. The pups grow rapidly and start moving with the pack as soon as they are able to keep up with the mother, and reach sexual maturity by the age of 1.5 years.

FEEDING: Dholes are diurnal coursing pack hunters and prefer open areas, and mosaics. They are equally adept at hunting on plains and hills. Dholes largely kill prey around 50 kg. in weight, but certainly the hunt is not limited by this, and a pack is capable of hunting adult sambar stags. Being a coursing predator, the dholes kill more young and old animals. The kill is consumed efficiently with hardly any remains in evidence of the small kills. In case of large prey, the bones are picked clean; even the skin on the skull is eaten. Scavenging tiger and leopard kills is not unknown. They share the entire spectrum of prey species of the tiger, and to a large extent that of the leopard. Mean prey size and habitat structure could vary. Several tribal cultures are associated with the dhole, in that they keep track of the pack movement, and are on the lookout for kills being made. Often they may drive away the dogs from the kill and appropriate the carcass, which in some localities may induce stress on the pack. Hunting domestic stock is not common, but the dhole sometimes is blamed for such activities, especially in their penumbral habitats, and the dens may be dug up and pups killed in retaliation.

COVER: Well wooded forests, with a mosaic of cover conditions and interspersed open areas, plains or hills. The breeding and rearing cover requirement are as above. Riparian zones and surrounds of water are important.

STRUCTURAL STAGES:

Early to late succession stages, ideally a mix, also interspersed plantations. Extensive late succession stages are not suitable.

REFERENCES:

Cohen1977,1978, Davidar 1972, 1977, Fox M.W. (Ed) 1975, Fox M.W. 1984, Johnsingh AJT 1981,1982,1983,1992 and 1997, Prater 1980, Sheldon J.W. 1992., Venkataraman et.al.1995.

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Small –Toothed Ferret Badger *Melogale moschata* Gray, 1831
Status : Endangered, Schedule I

Also known as the Chinese ferret badger, it is distributed throughout the northeast from West Bengal eastward. It is nocturnal, small in size colour varies from blackish grey to various shades of brown and overall a shiny appearance. The mask, cheeks and dorsal portions are yellowish to white. The sub-species *M.m.millsi* is reported from India. Expected to occur in GCA.

ECOSYSTEMS USED

Tropical and sub-tropical forests, evergreen, moist deciduous and also grasslands.

HABITAT REQUIREMENTS

REARING: Nothing specific is known. The young are born in burrows during May-June and the litter size varies from 1to 3.

FEEDING: They are omnivorous, active at dusk and night. They feed on a variety of fruits, small animals, insects and earthworms. As they feed on insect pests some of the local inhabitants encourage them to enter their houses unmolested.

COVER: Like most other badgers they dig burrows for shelter. They may also chhose suitable rock crevices for the purpose. They are good climbers and may sleep in branches of trees.

STRUCTURAL STAGES:

Presumably a combination of several, from early to late, typical of most small carnivores

REFERENCES:

Pocock 1941; Ramakantha 1992, 1995; Choudhary 1997a,b, 1999; Datta 1999; Prater 1980; Anon1972; Anon1999.

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Eurasian Otter *Lutra lutra*, Linn. 1758
Status : Endangered, Part II of Schedule II

The species is reported from Jammu and Kashmir, Himachal Pradesh, hills of Uttaranchal, Sikkim, West Bengal, Assam and Arunachal Pradesh. In southern India in Andhra Pradesh, Kerala, Tamil Nadu, Karnataka and Goa. Over the past several decades there appears to be a significant change in the pattern of distribution because of loss of habitat owing to reasons such as construction of dams, reclamation for paddy cultivation,acqua-culture, poaching for pelt, killing and destruction of holts by fishermen, loss of forest cover along its riparian habitats, pesticides entering water or ingested toxins through prey consumed Expected to occur in ACA.

ECOSYSTEMS USED

Occurs in a wide variety of aquatic habitats such as highland and lowland lakes, rivers,streams, marshes and coastal areas in forested tracts. Integrity of riparian forests is critical.

HABITAT REQUIREMENT

REARING: Males reach sexual maturity at the age of 18 months and females at 24. The period of gestation is approximately 65 days. The litter size varies between 1 to 5. Otters live in dens burrowed on sloping grounds, earth mounds called holts. These are normally in the vicinity of water. The female lines the wall and the floor of the holt with leaves, grass etc. The young remain in the holt for approximately 2-3 months and start accompanying the mother on hunting forays by the age of about 4 months. The female is polyoestrous which means that she can bear young at any time during the year. There however is some evidence of 'peaks' coinciding with the enhanced availability of food and feeding opportunities. The young remain with the mother for a period of about one year which means that inter-birth interval cannot be less than one year

FEEDING: Fish constitute the main diet, eel being a favorite. However the range of prey is considerably diverse to include insects, reptiles, crabs, amphibians, small birds and mammals. An otter may swim under a shoal of fishes and catch the one which is slower. Hunting is preceded by intensive search among reed beds, under the roots of trees, behind

and under rocks where fish tend to hide thus places of choice to catch a fish with least effort. Such in-stream habitat components are therefore very important and underscore the significance of riparian forests. Riparian forests also make a significant contribution of organic debris that plays a role in defining the aquatic faunal diversity.

COVER : Most requirements have been already cited. Grooming areas are very important and the most preferred are sand banks and sand spits within a distance of 10 to 15 meters of water.

STRUCTURAL STAGES :

Riparian forests that have retained its natural structural attributes and composition i.e. relatively undisturbed riparian vegetation. Other structural components that are in-stream need to include reed-beds, extending tree roots in the water, large woody debris, and rocks.

REFERENCES:

Anon 1992; Choudhury 1997a,b,1999; Hussain 1999a,b; Prater 1980.

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Smooth – Coated Otter *Lutra perspicillata* Geoffroy, 1826Status : Endangered Part II of Schedule II

The species is distributed throughout India except portions of Gujarat, Rajasthan, Haryana, Punjab and Himachal Pradesh. It occurs along large rivers,lakes, and reservoirs. Is found along coasts and estuaries in the mangrove forests. In the Terai it occurs along swamps and will also use flooded rice fields opportunistically. Occurs in ACA, GCA, SCA(in the MP portion, not Melgahat) and TCA. The species has declined due to the reasons that have affected all the three otter species in India quoted under the profile of the Eurasian Otter. It occurred in Melghat along the large perennial pools of the ephemeral rivers, especially in the Koktu and Dolar valleys now in the core area of the Melghat tiger reserve, till the mid 1960s. By early 1970s the species became extinct in Melghat, evidently due to the emerging popular method of fishing the pools by using extremely dangerous pesticide such as Endrin that was adopted by the local forest inhabitants. No species profile is documented for the Small-Clawed Otter

ECOSYSTEMS USED

It occurs in hills and plains in a variety of aquatic situations described earlier, ranging from the dry deciduous forests to the rain forests, coastal mangroves,and the tall wet grasslands of terai.

HABITAT REQUIREMENTS

REARING : Similar to the Eurasian Otter. It prefers rocky stretches in all seasons for dening and resting. Gestation period varies from 60 to 62 days. The litter size varies from 1to 5 cubs.

FEEDING : The prey predominantly consists of fish. Other items include shrimps, crabs, smaller vertebrates such as birds, rats, mud-skippers, and frogs. A typical group of smooth coated otters consists of a male, female and 3 to 5 young. Water areas with gradually sloping floor are preferred to those where the river bottom falls steeply. River/stream mouth areas are preferred for hunting as fish tend to congregate in such habitats. Other strategies and habitat elements similar to the Eurasian Otter.

COVER : Similar to the Eurasian Otter.

STRUCTURAL STAGES :

Similar to the Eurasian Otter.

REFERENCES :

Anon 1992; Chaudhury 1997a,b; 1999; Hussain 1999a,b; Prater 1980.

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Indian Giant Squirrel *Ratufa indica* (McClelland)
Status : Endangered, Schedule II, Part II

There are seven races of the species in India of which *Ratufa indica centralis* occurs in SCA and *R.i.maxima* occurs in ACA. In SCA it occurs only in the Satpura national park, the Bori and Pachmarhi wildlife sanctuaries. In the teak plantation dominated tract of Kesla Project in Bori WLS the squirrel is conspicuously present only in the tall riparian mixed forest community. In the drier teak dominated forests of the Melghat tiger reserve with no perennial rivers the species is absent.

The Indian Giant Squirrel is essentially a forest dwelling species. Along its appropriate habitats it occurs south of the Ganges river. The species is essentially arboreal and is active in and along the top canopy of large old trees with spreading crowns. It leaps across gaps of up to four meters within the canopy. It is shy and wary. When danger is perceived a loud repeated rattling call is uttered that is taken up by other squirrels in the neighborhood. The squirrel may live alone or in pairs.

ECOSYSTEMS USED

The dry and moist deciduous forests; the semi-evergreen and rain forests. In case of the first two types occurs as an obligate of the old riparian forests

HABITAT REQUIREMENTS

REARING : The squirrel builds usually two or more nests globular in shape using twigs and leaves in the canopy of large tall trees. The nests are placed near the slender terminal portion of a branch as an anti predator strategy. The nests serve as resting places as well as for raising the young. Young have been recorded in central India during March- April and in southern India during November- December.

FEEDING : A wide range of wild fruits and seeds, small and large. Fruits and seeds are often carried from site to site. Partially eaten fruit and some seeds always reach the ground. Thus the squirrel helps in germination and regeneration of several forest plant species.

COVER : Canopy contiguity is extremely important to maintain populations since it is not only necessary for movement but for more number of breeding sites, food and security. When threatened the squirrel lies flat on large branches or hides within the massive fork of a tree. Such structures are also important for resting. All this points out to large tall trees with contiguous canopy.

STRUCTURAL STAGES :

In the rain forest and semi-evergreen forest habitats, late succession and old growth forests. In the dry and moist deciduous forests the riparian tree community in the late succession stage and old growth is essential.

REFERENCES :

R. Borges; Prater 1980;

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CRITERIA FOR SELECTION OF VERTEBRATE SPECIES – WHR

- Endandered, threatened, endemic, rare
- Habitat specialists, obligates to speific habitat conditions
- Geographically restricted distribution

- Requiring separate seasonal habitats
- Wide ranging
- Principal prey of the tiger
- Using special and unique microhabitats
- Migratory
- Charismatic/ Flagship
- Culturally respected
- Representing specific successional/ structural stage
- Kestone

WHR MATRIX – Data Dictionary

Scientific name (cite source)
Vernacular name
Taxonomic class

A – amphibian

R – reptile

B – bird

M - mammal

Legal status

As denoted in Wildlife Protection Act: SI, SII, SIII, SIV, SV

As denoted in CITES: AI, AII, AIII

Conservation status (IUCN categories)

CE – critically endangered

EN – endangered

VU – vulnerable

LR – lower risk

DD – data deficient, might be one of above

[blank] – none of above

Endemism status (endemism = species found nowhere else for at least a portion of the year)

ER - Endemic to region

EC - Endemic to CA

No - neither of the above

Residency status (pertinent to the region in which the CA occurs)

P - Permanent (year-round) resident

S – Seasonal resident (occurs only seasonally and not year-round)

M – Seasonal migrant or movement only

V – vagrant / incidental

Conservation area

A – ACA

G – GCA

S – SCA

T - TCA

Abundance / distribution status within the CA

A – abundant and well-distributed

B – uncommon but widely distributed

C – fairly abundant but more patchily distributed with gaps

D – disjunct population patches

E – disjunct patches of small local populations at risk of local extirpation

F – extremely patchy with high risk of overall extirpation

Conflict with humans (more frequent than just incidental occurrences)

K – Human killing

H - Human injuries

C - Crop depredation

P - Destruction of property

L - Livestock depredation

Ecosystem types

Each species is coded for each ecosystem type as follows:

2 = Closely associated (provides critical resources for survival and reproduction)

1 = Associated (occurs but not critical)

0 = Absent

blank = does not occur in conservation area

Ecosystem types listed in the WHR matrix include (see attached specific listing):

Champion and Seth Forest Types of India (to the group level)

Other, non-CS types including plantations

Trophic category

He- Herbivore (plant-eating)

Fr – Frugivore (fleshy fruit-eating)

Gr – Granivore (seed-eating)

Ca - Carnivore (consumes animals other than insects)

Ov – Ovivore (egg-eating)

In – Insectivore (insect-eating)

Pi – Piscivore (fish-eating)

Cn – Carrion (dead animal-eating)

Habitat elements/substrates, B,F,Oth

Habitat elements of biotic origin

A. Snags

B. Snag recruits (dying trees, live trees with dead portions)

C. Hollow trees, chimney trees (living or dead)

D. Tree cavities (natural or created)

E. Large old trees (living)

F. Trees with fluting boles and buttresses

G. Down wood

H. Litter and duff layers on the ground

I. Litter in streams

J. Lianas

K. Fruit-bearing shrubs

L. Fruit-bearing trees

M. Epiphyte patches

Habitat elements of geomorphic or anthropogenic origin

N. Cliffs, talus, and ledges

O. Caves

P. Overhangs

Q. Dens (existing burrows dug by animals)

R. Sheet rocks

S. Large bouldery aggregates

T. Rock outcrops

U. Sandy banks and sand spits

V. Salt licks (exposed mineral soils)

W. Earth cuttings – exposed banks

X. Man-made (anthropogenic) structures (e.g., culverts, causeways, buildings, bridges)

Y. Additional / other (specify)

Structural stage

Early stage - managed

Mid stage - managed

Late stage - managed

Old-growth stage – unmanaged

Other - unmanaged

Key ecological functions

A. Pollination vector

B. Disperser of plant propagules, fruits, seeds, etc.

C. Primary tree cavity excavator

D. Primary ground burrow excavator

E. Creator of paths or runways (terrestrial or arboreal)

F. Soil digging

G. Soil compaction, trampling

H. Primary (staple) prey for carnivores

I. Other (specify)

Sensitivity to anthropogenic disturbance

A. Cannabis growing
B. Clearing of undergrowth
C. Construction activities in general
D. Cutting of climbers
E. Draining of wetlands
F. Extraction of flowers of NTFP species
G. Extraction of fruit of NTFP species
H. Extraction of honey from NTFP species
I. Fire (human-set ground fires)
J. Fishing
K. Fuelwood gathering
L. Harrowing of wild grasslands
M. Illicit timber and bamboo harvest / extraction
N. Impoundments
O. Introducing exotic vegetation
P. Jhum
Q. Legal hunting
R. Livestock grazing
S. Lopping
T. Loss of snags, hollow trees
U. Marking, thinning of immature trees, and legal felling of mature trees or bamboo harvesting
V. Pesticides and chemicals
W. Plantations in grassy blanks
X. Poaching (illegal hunting or capture)
Y. Railroads
Z. Religious visits / pilgrimages
AA. Removing of riparian vegetation
BB. Roads and vehicle traffic
CC. Rock climbing
DD. Sand mining
EE. Tourism and recreation

WHR MATRIX

Vernacular name	Rufous Woodpecker	Bank Myna	Green Avadavat	Tickell's Blue Flycatcher	Lesser Whistling Duck	Painted Francolin	Painted Bush Quail	Pintail Snipe	Greater Racket-tailed Drongo
Scientific name	*Celeus brachyurus*	*Acridotheres ginginianus*	*Amandava formosa*	*Cyornis tickelliae*	*Dendrocygna javanica*	*Francolinus pictus*	*Perdicula erythrorhyncha*	*Gallinago stenura*	*Dicrurus paradiseus*
Taxonomic class	B	B	B	B	B	B	B	B	B
Legal Status - Wildlife Protection Act	SIV	SIV	SIV	SIV	SIV	SIV	SIV	SIV	SIV
Legal Status - CITES									
Conservation status - IUCN			EN						
Endemism status	No	No	No	No	No	ER	No	No	No
Residency status	P	P	P	P	P	P	P	M	P
Conservation area	A,S	A,S	S	A,S,T,G	A,S,T,G	S,T,G	A,S	A,S,T,G	A,S,T,G
Abundance / distribution status	A	A	C	A	A	B	B	A	A
Conflict with humans									
Champion and Seth Forest Types of India (to the group level):									
Southern tropical dry deciduous forests – dry teak forest	2	2	1	2	1	2	2	1	1
South Indian tropical moist deciduous mixed forests	2	2		2	1			1	2
Riparian fringing forests	1			1	2			1	2
Southern tropical dry deciduous forests	2	2	1	2	1	2	2	1	1
Teak plantations (ACA, SCA)	1	1	1	1	1	1	1		1
Boswellia forests					1				1
Central Indian subtropical hill forests				1			1	1	2
Reservoirs (by name, TCA, SCA)					1			1	
Southern cutch thorn forests	1	2		2			2	1	1
Southern tropical moist deciduous forest	2				1	1		1	2
Southern moist and wet bamboo brakes	1		2			1	1	1	2
Southern tropical wet evergreen forests									
Nilgiri sub-tropical evergreen forest									2
Southern wet temperate forests (sholas, ACA)									1
Wet grassland habitat on hill plateaus (ACA, GCA)									
Rivers (by name, TCA, ACA & GCA)									
Vernacular name	Rufous Woodpecker	Bank Myna	Green Avadavat	Tickell's Blue Flycatcher	Lesser Whistling Duck	Painted Francolin	Painted Bush Quail	Pintail Snipe	Greater Racket-tailed Drongo

Scientific name	*Celeus brachyurus*	*Acridotheres ginginianus*	*Amandava formosa*	*Cyornis tickelliae*	*Dendrocygna javanica*	*Francolinus pictus*	*Perdicula erythrorhyncha*	*Gallinago stenura*	*Dicrurus paradiseus*
Coffee and cardamom (ACA)									
Tea (ACA)									
Wattle (ACA)									
Pinus (ACA)									
Dry savannah forest									
Tropical moist evergreen forest (GCA)									
Tropical semi-evergreen forest (GCA, TCA)									
Tropical moist deciduous forest (GCA, TCA)									
Shola type of mixed evergreen forest (GCA)									
Alluvial sal – kamrup alluvial sal forests									
Foot hill and plateau sal – eastern hill sal									
East Himalayan moist deciduous forests									
Assam alluvial plain semi evergreen forests (GCA)									
Secondary moist bamboo brakes									
Low alluvial savannah woodland (TCA)									
South Indian tropical moist deciduous teak forests									
Dry peninsular sal forests									
Northern tropical semi-evergreen forests									
Canebrakes (TCA)									
Northern Indian tropical moist deciduous forests (TCA)									
Moist Bhabhar sal (TCA)									
Western light plain sal (TCA)									
Western light alluvium plains sal / dry sal forests (TCA)									
Moist sal savannah (TCA)									
Low alluvial savannah woodland									
Barringtonia swamp forests									
Eastern seasonal swamp low forests (Cephalanthus)									
Dry sal forests									
Vernacular name	Rufous Woodpecker	Bank Myna	Green Avadavat	Tickell's Blue Flycatcher	Lesser Whistling Duck	Painted Francolin	Painted Bush Quail	Pintail Snipe	Greater Racket-tailed Drongo

Scientific name	*Celeus brachyurus*	*Acridotheres ginginianus*	*Amandava formosa*	*Cyornis tickelliae*	*Dendrocygna javanica*	*Francolinus pictus*	*Perdicula erythrorhyncha*	*Gallinago stenura*	*Dicrurus paradiseus*
Other, non-Champion and Seth types									
Dry tall grasslands on hill plateaus (SCA)			2			2	2	1	
Catchment for tributaries to rivers (by name, SCA, TCA)								1	
Extensive bamboo areas (GCA)									
Wet, tall grasslands interspersed with woodland and									
Swamp ('tals') interspersed (TCA)									
Sal plantations (100 yrs old; GCA)									
Extensive plantation on grassland habitats of teak, shisham, and eucalyptus (TCA)									
Young jhum (<10 yrs; GCA)									
Middle jhum (10-20 yrs; GCA)									
Old jhum (>20 yrs; GCA)									
Trophic category	In	Om	Gr	In	He	Gr	Gr	Ca	In
Habitat elements/substrates									
Habitat elements of biotic origin (special habitats)									
Snags	B,F								F
Snag recruits (dying trees, live trees with dead portions)	B,F								F
Hollow trees, chimney trees (living or dead)	B,F	B							
Tree cavities (natural or created)	B,F	B			B				
Large old trees (living)	F			F					B,F
Trees with fluting boles and buttresses	F								F
Down wood	F					F			
Litter and duff layers		F	F	F		B,F	B,F		F
Litter in streams					F			F	
Lianas				F		F			F
Fruit-bearing shrubs		F	F	F		F	F		F
Fruit bearing trees		F	F						F
Epiphyte patches				F					B,F
Vernacular name	Rufous Woodpecker	Bank Myna	Green Avadavat	Tickell's Blue Flycatcher	Lesser Whistling Duck	Painted Francolin	Painted Bush Quail	Pintail Snipe	Greater Racket-tailed Drongo

Scientific name	*Celeus brachyurus*	*Acridotheres ginginianus*	*Amandava formosa*	*Cyornis tickelliae*	*Dendrocygna javanica*	*Francolinus pictus*	*Perdicula erythrorhyncha*	*Gallinago stenura*	*Dicrurus paradiseus*
Habitat elements of geomorphic origin									
Cliffs, talus, and ledges									
Caves									
Overhangs									
Dens (existing burrows dug by animals)									
Sheet rocks									
Large bouldery aggregates									
Rock outcrops					F				
Sandy banks and sand spits					F			F	
Salt licks (exposed mineral soils)									
Earth cuttings									
Man-made (anthropogenic) structures		B		B					
Additional / other (specify)								Marshy area	
Structural stage									
Early stage		X	X	X		X	X	X	X
Mid stage	X	X	X	X		X			X
Late stage	X			X	X				X
Old-growth stage - unmanaged	X			X	X				X
Other - unmanaged		X		X					X
Key ecological functions	C				Agri Pest		B		
Sensitivity to anthropogenic disturbance	K,M,S,T,U		X		E,X	B,I,U,X	B,G,I,K,U,X		

Vernacular name	Verditer Flycatcher	White-rumped Vulture	Red-headed Vulture	Streak-throated Swallow	Southern Grey Shrike	Purple Sunbird	Brown Hawk Owl	Baya Weaver	Streak-throated Woodpecker
Scientific name	*Eumyias thalassina*	*Gyps bengalensis*	*Sarcogyps calvus*	*Hirundo fluvicola*	*Lanius meridionalis*	*Nectarinia asiatica*	*Ninox scutulata*	*Ploceus philippinus*	*Picus xanthopygaeus*
Taxonomic class	B	B	B	B	B	B	B	B	B
Legal Status - Wildlife Protection Act	SIV	SIV	SIV	SIV	SIV	SIV	SIV	SIV	SIV
Legal Status - CITES									
Conservation status - IUCN									
Endemism status	No	No	No	No	No	No	No	No	No
Residency status	P	P	P	P	P	P	P	P	P
Conservation area	A,S,T,G	A,S,T,G	S,T,G	A,S,T	A,S,T	A,S,T,G	A,S,T,G	A,S,T,G	A,S,T,G
Abundance / distribution status	B	B	D	B	B	A	A	A	B
Conflict with humans									
Champion and Seth Forest Types of India (to the group level):									
Southern tropical dry deciduous forests – dry teak forest	2	2	2	1	2	2	1	1	2
South Indian tropical moist deciduous mixed forests	2				1	1	2	1	1
Riparian fringing forests	2			1		1	2	1	1
Southern tropical dry deciduous forests	2	1	1	1	2	2	1	1	2
Teak plantations (ACA, SCA)	1			1	1	1	1	1	2
Boswellia forests	1				1		1	1	2
Central Indian subtropical hill forests	2				1	1	2	1	1
Reservoirs (by name, TCA, SCA)				1				1	
Southern cutch thorn forests	1	2	1	1	2	2	2	1	2
Southern tropical moist deciduous forest	2					1	2	1	1
Southern moist and wet bamboo brakes	1			1	1		1	1	1
Southern tropical wet evergreen forests									
Nilgiri sub-tropical evergreen forest	2								
Southern wet temperate forests (sholas, ACA)	2								
Wet grassland habitat on hill plateaus (ACA, GCA)									
Rivers (by name, TCA, ACA & GCA)									
Vernacular name	Verditer Flycatcher	White-rumped Vulture	Red-headed Vulture	Streak-throated Swallow	Southern Grey Shrike	Purple Sunbird	Brown Hawk Owl	Baya Weaver	Streak-throated Woodpecker

Scientific name	*Eumyias thalassina*	*Gyps bengalensis*	*Sarcogyps calvus*	*Hirundo fluvicola*	*Lanius meridionalis*	*Nectarinia asiatica*	*Ninox scutulata*	*Ploceus philippinus*	*Picus xanthopygaeus*
Coffee and cardamom (ACA)									
Tea (ACA)									
Wattle (ACA)									
Pinus (ACA)									
Dry savannah forest									
Tropical moist evergreen forest (GCA)									
Tropical semi-evergreen forest (GCA, TCA)									
Tropical moist deciduous forest (GCA, TCA)									
Shola type of mixed evergreen forest (GCA)									
Alluvial sal – kamrup alluvial sal forests									
Foot hill and plateau sal – eastern hill sal									
East Himalayan moist deciduous forests									
Assam alluvial plain semi evergreen forests (GCA)									
Secondary moist bamboo brakes									
Low alluvial savannah woodland (TCA)									
South Indian tropical moist deciduous teak forests									
Dry peninsular sal forests									
Northern tropical semi-evergreen forests									
Canebrakes (TCA)									
Northern Indian tropical moist deciduous forests (TCA)									
Moist Bhabhar sal (TCA)									
Western light plain sal (TCA)									
Western light alluvium plains sal / dry sal forests (TCA)									
Moist sal savannah (TCA)									
Low alluvial savannah woodland									
Barringtonia swamp forests									
Eastern seasonal swamp low forests (Cephalanthus)									
Dry sal forests									
Vernacular name	Verditer Flycatcher	White-rumped Vulture	Red-headed Vulture	Streak-throated Swallow	Southern Grey Shrike	Purple Sunbird	Brown Hawk Owl	Baya Weaver	Streak-throated Woodpecker

Scientific name	*Eumyias thalassina*	*Gyps bengalensis*	*Sarcogyps calvus*	*Hirundo fluvicola*	*Lanius meridionalis*	*Nectarinia asiatica*	*Nimox scutulata*	*Ploceus philippinus*	*Picus xanthopygaeus*
Other, non-Champion and Seth types									
Dry tall grasslands on hill plateaus (SCA)		1	1	1	1	1		1	
Catchment for tributaries to rivers (by name, SCA, TCA)									
Extensive bamboo areas (GCA)									
Wet, tall grasslands interspersed with woodland and									
Swamp ('tals') interspersed (TCA)									
Sal plantations (100 yrs old; GCA)									
Extensive plantation on grassland habitats of teak, shisham, and eucalyptus (TCA)									
Young jhum (<10 yrs; GCA)									
Middle jhum (10-20 yrs; GCA)									
Old jhum (>20 yrs; GCA)									
Trophic category	In	Cn	Cn	In	In	Om	Ca	Gr	In
Habitat elements/substrates									
Habitat elements of biotic origin (special habitats)		Oth	Oth						
Snags	F	Oth	Oth		F		F		F
Snag recruits (dying trees, live trees with dead portions)	F	Oth	Oth		F		F		F
Hollow trees, chimney trees (living or dead)		Oth	Oth				B,F		B,F
Tree cavities (natural or created)	B	Oth	Oth				B,F		B,F
Large old trees (living)	F	B	B		B,F	F	F		F
Trees with fluting boles and buttresses	F	Oth	Oth		F				F
Down wood									
Litter and duff layers	F				F			F	
Litter in streams									
Lianas	F				F	B,F	F		
Fruit-bearing shrubs	F								
Fruit bearing trees	F								
Epiphyte patches	F				B,F	B			
Vernacular name	Verditer Flycatcher	White-rumped Vulture	Red-headed Vulture	Streak-throated Swallow	Southern Grey Shrike	Purple Sunbird	Brown Hawk Owl	Baya Weaver	Streak-throated Woodpecker

Scientific name	*Eumyias thalassina*	*Gyps bengalensis*	*Sarcogyps calvus*	*Hirundo fluvicola*	*Lanius meridionalis*	*Nectarinia asiatica*	*Ninox scutulata*	*Ploceus philippinus*	*Picus xanthopygaeus*
Habitat elements of geomorphic origin									
Cliffs, talus, and ledges				B					
Caves				B					
Overhangs				B					
Dens (existing burrows dug by animals)									
Sheet rocks				F					
Large bouldery aggregates				F					
Rock outcrops				F					
Sandy banks and sand spits				F					
Salt licks (exposed mineral soils)									
Earth cuttings									
Man-made (anthropogenic) structures				B		F			
Additional / other (specify)								Marshy areas	
Structural stage									
Early stage		X	X	X	X	X	X	X	
Mid stage	X	X	X	X	X	X	X	X	
Late stage	X			X		X	X		X
Old-growth stage - unmanaged	X			X		X	X		X
Other - unmanaged		X	X	X		X	X	X	
Key ecological functions		Scavenger	Scavenger			A			C
Sensitivity to anthropogenic disturbance	B,D,I,K,S,U							I,X	K,M,S,T,U

Vernacular name	White-throated Fantail	Asian Paradise-Flycatcher	Green Sandpiper	Bonelli's Eagle	Crested Serpent Eagle	Osprey	Eurasian Cuckoo	Indian Cuckoo
Scientific name	*Rhipidura albicollis*	*Terpsiphone paradisi*	*Tringa ochropus*	*Hieraaetus fasciatus*	*Spilornis cheela*	*Pandion haliaetus*	*Cuculus canorus*	*Cuculus micropterus*
Taxonomic class	B	B	B	B	B	B	B	B
Legal Status - Wildlife Protection Act	SIV	SIV	SIV	SI	SI	SI	SIV	SIV
Legal Status - CITES								
Conservation status - IUCN						EN		
Endemism status	No	No	No	No	No	No	No	No
Residency status	P	P	P	P	P	P	P	P
Conservation area	A,S,T,G	A,S,T,G	A,S,T,G	A,S,T,G	A,S,T,G	A,S	A,S,T	A,S,T,G
Abundance / distribution status	B	A	A	B	A	B	B	B
Conflict with humans								
Champion and Seth Forest Types of India (to the group level):								
Southern tropical dry deciduous forests – dry teak forest	2	1	1		2			2
South Indian tropical moist deciduous mixed forests	1	1	1		2		2	2
Riparian fringing forests	1	1	2		2		2	2
Southern tropical dry deciduous forests	2	1	1		2		1	2
Teak plantations (ACA, SCA)	1	1	1		2			2
Boswellia forests	1	1	1		2		1	2
Central Indian subtropical hill forests	2	1	1		2		2	2
Reservoirs (by name, TCA, SCA)								
Southern cutch thorn forests	1	1	1		1			1
Southern tropical moist deciduous forest	1	1	1		2		2	2
Southern moist and wet bamboo brakes	1	1			1		1	1
Southern tropical wet evergreen forests								
Nilgiri sub-tropical evergreen forest								
Southern wet temperate forests (sholas, ACA)								
Wet grassland habitat on hill plateaus (ACA, GCA)								
Rivers (by name, TCA, ACA & GCA)								
Vernacular name	White-throated Fantail	Asian Paradise-Flycatcher	Green Sandpiper	Bonelli's Eagle	Crested Serpent Eagle	Osprey	Eurasian Cuckoo	Indian Cuckoo

Scientific name	*Rhipidura albicollis*	*Terpsiphone paradisi*	*Tringa ochropus*	*Hieraaetus fasciatus*	*Spilornis cheela*	*Pandion haliaetus*	*Cuculus canorus*	*Cuculus micropterus*
Coffee and cardamom (ACA)								
Tea (ACA)								
Wattle (ACA)								
Pinus (ACA)								
Dry savannah forest								
Tropical moist evergreen forest (GCA)								
Tropical semi-evergreen forest (GCA, TCA)								
Tropical moist deciduous forest (GCA, TCA)								
Shola type of mixed evergreen forest (GCA)								
Alluvial sal – kamrup alluvial sal forests								
Foot hill and plateau sal – eastern hill sal								
East Himalayan moist deciduous forests								
Assam alluvial plain semi evergreen forests (GCA)								
Secondary moist bamboo brakes								
Low alluvial savannah woodland (TCA)								
South Indian tropical moist deciduous teak forests								
Dry peninsular sal forests								
Northern tropical semi-evergreen forests								
Canebrakes (TCA)								
Northern Indian tropical moist deciduous forests (TCA)								
Moist Bhabhar sal (TCA)								
Western light plain sal (TCA)								
Western light alluvium plains sal / dry sal forests (TCA)								
Moist sal savannah (TCA)								
Low alluvial savannah woodland								
Barringtonia swamp forests								
Eastern seasonal swamp low forests (Cephalanthus)								
Dry sal forests								
Vernacular name	White-throated Fantail	Asian Paradise-Flycatcher	Green Sandpiper	Bonelli's Eagle	Crested Serpent Eagle	Osprey	Eurasian Cuckoo	Indian Cuckoo

Scientific name	*Rhipidura albicollis*	*Terpsiphone paradisi*	*Tringa ochropus*	*Hieraaetus fasciatus*	*Spilornis cheela*	*Pandion haliaetus*	*Cuculus canorus*	*Cuculus micropterus*
Other, non-Champion and Seth types								
Dry tall grasslands on hill plateaus (SCA)			2		1			
Catchment for tributaries to rivers (by name, SCA, TCA)								
Extensive bamboo areas (GCA)								
Wet, tall grasslands interspersed with woodland								
Swamp ('tals') interspersed (TCA)								
Sal plantations (100 yrs old; GCA)								
Extensive plantation on grassland habitats of teak, shisham, and eucalyptus (TCA)								
Young jhum (<10 yrs; GCA)								
Middle jhum (10-20 yrs; GCA)								
Old jhum (>20 yrs; GCA)								
Trophic category	In	In	Om	Ca	Ca	Pi	In	In
Habitat elements/substrates								
Habitat elements of biotic origin (special habitats)								
Snags								
Snag recruits (dying trees, live trees with dead portions)								
Hollow trees, chimney trees (living or dead)								
Tree cavities (natural or created)								
Large old trees (living)	F							
Trees with fluting boles and buttresses	F							
Down wood								
Litter and duff layers	F							
Litter in streams								
Lianas	F							
Fruit-bearing shrubs	F							
Fruit bearing trees	F							
Epiphyte patches	B,F							
Vernacular name	White-throated Fantail	Asian Paradise-Flycatcher	Green Sandpiper	Bonelli's Eagle	Crested Serpent Eagle	Osprey	Eurasian Cuckoo	Indian Cuckoo

Scientific name	*Rhipidura albicollis*	*Terpsiphone paradisi*	*Tringa ochropus*	*Hieraaetus fasciatus*	*Spilornis cheela*	*Pandion haliaetus*	*Cuculus canorus*	*Cuculus micropterus*
Habitat elements of geomorphic origin								
Cliffs, talus, and ledges								
Caves								
Overhangs								
Dens (existing burrows dug by animals)								
Sheet rocks								
Large bouldery aggregates								
Rock outcrops			F					
Sandy banks and sand spits			F					
Salt licks (exposed mineral soils)								
Earth cuttings								
Man-made (anthropogenic) structures								
Additional / other (specify)			Marshes					
Structural stage								
Early stage		X	X	X	X			X
Mid stage	X	X	X	X	X	X	X	X
Late stage	X	X	X	X	X	X	X	X
Old-growth stage - unmanaged	X	X	X	X	X	X	X	X
Other - unmanaged		X	X	X	X	X	X	X
Key ecological functions								
Sensitivity to anthropogenic disturbance	B,D,I,S,U	B,D,I,R,S,U	E,N,R,AA,DD	E,J,S,T,U,	D,F,G,H,K,S,T,U	E,J,N,AA		

Vernacular name	Pallas's Fish-Eagle	Malabar Whistling Thrush	Thickbilled Flowerpecker	Demoiselle Crane	Black-capped Kingfisher	Dusky Crag Martin	Brown Fish Owl	Oriental Honey Buzzard	Scaly-bellied Woodpecker
Scientific name	*Haliaeetus leucoryphus*	*Myiophonus horsfieldii*	*Dicaeum agile*	*Grus virgo*	*Halcyon pileata*	*Hirundo concolor*	*Ketupa zeylonensis*	*Pernis ptilorhyncus*	*Picus squamatus*
Taxonomic class	B	B	B	B	B	B	B	B	B
Legal Status - Wildlife Protection Act	SIV?	SIV	SIV	SIV	SIV	SIV	SIV	SI	SIV
Legal Status - CITES									
Conservation status - IUCN									
Endemism status	No	ER	No	No	No	No	No	No	No
Residency status	P	P	P	M	P	P	P	P	P
Conservation area	S,T,G	A,S	A,S,T,G	S,T	A	A,S	A,S,T,G	A,S,T,G	A,S,T,G
Abundance / distribution status	B	B	A	C	C	B	B	B	B
Conflict with humans									
Champion and Seth Forest Types of India (to the group level):									
Southern tropical dry deciduous forests – dry teak forest	1	1	1		1	1	1	2	1
South Indian tropical moist deciduous mixed forests	1	1	2		1	1	2	2	1
Riparian fringing forests	2	2	2	1	2		2	2	2
Southern tropical dry deciduous forests	1	1	1		1	1	1	2	1
Teak plantations (ACA, SCA)	1		1			1	1	1	1
Boswellia forests	1		1			1	1	1	1
Central Indian subtropical hill forests	1	2	2			1	2	2	2
Reservoirs (by name, TCA, SCA)	2			1	2		1		
Southern cutch thorn forests	1		1			1	1	1	1
Southern tropical moist deciduous forest	1	1	2		1	1	2	2	2
Southern moist and wet bamboo brakes	1	1					2		1
Southern tropical wet evergreen forests									
Nilgiri sub-tropical evergreen forest									
Southern wet temperate forests (sholas, ACA)									
Wet grassland habitat on hill plateaus (ACA, GCA)									
Rivers (by name, TCA, ACA & GCA)									
Vernacular name	Pallas's Fish-Eagle	Malabar Whistling Thrush	Thickbilled Flowerpecker	Demoiselle Crane	Black-capped Kingfisher	Dusky Crag Martin	Brown Fish Owl	Oriental Honey Buzzard	Scaly-bellied Woodpecker

Scientific name	*Haliaeetus leucoryphus*	*Myiophonus horsfieldii*	*Dicaeum agile*	*Grus virgo*	*Halcyon pileata*	*Hirundo concolor*	*Ketupa zeylonensis*	*Pernis ptilorhyncus*	*Picus squamatus*
Coffee and cardamom (ACA)									
Tea (ACA)									
Wattle (ACA)									
Pinus (ACA)									
Dry savannah forest									
Tropical moist evergreen forest (GCA)									
Tropical semi-evergreen forest (GCA, TCA)									
Tropical moist deciduous forest (GCA, TCA)									
Shola type of mixed evergreen forest (GCA)									
Alluvial sal – kamrup alluvial sal forests									
Foot hill and plateau sal – eastern hill sal									
East Himalayan moist deciduous forests									
Assam alluvial plain semi evergreen forests (GCA)									
Secondary moist bamboo brakes									
Low alluvial savannah woodland (TCA)									
South Indian tropical moist deciduous teak forests									
Dry peninsular sal forests									
Northern tropical semi-evergreen forests									
Canebrakes (TCA)									
Northern Indian tropical moist deciduous forests (TCA)									
Moist Bhabhar sal (TCA)									
Western light plain sal (TCA)									
Western light alluvium plains sal / dry sal forests (TCA)									
Moist sal savannah (TCA)									
Low alluvial savannah woodland									
Barringtonia swamp forests									
Eastern seasonal swamp low forests (Cephalanthus)									
Dry sal forests									
Vernacular name	Pallas's Fish-Eagle	Malabar Whistling Thrush	Thickbilled Flowerpecker	Demoiselle Crane	Black-capped Kingfisher	Dusky Crag Martin	Brown Fish Owl	Oriental Honey Buzzard	Scaly-bellied Woodpecker

Scientific name	*Haliaeetus leucoryphus*	*Myiophonus horsfieldii*	*Dicaeum agile*	*Grus virgo*	*Halcyon pileata*	*Hirundo concolor*	*Ketupa zeylonensis*	*Pernis ptilorhyncus*	*Picus squamatus*
Other, non-Champion and Seth types									
Dry tall grasslands on hill plateaus (SCA)	1	1		1		1			
Catchment for tributaries to rivers (by name, SCA, TCA)	2	2							
Extensive bamboo areas (GCA)									
Wet, tall grasslands interspersed with woodland									
Swamp ('tals') interspersed (TCA)									
Sal plantations (100 yrs old; GCA)									
Extensive plantation on grassland habitats of teak, shisham, and eucalyptus (TCA)									
Young jhum (<10 yrs; GCA)									
Middle jhum (10-20 yrs; GCA)									
Old jhum (>20 yrs; GCA)									
Trophic category	Pi	In	Om	Ca	Pi	In	Ca	Ca	In
Habitat elements/substrates									
Habitat elements of biotic origin (special habitats)									
Snags									
Snag recruits (dying trees, live trees with dead portions)									
Hollow trees, chimney trees (living or dead)									
Tree cavities (natural or created)									
Large old trees (living)									
Trees with fluting boles and buttresses									
Down wood									
Litter and duff layers									
Litter in streams									
Lianas									
Fruit-bearing shrubs									
Fruit bearing trees									
Epiphyte patches									
Vernacular name	Pallas's Fish-Eagle	Malabar Whistling Thrush	Thickbilled Flowerpecker	Demoiselle Crane	Black-capped Kingfisher	Dusky Crag Martin	Brown Fish Owl	Oriental Honey Buzzard	Scaly-bellied Woodpecker

Scientific name	*Haliaeetus leucoryphus*	*Myiophonus horsfieldii*	*Dicaeum agile*	*Grus virgo*	*Halcyon pileata*	*Hirundo concolor*	*Ketupa zeylonensis*	*Pernis ptilorhyncus*	*Picus squamatus*
Habitat elements of geomorphic origin									
Cliffs, talus, and ledges									
Caves									
Overhangs									
Dens (existing burrows dug by animals)									
Sheet rocks									
Large bouldery aggregates									
Rock outcrops									
Sandy banks and sand spits									
Salt licks (exposed mineral soils)									
Earth cuttings									
Man-made (anthropogenic) structures									
Additional / other (specify)									
Structural stage									
Early stage	X		X	X		X	X		
Mid stage	X	X	X			X	X	X	X
Late stage	X	X	X		X	X	X	X	X
Old-growth stage - unmanaged	X	X	X		X	X	X	X	X
Other - unmanaged	X		X			X	X		
Key ecological functions									
Sensitivity to anthropogenic disturbance	E,J,N,AA	B,C,D,E,I,K,R,U,AA		E,J,N,R,X	C,E,I,J,R,AA,BB,EE				

Vernacular name	Indian Scimitar Babbler	Chestnut-fronted Shrike Babbler	Brown Wood Owl	Mottled Wood Owl	Yellow-footed Green Pigeon	Yellow-wattled Lapwing	Great Hornbill	Eurasian Eagle Owl	Eurasian Thick-knee
Scientific name	*Pomatorhinus horsfieldii*	*Pteruthius aenobarbus*	*Strix leptogrammica*	*Strix ocellata*	*Treron phoenicoptera*	*Vanellus malabaricus*	*Buceros bicornis*	*Bubo bubo*	*Burhinus oedicnemus*
Taxonomic class	B	B	B	B	B	B	B	B	B
Legal Status - Wildlife Protection Act	SIV	SIV	SIV	SIV	SIV	SIV	SI	SIV	SIV
Legal Status - CITES									
Conservation status - IUCN							EN		
Endemism status	No	ER	No	No	No	No	No	No	No
Residency status	P	P	P	P	P	P	P	P	P
Conservation area	A,S,T,G	G	A,S,T,G	A,S,T	A,S,T,G	A,S,T	A,S,T	A,S,T,G	A,S,T,G
Abundance / distribution status	B	B	B	B	A	A	C	B	B
Conflict with humans									
Champion and Seth Forest Types of India (to the group level):									
Southern tropical dry deciduous forests – dry teak forest	1		1	2				1	1
South Indian tropical moist deciduous mixed forests	2		1	2				1	
Riparian fringing forests	2		2	2		1		2	
Southern tropical dry deciduous forests	1		1	2		1		1	1
Teak plantations (ACA, SCA)	1		1	2				1	
Boswellia forests	1		1	2				1	1
Central Indian subtropical hill forests	2		1	2				2	
Reservoirs (by name, TCA, SCA)						1			1
Southern cutch thorn forests	1		1	2		1			2
Southern tropical moist deciduous forest	2		2	2				1	
Southern moist and wet bamboo brakes	2		1	2				1	
Southern tropical wet evergreen forests									
Nilgiri sub-tropical evergreen forest									
Southern wet temperate forests (sholas, ACA)									
Wet grassland habitat on hill plateaus (ACA, GCA)									
Rivers (by name, TCA, ACA & GCA)									
Vernacular name	Indian Scimitar Babbler	Chestnut-fronted Shrike Babbler	Brown Wood Owl	Mottled Wood Owl	Yellow-footed Green Pigeon	Yellow-wattled Lapwing	Great Hornbill	Eurasian Eagle Owl	Eurasian Thick-knee

Scientific name	*Pomatorhinus horsfieldii*	*Pteruthius aenobarbus*	*Strix leptogrammica*	*Strix ocellata*	*Treron phoenicoptera*	*Vanellus malabaricus*	*Buceros bicornis*	*Bubo bubo*	*Burhinus oedicnemus*
Coffee and cardamom (ACA)									
Tea (ACA)									
Wattle (ACA)									
Pinus (ACA)									
Dry savannah forest									
Tropical moist evergreen forest (GCA)									
Tropical semi-evergreen forest (GCA, TCA)									
Tropical moist deciduous forest (GCA, TCA)									
Shola type of mixed evergreen forest (GCA)									
Alluvial sal – kamrup alluvial sal forests									
Foot hill and plateau sal – eastern hill sal									
East Himalayan moist deciduous forests									
Assam alluvial plain semi evergreen forests (GCA)									
Secondary moist bamboo brakes									
Low alluvial savannah woodland (TCA)									
South Indian tropical moist deciduous teak forests									
Dry peninsular sal forests									
Northern tropical semi-evergreen forests									
Canebrakes (TCA)									
Northern Indian tropical moist deciduous forests (TCA)									
Moist Bhabhar sal (TCA)									
Western light plain sal (TCA)									
Western light alluvium plains sal / dry sal forests (TCA)									
Moist sal savannah (TCA)									
Low alluvial savannah woodland									
Barringtonia swamp forests									
Eastern seasonal swamp low forests (Cephalanthus)									
Dry sal forests									
Vernacular name	Indian Scimitar Babbler	Chestnut-fronted Shrike Babbler	Brown Wood Owl	Mottled Wood Owl	Yellow-footed Green Pigeon	Yellow-wattled Lapwing	Great Hornbill	Eurasian Eagle Owl	Eurasian Thick-knee

Scientific name	*Pomatorhinus horsfieldii*	*Pteruthius aenobarbus*	*Strix leptogrammica*	*Strix ocellata*	*Treron phoenicoptera*	*Vanellus malabaricus*	*Buceros bicornis*	*Bubo bubo*	*Burhinus oedicnemus*
Other, non-Champion and Seth types									
Dry tall grasslands on hill plateaus (SCA)			1	1		2			1
Catchment for tributaries to rivers (by name, SCA, TCA)									
Extensive bamboo areas (GCA)									
Wet, tall grasslands interspersed with woodland									
Swamp ('tals') interspersed (TCA)									
Sal plantations (100 yrs old; GCA)									
Extensive plantation on grassland habitats of teak, shisham, and eucalyptus (TCA)									
Young jhum (<10 yrs; GCA)									
Middle jhum (10-20 yrs; GCA)									
Old jhum (>20 yrs; GCA)									
Trophic category							Fr		
Habitat elements/substrates									
Habitat elements of biotic origin (special habitats)									
Snags							F		
Snag recruits (dying trees, live trees with dead portions)							F		
Hollow trees, chimney trees (living or dead)							B		
Tree cavities (natural or created)							B		
Large old trees (living)							F		
Trees with fluting boles and buttresses							F		
Down wood									
Litter and duff layers									
Litter in streams									
Lianas							F		
Fruit-bearing shrubs							F		
Fruit bearing trees							F		
Epiphyte patches							F		
Vernacular name	Indian Scimitar Babbler	Chestnut-fronted Shrike Babbler	Brown Wood Owl	Mottled Wood Owl	Yellow-footed Green Pigeon	Yellow-wattled Lapwing	Great Hornbill	Eurasian Eagle Owl	Eurasian Thick-knee

Scientific name	*Pomatorhinus horsfieldi*	*Pteruthius aenobarbus*	*Strix leptogrammica*	*Strix ocellata*	*Treron phoenicoptera*	*Vanellus malabaricus*	*Buceros bicornis*	*Bubo bubo*	*Burhinus oedicnemus*
Habitat elements of geomorphic origin									
Cliffs, talus, and ledges									
Caves									
Overhangs									
Dens (existing burrows dug by animals)									
Sheet rocks									
Large bouldery aggregates									
Rock outcrops									
Sandy banks and sand spits									
Salt licks (exposed mineral soils)									
Earth cuttings									
Man-made (anthropogenic) structures									
Additional / other (specify)									
Structural stage									
Early stage					X	X			
Mid stage	X	?	X	X	X	X			
Late stage	X	?	X	X	X		X		
Old-growth stage - unmanaged	X	?	X	X	X		X		
Other - unmanaged					X				
Key ecological functions							B		
Sensitivity to anthropogenic disturbance	A,B,D,I,K,M,R,S,U					E,I,L,N,R	B,C,F,G,I,K,S,T,U,X,AA		

Vernacular name	Spotted Deer	Sambar	Gaur	Cantro's Leaf-nosed Bat	Short-nosed Fruit Bat	Woolly Horse-shoe Bat	Leopard	Tiger	Flying Fox
Scientific name	*Axis axis*	*Cervus unicolor*	*Bos gaurus*	*Hipposideros galeritus*	*Cynopterus sphinx*	*Rhinolopus luctus*	*Panthera pardus*	*Panthera tigris*	*Pteropus gigantius*
Taxonomic class	M	M	M	M	M	M	M	M	M
Legal Status - Wildlife Protection Act	SIII	SIII	SI	SV	SV	SV	SI	SI	SV
Legal Status - CITES									
Conservation status - IUCN			EN				EN	EN	
Endemism status	No	No	No		No	ER	No	No	No
Residency status	P	P	P	P	P	P	P	P	P
Conservation area	A,S,T,G	A,S,T,G	A,S,G	S	A,S,T,G	S	A,S,T,G	A,S,T,G	A,S,T,G
Abundance / distribution status	A	A	A	D	B	C	B	C	A
Conflict with humans							K,H	K,H	
Champion and Seth Forest Types of India (to the group level):									
Southern tropical dry deciduous forests – dry teak forest	1						2	2	
South Indian tropical moist deciduous mixed forests	1						2	2	
Riparian fringing forests	2						2	2	
Southern tropical dry deciduous forests	1						2	2	
Teak plantations (ACA, SCA)	2						1	1	
Boswellia forests	2						1	1	
Central Indian subtropical hill forests	2						2	2	
Reservoirs (by name, TCA, SCA)	2								
Southern cutch thorn forests	2						2	2	
Southern tropical moist deciduous forest	2						2	2	
Southern moist and wet bamboo brakes	1						2	2	
Southern tropical wet evergreen forests									
Nilgiri sub-tropical evergreen forest	0						2	2	
Southern wet temperate forests (sholas, ACA)	1								
Wet grassland habitat on hill plateaus (ACA, GCA)	1								
Rivers (by name, TCA, ACA & GCA)	0								
Vernacular name	Spotted Deer	Sambar	Gaur	Cantro's Leaf-nosed Bat	Short-nosed Fruit Bat	Woolly Horse-shoe Bat	Leopard	Tiger	Flying Fox

Scientific name	*Axis axis*	*Cervus unicolor*	*Bos gaurus*	*Hipposideros galeritus*	*Cynopterus sphinx*	*Rhinolopus luctus*	*Panthera pardus*	*Panthera tigris*	*Pteropus gigantius*
Coffee and cardamom (ACA)	1								
Tea (ACA)	1								
Wattle (ACA)									
Pinus (ACA)									
Dry savannah forest									
Tropical moist evergreen forest (GCA)									
Tropical semi-evergreen forest (GCA, TCA)									
Tropical moist deciduous forest (GCA, TCA)									
Shola type of mixed evergreen forest (GCA)									
Alluvial sal – kamrup alluvial sal forests									
Foot hill and plateau sal – eastern hill sal									
East Himalayan moist deciduous forests									
Assam alluvial plain semi evergreen forests (GCA)									
Secondary moist bamboo brakes									
Low alluvial savannah woodland (TCA)									
South Indian tropical moist deciduous teak forests									
Dry peninsular sal forests									
Northern tropical semi-evergreen forests									
Canebrakes (TCA)									
Northern Indian tropical moist deciduous forests (TCA)									
Moist Bhabhar sal (TCA)									
Western light plain sal (TCA)									
Western light alluvium plains sal / dry sal forests (TCA)									
Moist sal savannah (TCA)									
Low alluvial savannah woodland									
Barringtonia swamp forests									
Eastern seasonal swamp low forests (Cephalanthus)									
Dry sal forests									
Vernacular name	Spotted Deer	Sambar	Gaur	Cantro's Leaf-nosed Bat	Short-nosed Fruit Bat	Woolly Horse-shoe Bat	Leopard	Tiger	Flying Fox

Scientific name	*Axis axis*	*Cervus unicolor*	*Bos gaurus*	*Hipposideros galeritus*	*Cynopterus sphinx*	*Rhinolopus luctus*	*Panthera pardus*	*Panthera tigris*	*Pteropus gigantius*
Other, non-Champion and Seth types									
Dry tall grasslands on hill plateaus (SCA)							2	2	
Catchment for tributaries to rivers (by name, SCA, TCA)							2	2	
Extensive bamboo areas (GCA)									
Wet, tall grasslands interspersed with woodland									
Swamp ('tals') interspersed (TCA)									
Sal plantations (100 yrs old; GCA)									
Extensive plantation on grassland habitats of teak, shisham, and eucalyptus (TCA)									
Young jhum (<10 yrs; GCA)									
Middle jhum (10-20 yrs; GCA)									
Old jhum (>20 yrs; GCA)									
Trophic category	He	He	He	In	Fr	In	Ca	Ca	Fr
Habitat elements/substrates									
Habitat elements of biotic origin (special habitats)									
Snags			Oth			B			
Snag recruits (dying trees, live trees with dead portions)						B			
Hollow trees, chimney trees (living or dead)			Oth	B,F	B,F	B	B	B	
Tree cavities (natural or created)				B,F	B,F	B	B	B	
Large old trees (living)				F	B,F	F			
Trees with fluting boles and buttresses									
Down wood									
Litter and duff layers	F	F	F						
Litter in streams									
Lianas	F	F	F						
Fruit-bearing shrubs	F	F	F	F	F				
Fruit bearing trees	F	F	F	F	F				
Epiphyte patches									
Vernacular name	Spotted Deer	Sambar	Gaur	Cantro's Leaf-nosed Bat	Short-nosed Fruit Bat	Woolly Horse-shoe Bat	Leopard	Tiger	Flying Fox

Scientific name	*Axis axis*	*Cervus unicolor*	*Bos gaurus*	*Hipposideros galeritus*	*Cynopterus sphinx*	*Rhinolopus luctus*	*Panthera pardus*	*Panthera tigris*	*Pteropus gigantius*
Habitat elements of geomorphic origin									
Cliffs, talus, and ledges				B					
Caves				B	Oth	B	B	B	
Overhangs				B	Oth	B	B	B	
Dens (existing burrows dug by animals)							B	B	
Sheet rocks									
Large bouldery aggregates		Oth	Oth						
Rock outcrops									
Sandy banks and sand spits			Oth						
Salt licks (exposed mineral soils)	F	F	F				F	F	
Earth cuttings									
Man-made (anthropogenic) structures							B,F	B,F	
Additional / other (specify)									
Structural stage									
Early stage	X		X	X	X	X	X	X	
Mid stage	X	X	X	X	X	X	X	X	
Late stage		X	X	X	X	X	X	X	
Old-growth stage - unmanaged		X	X	X	X	X	X	X	
Other - unmanaged			X	X	X	X	X	X	
Key ecological functions	B,H	B,H	B,H		B				
Sensitivity to anthropogenic disturbance	B,E,F,G,I,L,R,X	B,E,F,G,I,L,R,X	B,E,F,G,I,L,R,X	B,I,U	K,M,S,T,U				

Vernacular name	Fulvous Fruit Bat	Indian Chevrotain. Mouse Deer	Four-horned Antelope	Wild Dog	Indian Giant Squirrel	Smooth Coated Otter	Nilgai	Leopard Cat	Rusty Spotted Cat
Scientific name	*Rousettus leschnaultii*	*Tragulus meminna*	*Tetraceros quadricormis*	*Cuon alpinus*	*Ratufa indica*	*Lutra perspicillata*	*Boselaphus tragocamelus*	*Felis bengalensis bengalensis*	*Felis rubiginosa*
Taxonomic class	M	M	M	M	M	M	M	M	M
Legal Status - Wildlife Protection Act	SV	SI	SI	SII	SII	SII	SIII	SI	SI
Legal Status - CITES									
Conservation status - IUCN		EN	EN	Vul	EN	EN			
Endemism status	No	No	No	No	No	No	No	No	No
Residency status	P	P	P	P	P	P	P	P	P
Conservation area	A,S,T,G	A,S	S	A,S,G	A,S	A,S,T,G	S,T,G	A,S,T,G	A
Abundance / distribution status	C	C	B	B	A	C	A	B	C
Conflict with humans							C		
Champion and Seth Forest Types of India (to the group level):									
Southern tropical dry deciduous forests – dry teak forest	2		2	2	1	1	2	1	2
South Indian tropical moist deciduous mixed forests	2	1	1	2	1	1		1	
Riparian fringing forests	2	2		2	2	2	1	1	
Southern tropical dry deciduous forests	2		2	2	1	1	2	1	
Teak plantations (ACA, SCA)	1		1	2	1	1	1	1	
Boswellia forests	1		1	2	1	1	2	1	
Central Indian subtropical hill forests	2	2		2	2	1		1	
Reservoirs (by name, TCA, SCA)						2			
Southern cutch thorn forests			2	2	1		2	1	2
Southern tropical moist deciduous forest		1	1	2	2	1		1	
Southern moist and wet bamboo brakes	2	2		2	1	1	1	1	
Southern tropical wet evergreen forests									
Nilgiri sub-tropical evergreen forest								1	
Southern wet temperate forests (sholas, ACA)									
Wet grassland habitat on hill plateaus (ACA, GCA)								1	
Rivers (by name, TCA, ACA & GCA)									
Vernacular name	Fulvous Fruit Bat	Indian Chevrotain. Mouse Deer	Four-horned Antelope	Wild Dog	Indian Giant Squirrel	Smooth Coated Otter	Nilgai	Leopard Cat	Rusty Spotted Cat

Scientific name	*Rousettus leschnaultii*	*Tragulus meminna*	*Tetraceros quadricornis*	*Cuon alpinus*	*Ratufa indica*	*Lutra perspicillata*	*Boselaphus tragocamelus*	*Felis bengalensis bengalensis*	*Felis rubiginosa*
Coffee and cardamom (ACA)									
Tea (ACA)									
Wattle (ACA)									
Pinus (ACA)									
Dry savannah forest									
Tropical moist evergreen forest (GCA)									
Tropical semi-evergreen forest (GCA, TCA)									
Tropical moist deciduous forest (GCA, TCA)									
Shola type of mixed evergreen forest (GCA)									
Alluvial sal – kamrup alluvial sal forests									
Foot hill and plateau sal – eastern hill sal									
East Himalayan moist deciduous forests									
Assam alluvial plain semi evergreen forests (GCA)									
Secondary moist bamboo brakes									
Low alluvial savannah woodland (TCA)									
South Indian tropical moist deciduous teak forests									2
Dry peninsular sal forests									
Northern tropical semi-evergreen forests									
Canebrakes (TCA)									
Northern Indian tropical moist deciduous forests (TCA)									
Moist Bhabhar sal (TCA)									
Western light plain sal (TCA)									
Western light alluvium plains sal / dry sal forests (TCA)									
Moist sal savannah (TCA)									
Low alluvial savannah woodland									
Barringtonia swamp forests									
Eastern seasonal swamp low forests (Cephalanthus)									
Dry sal forests									
Vernacular name	Fulvous Fruit Bat	Indian Chevrotain. Mouse Deer	Four-horned Antelope	Wild Dog	Indian Giant Squirrel	Smooth Coated Otter	Nilgai	Leopard Cat	Rusty Spotted Cat

Scientific name	*Rousettus leschnaultii*	*Tragulus meminna*	*Tetraceros quadricornis*	*Cuon alpinus*	*Ratufa indica*	*Lutra perspicillata*	*Boselaphus tragocamelus*	*Felis bengalensis bengalensis*	*Felis rubiginosa*
Other, non-Champion and Seth types									
Dry tall grasslands on hill plateaus (SCA)	1		2	2			2		
Catchment for tributaries to rivers (by name, SCA, TCA)						2			
Extensive bamboo areas (GCA)									
Wet, tall grasslands interspersed with woodland									
Swamp ('tals') interspersed (TCA)									
Sal plantations (100 yrs old; GCA)									
Extensive plantation on grassland habitats of teak, shisham, and eucalyptus (TCA)									
Young jhum (<10 yrs; GCA)									
Middle jhum (10-20 yrs; GCA)									
Old jhum (>20 yrs; GCA)									
Trophic category	Fr	He	He	Ca	He			Ca	Ca
Habitat elements/substrates									
Habitat elements of biotic origin (special habitats)									
Snags									
Snag recruits (dying trees, live trees with dead portions)									
Hollow trees, chimney trees (living or dead)								B	
Tree cavities (natural or created)								B	
Large old trees (living)									
Trees with fluting boles and buttresses									
Down wood									
Litter and duff layers									
Litter in streams									
Lianas									
Fruit-bearing shrubs									
Fruit bearing trees									
Epiphyte patches									
Vernacular name	Fulvous Fruit Bat	Indian Chevrotain. Mouse Deer	Four-horned Antelope	Wild Dog	Indian Giant Squirrel	Smooth Coated Otter	Nilgai	Leopard Cat	Rusty Spotted Cat

Scientific name	*Rousettus leschnaultii*	*Tragulus meminna*	*Tetraceros quadricornis*	*Cuon alpinus*	*Ratufa indica*	*Lutra perspicillata*	*Boselaphus tragocamelus*	*Felis bengalensis bengalensis*	*Felis rubiginosa*
Habitat elements of geomorphic origin									
Cliffs, talus, and ledges									
Caves									
Overhangs									
Dens (existing burrows dug by animals)									
Sheet rocks									
Large bouldery aggregates									
Rock outcrops									
Sandy banks and sand spits									
Salt licks (exposed mineral soils)									
Earth cuttings									
Man-made (anthropogenic) structures									
Additional / other (specify)									
Structural stage									
Early stage									X
Mid stage									X
Late stage								X	
Old-growth stage - unmanaged								X	
Other - unmanaged									
Key ecological functions									
Sensitivity to anthropogenic disturbance								X	X

Vernacular name	Hyena	Indian Porcupine	Large Brown Flying Squirrel	Wild Pig	Small Indian Civet	Golden Cat	Honey Badger or Ratel	Indian/Great False Vampire Bat	Sloth bear
Scientific name	*Hyaena hyaena*	*Hystrix indica*	*Petaurista petaurista*	*Sus scrofa*	*Viverricula indica*	*Felis temmincki*	*Mellivora capensis*	*Megaderma lyra*	*Melursus urcinus*
Taxonomic class	M	M	M	M	M	M	M	M	M
Legal Status - Wildlife Protection Act	SIII	SIV	SII		SII	SI	SI	SV	SI
Legal Status - CITES									
Conservation status - IUCN							EN		EN
Endemism status	No	No	No	No	No	No	No	No	No
Residency status	P	P	P	P	P	P	P	P	P
Conservation area	A,S	A,S,T,G		A,S,TG	A,S,T,G	G	A,S,T	A,S,T,G	A,S,T
Abundance / distribution status	C	A	C	A	A	D	C	B	B
Conflict with humans		C							
Champion and Seth Forest Types of India (to the group level):									
Southern tropical dry deciduous forests – dry teak forest	1	2		2	1	?	2	2	2
South Indian tropical moist deciduous mixed forests		2		2	1	?	1	2	2
Riparian fringing forests		2		2		?	1	2	2
Southern tropical dry deciduous forests	1	2		2	2	?	2	2	2
Teak plantations (ACA, SCA)	1	2		2	1	?	1	2	2
Boswellia forests		2		2	1	?		2	2
Central Indian subtropical hill forests	1	2		2		?	1	2	2
Reservoirs (by name, TCA, SCA)		0				?			
Southern cutch thorn forests	1	2		2	2	?	2	2	2
Southern tropical moist deciduous forest		2		2		?	1	2	2
Southern moist and wet bamboo brakes		2		2	2	?	1	2	1
Southern tropical wet evergreen forests									
Nilgiri sub-tropical evergreen forest		2		2	2	?			
Southern wet temperate forests (sholas, ACA)		2		2	2	?			
Wet grassland habitat on hill plateaus (ACA, GCA)		2		2	2	?			
Rivers (by name, TCA, ACA & GCA)		2							
Vernacular name	Hyena	Indian Porcupine	Large Brown Flying Squirrel	Wild Pig	Small Indian Civet	Golden Cat	Honey Badger or Ratel	Indian/Great False Vampire Bat	Sloth bear

Scientific name	*Hyaena hyaena*	*Hystrix indica*	*Petaurista petaurista*	*Sus scrofa*	*Viverricula indica*	*Felis temmincki*	*Mellivora capensis*	*Megaderma lyra*	*Melursus urcinus*
Coffee and cardamom (ACA)		2							
Tea (ACA)		2							
Wattle (ACA)		2							
Pinus (ACA)		2							
Dry savannah forest	1	2							
Tropical moist evergreen forest (GCA)									
Tropical semi-evergreen forest (GCA, TCA)									
Tropical moist deciduous forest (GCA, TCA)									
Shola type of mixed evergreen forest (GCA)									
Alluvial sal – kamrup alluvial sal forests									
Foot hill and plateau sal – eastern hill sal									
East Himalayan moist deciduous forests									
Assam alluvial plain semi evergreen forests (GCA)									
Secondary moist bamboo brakes									
Low alluvial savannah woodland (TCA)									
South Indian tropical moist deciduous teak forests							1		
Dry peninsular sal forests									
Northern tropical semi-evergreen forests									
Canebrakes (TCA)									
Northern Indian tropical moist deciduous forests (TCA)									
Moist Bhabhar sal (TCA)									
Western light plain sal (TCA)									
Western light alluvium plains sal / dry sal forests (TCA)									
Moist sal savannah (TCA)									
Low alluvial savannah woodland									
Barringtonia swamp forests									
Eastern seasonal swamp low forests (Cephalanthus)									
Dry sal forests									
Vernacular name	Hyena	Indian Porcupine	Large Brown Flying Squirrel	Wild Pig	Small Indian Civet	Golden Cat	Honey Badger or Ratel	Indian/Great False Vampire Bat	Sloth bear

Scientific name	*Hyaena hyaena*	*Hystrix indica*	*Petaurista petaurista*	*Sus scrofa*	*Viverricula indica*	*Felis temmincki*	*Mellivora capensis*	*Megaderma lyra*	*Melursus urcinus*
Other, non-Champion and Seth types									
Dry tall grasslands on hill plateaus (SCA)	1	2		1				1	1
Catchment for tributaries to rivers (by name, SCA, TCA)		2							
Extensive bamboo areas (GCA)									
Wet, tall grasslands interspersed with woodland									
Swamp ('tals') interspersed (TCA)									
Sal plantations (100 yrs old; GCA)									
Extensive plantation on grassland habitats of teak, shisham, and eucalyptus (TCA)									
Young jhum (<10 yrs; GCA)									
Middle jhum (10-20 yrs; GCA)									
Old jhum (>20 yrs; GCA)									
Trophic category	Ca		He	Om	Om	Ca	Om	Ca	Om
Habitat elements/substrates									
Habitat elements of biotic origin (special habitats)									
Snags									
Snag recruits (dying trees, live trees with dead portions)									
Hollow trees, chimney trees (living or dead)						B			
Tree cavities (natural or created)		B				B			
Large old trees (living)									
Trees with fluting boles and buttresses									
Down wood		F		F					
Litter and duff layers				F					
Litter in streams									
Lianas				F			F		
Fruit-bearing shrubs		F		F			F		
Fruit bearing trees				F			F		
Epiphyte patches									
Vernacular name	Hyena	Indian Porcupine	Large Brown Flying Squirrel	Wild Pig	Small Indian Civet	Golden Cat	Honey Badger or Ratel	Indian/Great False Vampire Bat	Sloth bear

Scientific name	*Hyaena hyaena*	*Hystrix indica*	*Petaurista petaurista*	*Sus scrofa*	*Viverricula indica*	*Felis temmincki*	*Mellivora capensis*	*Megaderma lyra*	*Melursus urcinus*
Habitat elements of geomorphic origin									
Cliffs, talus, and ledges					B				
Caves		B			B	B			
Overhangs		B			B	B			
Dens (existing burrows dug by animals)		B			B	B			
Sheet rocks					B				
Large bouldery aggregates		B			F				
Rock outcrops		B			B				
Sandy banks and sand spits		B							
Salt licks (exposed mineral soils)				F					
Earth cuttings		B							
Man-made (anthropogenic) structures									
Additional / other (specify)				Swampy areas					
Structural stage									
Early stage		X		X	X		X		
Mid stage		X		X	X		X		
Late stage		X		X	X		X		
Old-growth stage - unmanaged		X		X	X		X		
Other - unmanaged		X			X		X		
Key ecological functions		D		E,F,G					
Sensitivity to anthropogenic disturbance					B,C,D,F,G,H,J,K,M,R,U,V,Z,BB				

Vernacular name	Indian Pangolin	Barking Deer	Marsh Crocodile	Indian Rock Python	Brahminy Terrapin	Peninsular Mud Turtle	Indian Pond Terrapin	Common Indian Monitor	Indian Chameleon
Scientific name	*Manis crassicaudata*	*Muntiacus muntjak*	*Crocodilus palustris*	*Python molursus*	*Hardella thurgii*	*Lessimys punctata granosa*	*Melanochelys trijuga*	*Varanus benghalensis*	*Chamaeleon zeylanicus*
Taxonomic class	M	M	R	R	R	R	R	R	R
Legal Status - Wildlife Protection Act	SI	SIII	SI	SI				SIII	SII
Legal Status - CITES									
Conservation status - IUCN									
Endemism status	No	No	No	No			No	No	No
Residency status	P	P	P	P			P	P	P
Conservation area	A,S,T,G	A,S,T,G	A,S,T,G	A,S,T,G		S			
Abundance / distribution status	B	B	C	A		C	A	A	B
Conflict with humans									
Champion and Seth Forest Types of India (to the group level):									
Southern tropical dry deciduous forests – dry teak forest	2	2	1	2					
South Indian tropical moist deciduous mixed forests	2	2	1	2					
Riparian fringing forests	2	2	2	2					
Southern tropical dry deciduous forests	2	2	1	2					
Teak plantations (ACA, SCA)	2	1	1	2					
Boswellia forests	2		1	2					
Central Indian subtropical hill forests	2	2	1	2					
Reservoirs (by name, TCA, SCA)			2						
Southern cutch thorn forests	2	1	1	2					
Southern tropical moist deciduous forest	2	2	1	2					
Southern moist and wet bamboo brakes	2		1	2					
Southern tropical wet evergreen forests									
Nilgiri sub-tropical evergreen forest		2							
Southern wet temperate forests (sholas, ACA)		2							
Wet grassland habitat on hill plateaus (ACA, GCA)		1							
Rivers (by name, TCA, ACA & GCA)									
Vernacular name	Indian Pangolin	Barking Deer	Marsh Crocodile	Indian Rock Python	Brahminy Terrapin	Peninsular Mud Turtle	Indian Pond Terrapin	Common Indian Monitor	Indian Chameleon

Scientific name	*Manis crassicaudata*	*Muntiacus muntjak*	*Crocodilus palustris*	*Python molursus*	*Hardella thurgii*	*Lessimys punctata granosa*	*Melanochelys trijuga*	*Varanus benghalensis*	*Chamaeleon zeylanicus*
Coffee and cardamom (ACA)									
Tea (ACA)									
Wattle (ACA)									
Pinus (ACA)									
Dry savannah forest									
Tropical moist evergreen forest (GCA)									
Tropical semi-evergreen forest (GCA, TCA)									
Tropical moist deciduous forest (GCA, TCA)									
Shola type of mixed evergreen forest (GCA)									
Alluvial sal – kamrup alluvial sal forests									
Foot hill and plateau sal – eastern hill sal									
East Himalayan moist deciduous forests									
Assam alluvial plain semi evergreen forests (GCA)									
Secondary moist bamboo brakes									
Low alluvial savannah woodland (TCA)									
South Indian tropical moist deciduous teak forests									
Dry peninsular sal forests									
Northern tropical semi-evergreen forests									
Canebrakes (TCA)									
Northern Indian tropical moist deciduous forests (TCA)									
Moist Bhabhar sal (TCA)									
Western light plain sal (TCA)									
Western light alluvium plains sal / dry sal forests (TCA)									
Moist sal savannah (TCA)									
Low alluvial savannah woodland									
Barringtonia swamp forests									
Eastern seasonal swamp low forests (Cephalanthus)									
Dry sal forests									
Vernacular name	Indian Pangolin	Barking Deer	Marsh Crocodile	Indian Rock Python	Brahminy Terrapin	Peninsular Mud Turtle	Indian Pond Terrapin	Common Indian Monitor	Indian Chameleon

Scientific name	*Manis crassicaudata*	*Muntiacus muntjak*	*Crocodilus palustris*	*Python molursus*	*Hardella thurgii*	*Lessimys punctata granosa*	*Melanochelys trijuga*	*Varanus benghalensis*	*Chamaeleon zeylanicus*
Other, non-Champion and Seth types									
Dry tall grasslands on hill plateaus (SCA)	2								
Catchment for tributaries to rivers (by name, SCA, TCA)									
Extensive bamboo areas (GCA)									
Wet, tall grasslands interspersed with woodland									
Swamp ('tals') interspersed (TCA)									
Sal plantations (100 yrs old; GCA)									
Extensive plantation on grassland habitats of teak, shisham, and eucalyptus (TCA)									
Young jhum (<10 yrs; GCA)									
Middle jhum (10-20 yrs; GCA)									
Old jhum (>20 yrs; GCA)									
Trophic category		He						Om	
Habitat elements/substrates									
Habitat elements of biotic origin (special habitats)									
Snags									
Snag recruits (dying trees, live trees with dead portions)									
Hollow trees, chimney trees (living or dead)		B							
Tree cavities (natural or created)		B							
Large old trees (living)		F							
Trees with fluting boles and buttresses									
Down wood		B							
Litter and duff layers		F							
Litter in streams									
Lianas									
Fruit-bearing shrubs		F							
Fruit bearing trees		F							
Epiphyte patches									
Vernacular name	Indian Pangolin	Barking Deer	Marsh Crocodile	Indian Rock Python	Brahminy Terrapin	Peninsular Mud Turtle	Indian Pond Terrapin	Common Indian Monitor	Indian Chameleon

Scientific name	*Manis crassicaudata*	*Muntiacus muntjak*	*Crocodilus palustris*	*Python molursus*	*Hardella thurgii*	*Lessimys punctata granosa*	*Melanochelys trijuga*	*Varanus benghalensis*	*Chamaeleon zeylanicus*
Habitat elements of geomorphic origin									
Cliffs, talus, and ledges									
Caves									
Overhangs									
Dens (existing burrows dug by animals)									
Sheet rocks									
Large bouldery aggregates									
Rock outcrops									
Sandy banks and sand spits									
Salt licks (exposed mineral soils)									
Earth cuttings									
Man-made (anthropogenic) structures									
Additional / other (specify)									
Structural stage									
Early stage									
Mid stage		X							
Late stage		X							X
Old-growth stage - unmanaged		X							X
Other - unmanaged									X
Key ecological functions		G							
Sensitivity to anthropogenic disturbance		B,C,D,F,G,H,I,K,L,M,O,R,U,X,BB,EE							

Chapter 4

Social and Economic Situation

Introduction:

To study the socio- economics pattern of the area and to assess the dependencies of the people and the biotic pressures on the resource, two type of approaches were resorted to,

a. Extensive Study
b. Intensive study

The traditions, customs and pattern of life style of local tribal people in an around SCA is more or less same in the entire sudy area. Dependencies of the local population on the forestry resources is also more or less same.

Since the Forest Department of Madhya Pradesh is already involved with lots of socio economic activites in a planned manner under the Madhya Pradesh Forestry Project it was not necessary to collect data and suggest strategies for issues like Eco development, Joint Forest Managemenmt etc. As regards the Maharashtra component, i.e. for the Melghat Tiger Reserve and surrounding Managed Forests activities related to socio economic development have been undertaken under the Project Tiger and various socio economic schemes of the Revenue Department. The activities related to Project Tiger have already been elucidated in Chapter I and Economic Development Model (Pardesi, 1992) may be found at the end of this Chapter.

4.1 Extensive Study Area:

The overall situation has been described as an overview of needs and dependencies of the local people as regards Betul and Hoshangabad district for which secondary information of the Forest and the Revenue Department has been used.

4.1.1 The existing situation in the zone of influence (ZI)

The Zone of Influence may be categorized into three, depending on the severity of disturbance:

First Order : Amongst the protected areas depending on the disturbance gradient and disturbance from within the Protected Area

Second Order : Between the Protected Area and the Managed Forests

Third Order : Between the Protected Areas and Managed Forest on one side vis-à-vis human habitations which exert tremendous biotic pressure on the resources.

The Satpura Conservation Area is one of the largest contigous patches of forest extending from the west Melghat forest division in the south-west to the remnant forest division of Hoshangabad. In this entire area of around 15, 500 sq. kms. every management category is represented. It has a well protected Bori Wildlife Sanctuary and Satpura National Park and a disturbed Pachmarhi Wildlife Sanctuary. Flanked between the well protected Melghat Tiger Reserve in the south west and the BSP PA Complex in the north, there are three Managed Forests with varying disturbance regimes. There is a proposed Rampur-Bhatori Wildlife Sanctuary which houses a very good habitat for wild animals but has lots of corporation activities going on (**Plate 1**). The managed forest area in the north, west and south Betul division are highly fragmented and the south division has most of the area as non-forest except for the forest in Sawalmendha, Bhainsdehi and Athner range. Starting from the north

the remnant division of Hoshangabad is just a small strip ranging from 5 to 40 km. after the Bori and Pachmarhi Sanctuaries and Satpura National Park were carved out from Hoshangabad District. The fragmentation status of entire Satpura Conservation Area indicates various biotic interference regimes operating in the area (**Plate 43**). The Hoshangabad Forest Division is subjected to two kinds of Zone of Influences.

1. The influence it has over the BSP PA complex - Biotic pressure by way of illegal grazing, illicit cutting, management and silivicultural practices, frequent fires, timber harvesting, firewood collection and NTFP collection.

2. The influence on the Hoshangabad Managed Forest Division - By way of man-animal conflict, crop depredation and cattle lifting since they are contiguous areas.

The situation is such, that the local people go upto the extent of saying that the problems faced by them in the Managed Forest areas are due to the close vicinity of BSP Protected Area complex or rather due to these being carved out of the forest area of Hoshangabad District.

The other critical zone of influence is the five km strip of non- forested area where habitations are spread out to the north of the remnant Hoshangabad Division. The villages in this 5 Km strip ranges from 200 to 250, which include small and large villages and townships. The dot locations in the village Map of Satpura Conservation Area gives an idea of the kind of influence that the habitations inside the Managed Forests might be imposing on the Managed Forest Division (**Plate 46** and **47**). There is heavy pressure for timber and fuelwood leading to illicit cutting. The other dependencies are livestock grazing, NTFP, honey and gum collection.

Within the BSP PA Complex the zone of influence extends along the Tawa reservoir where the villagers from across do extensive farming in the draw down areas and the cattle cross over to the Bori Sanctuary and graze thus getting into direct confrontation with wild animals. The Pachmarhi plateau adversely influences its surrounds namely the Satpura National Park and the Pachmarhi Sanctuary. Some of these influences are as below:

- Pollution of the Nagdwari and the Denwa River by way of polluted streams which drain down into these rivers.
- Excessive tourism development on the plateau has drastically disturbed the surrounding ecosystem.
- Heavy biotic disturbance of all kinds by way of pilgrimage to Chauragad and Mahadev.
- Removal of plant material by educational and research groups.

The Churna village in Bori Sanctuary has considerable influence on the surrounding wildlife habitat by way of grazing. Cattle from the other surrounding villages also graze in the sanctuary area. The local people are also involved in NTFP and Tendu leaves collection without valid permission. The villagers during the tendu season collect tendu leaves from the adjoining managed forest and intentionally stray into the sanctuary area, which leads to considerable amount of disturbance.

Along the eastern boundary of the Pachmarhi WLS and the north and south Betul Divisions there is a zone of influence in the form of Chindwara Managed Forest Division. It is again a disturbance to the Protected Areas resulting from all the forestry operations being carried out, although these are as per the prescriptions laid down in the Working Plans. The other adverse influences are by way of human inflicted disturbances like frequent fires, illicit cutting, grazing and poaching. But it is also pertinent to mention here that the Chindwara forests acts as a buffer in protecting the wildlife habitats in the PAs from more serious and severe disturbance.

A typical ZI exists at the confluence of the boundaries of the North Betul Managed Forests Division and Bori WLS, where lies sandwitched the proposed Rampur-Bhatouri WLS, which is under control of the Forest Development Corporation currently and is highly disturbed on account of felling and lumbering activities. Although the fellings are carried as per prescribed norms, the activities significantly contribute in disturbing the prime wildlife habitat. The activities also have a disturbing effect on the Bori WLS in the north. Once this area gets notified as a Wildlife Sanctuary the secenario may change (**Plate 44)**. The Protected and Reserved Forests in the Betul District are shown in **(Plate 45**).

Another zone of influence affecting the managed forest areas in the North Betul Division is the area surrounding the townships Sarni, Barbat pur and Amla (which are also Forest Ranges) amongst which the adverse influence of the Sarni range is more as compared to the other two since there is lot of mining activity going on. So also Amla township is highly disturbing since there is no backup forest area south of Amla to cater to various dependencies. In case of Barbatpur township, the biotic disturbance is moderate as compared to these two townships (**Plate 44**).

The most critical zone of influence which affects adversely is in the South Betul Managed Forest Division, which is also considered to be biotically the most disturbed. On the northern side there is a huge expanse of revenue area intermixed with varied landuses including highly fragmented Protected Forests, agriculture, scrublands and wastelands subjected to varying disturbance regimes and heavy dependency on the forestry resource in terms of timber and firewood. The Tapti and the Multai Forest Ranges are highly fragmented with sprinkles of Reserved and Protected Forests, which are highly degraded. The eastern fringe of the Bhainsdehi Range exerts extensive biotic pressure on the managed forest areas to the west. The western side is well secured on account of a common boundary with the Melghat Tiger Reserve. The southern boundary of the south Betul Managed Forests Division also forms the interstate boundary with Maharashtra. This is one of the most critical ZI because there is absolutely no forest in the adjoining Maharashtra area which shares a common boundary with Athner and Sawalmendha Range.

As regards the Melghat Tiger Reserve, a 10 Km. belt along the periphery is critically influencing the Managed Forest Divisions viz the south, east and west Melghat and the Gugamal National Park and the Melghat Sanctuary. Especially there are heavy dependencies on the managed forest areas. The tribal population in and around these areas is totally dependent on the forests for small timber, fuelwood and are also involved in NTFP collection.

There is a huge and extensive network of roads (metalled, unmetalled roads, forest roads etc.) in the south Betul division followed by lesser intensity in the west Betul and the north Betul Divisions. This again indicates that the south, west and north Betul Divisions are the most disturbed, moderately disturbed and least disturbed areas respectively. There is a low network of roads in the Satpura PA Complex and the Melghat Tiger Reserve. Here is an indication that the State Forest Department does not want extensive development of road network for reasons of protection (**Plate 42, 48** and **49**). The statistics of the roads has been given in Chapter V in this volume.

A look at the road map indicates very small roadless area in case of Managed Forests. As regards the roads passing through Reserved Forests in the Managed Forest Division and Protected Areas, a distance of 100, 200, 300m may be considered as highly disturbing, moderately disturbing and less disturbing zones as far as disturbance to wild animals is concerned. However, the intensity of disturbance will vary depending upon the type of the road. The disturbance zone may also differ from Protected Areas to Managed Forests.

4.2 An overview of dependencies in Betul and Hoshangabad Districts

In order to analyse the dependencies and various kinds of pressures to which the study area might have been subjected to, some statistical trends like landuse over the last 15 years, livestock population over the last 20 years, human population over the last 90 years for Betul and Hooshangabad District was obtained from the revenue records and the same is reproduced in Tables 7, 8, 9 and 10. It can be seen from Table 7 that there has been a drastic decline in the forest area between 1985-86 and 1995-96 both in the case of Betul and Hoshangabad District. There has also been a decline in grazing land available for cattle in both the Districts. There has been a steady increase in the livestock population namely bulls and cows, buffoloes, sheep, goats and other categories from 1970-71 to 1995-96 in case of Betul District. In case of Hoshangabad District there has been an increase in the number of bulls and cows but a decrease in the number of buffoloes, sheeps, goats and other categories between 1992-93 to 1997-98 (Table 8 and Fig 24). This might be the result of majority of the area being under Protected Area Network with a very small area left out in the form of Hoshangabad Division for grazing. Compared to the cattle population the Veterinary Services are highly insufficient (Table 8, 11 and 12). The total number of animals sterilized and vaccinated is very low as compared to the prevailing livestock population. This also indicates more chances of transmission of diseases to the wild herbivores in the Managed Forests and the Protected Areas since the resources are being shared both by the domestic cattle and wild herbivores.

In case of Betul District the human population has increased four times over the last 90 years which is an indicator of increasing pressure and demand on the natural resources. In case of Hoshangabad District the increase in population has been gradual. The population has increased 2.7 times over the last 90 years (Table 9, 10 and Fig 23). In three major tehsils the growth in Urban Population is more than Rural Population in Betul District (Fig 21). The comparable population trends between rural and total population according to 1991 census shows almost a similar ratio in most of the tehsils of Betul District except for Betul and Multai (Fig 22). As regards comparison of rural and total population of Betul spread over three census periods between 1971 and

Table 7. Landuse as per Revenue Records in Betul and Hoshangabad Districts (in Hectares)

Betul				
Year	Forest	Non Agricultural	Grazing land	Agricultural
1985-86	405396	72338	20185	43764
1989-90	395095	71250	26344	46666
1995-96	115557	72093	7976	521500
Hoshangabad				
Year	Forests	Non Agriculture	Grazing land	Agriculture
1992-93	106000	120528	26311	673224
1994-95	106101	121980	24345	706493
1997-98	77191	78059	157414	71342

1981 indicates a progressive but steady growth of rural population as compared to total population (Fig 25).

The dependency of people on the forest has been increasing manifold as regards demand for timber, fuel wood, NTFP, and areas for livestock grazing,

Table 8. Live stock Population in Betul and Hoshangabad Districts

Betul					
Year	Bulls and cow	Buffaloes	Sheep	Goats	others
1970-71	479255	59988	4865	91552	6933
1976-77	521350	80411	12935	129955	8656
1981-82	550036	85331	3494	136638	11565
1985-86	513393	86292	5740	121468	9746
1992-93	573589	113767	7909	139476	11240
1995-96	522459	100616	7520	124368	10638
Hoshangabad Livestock Populations					
Year	Cow and Bulls	Buffaloes	Sheep	Goat	Others
1992-93	206116	136579	640	95832	5801
1995-96	182900	113461	2983	91778	4696
1997-98	358437	101185	555	69012	4756

Table 9. Human Population and Density for Betul District

Year	Betul Human Population	Density
1901	287807	29
1911	390386	39
1921	363737	36
1931	406262	40
1941	438382	44
1951	451655	45
1961	560412	56
1971	736196	73
1981	925387	92
1991	1181501	118

Table 10. Human Population and Density for Hoshangabad District

Hoshangabad Human Population		
Year	Human Population	Density
1901	459680	46
1911	472416	47
1921	458536	46
1931	502145	50
1941	502951	50
1951	508782	51
1961	616293	62
1971	88580	80
1981	1003939	100
1991	1267211	126

Table 11. Veterinary Services Status in Betul

Year	Hospitals	Dispensary	Animals Treated	Sterilization	Vaccinated
1970-71	11	25	62865	4642	122263
1976-77	11	25	131788	4950	165535
1981-82	14	30	175750	6781	215108
1991-92	18	57	180292	3632	974785
1995-96	19	48	194194	11087	592482

Table 12. Veterinary Services Status 1998 in Hoshangabad

Hoshangabad Veterinary Services Status					
Hospitals	Dispensaries	Dispensaries	Animals Treated	Steralised	Inoculated
14	27	11	3976	7345	6043

which has lead to shrinkage and degradation of forests. The pressure is also in terms of encroachments on forest lands, illicit cutting, and poaching

4.3 Genesis of people oriented management in Madhya Pradesh

The Madhya Pradesh Forestry Project financially aided by the World Bank (IDA) has become effective from 29th September, 1995. The Project, with a total outlay of Rs.795 crores, was to be implemented in two phases of four and five years duration respectively. The first phase of four years have an investment of approximate Rs.246 crores equivalent to US $ 67.3 million.

The main beneficiaries of the Project include forest fringe dwellers, a major proportion of whom are tribal people belonging to the poorest sections of the society. The Project incorporates specific measures to safeguard the interests of both landless and women, through participation in Village Forest Committees (VFCs), employment preference, and gender sensitive monitoring.

4.3.1 Project Objective

The main objective of the Project is to assist the Government of Madhya Pradesh (GOMP) strategy for the development of the forestry sector in the State which is in accordance with the National Forest Policy 1988. More specifically the objectives are:

- to ensure environmental stability and maintain ecological balance.
- to conserve the national biological heritage.
- to increase substantially the forest and tree cover in forest and farm lands
- to increase the productivity of forests and trees.
- taking special account of the interests of tribal people and other disadvantaged groups.

4.3.2 Project Design

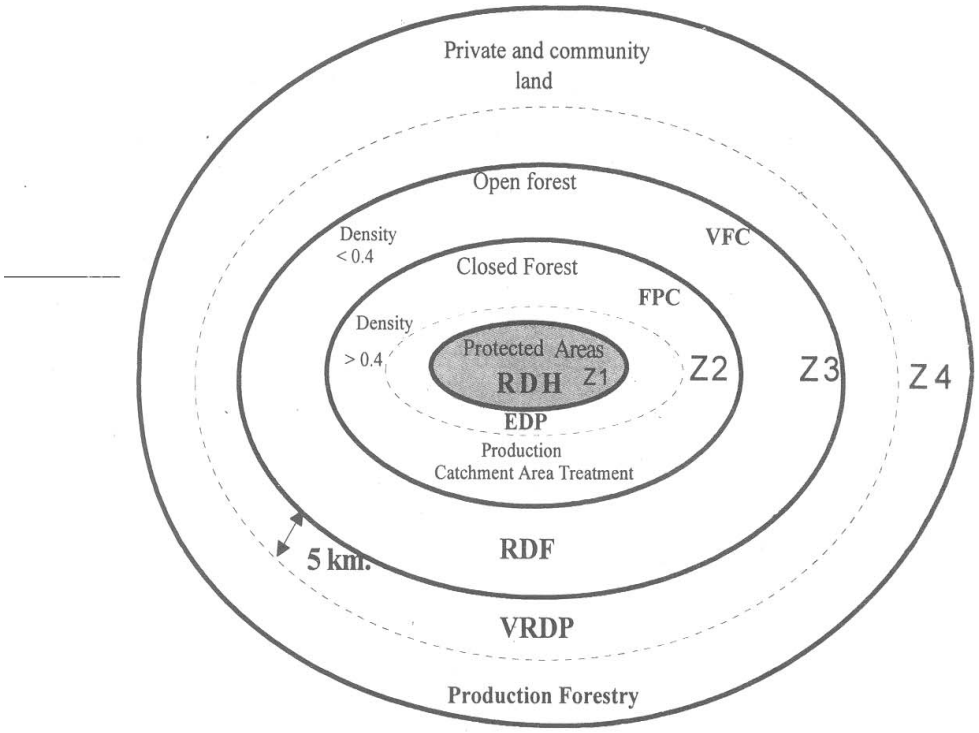
In order to facilitate the desired changes in sector management in a gradual and steady manner, the Project is divided into two phases. The first phase of four years is described below. Approval for the second phase of the Project would be sought during

the last year of implementation of the first phase. This flexibility in the design of the Project has been provided to leave scope for modification in the process, systems and skills required for implementation of the National Forest Policy 1988, in the light of experience gained in the first phase.

4.3.3 The Strategy

The new strategy adopted by the Madhya Pradesh Forest Department (MPFD) involved changes in the sectoral policy framework. This would focus on creating a market oriented environment and an appropriate legislative and administrative framework for increasing participatory management of forest resources in which communities are treated as partners in the management of these resources.

This strategy is built on the concept of forest zoning which is based on an understanding of the expected land use and a realistic assessment of what is technically feasible in light of the site specific capability of land and incentive structure.



Z1 - Protected Areas (National Parks and Wildlife Sanctuaries)
Z2 - Closed Forests outside the P.A. (Density > 0.4)
Z3 - Open Forests (Density < 0.4)
Z4 - Private and Community Land

RDH - Rehabilitation of Degraded Habitat
RDF - Rehabilitation of Degraded Forests
VFC - Village Forest Committee
FPC - Forest Protection Committee
VRDP- Village Resource Development Programme
EDP - Eco Development Programme

Diagram 6 : Forest Zonation

The Strategy encompassed implementation of programmes related to the above mentioned concept of forest zonation. A summary of primary management objectives for different zones is as follows:

- Development of human resources and skills to enable staff to implement the new system.

The Project would assist these changes by providing for an intensive programme of orientation

Table 13. Primary Management objectives for different zones

Area	Primary management objective
1. **Conservation Areas**	Conservation of biodiversity
2. **Closed Forest** Crown density More than 0.4	(i) Maintenance of forest cover. Enrichment of stocking by augmenting natural regeneration to eventually increased production. (ii) Timber and NTFP production.
3. **Open Forests** Crown density less than 0.4	(i) Increase in forest cover (ii) Production of local community requirements
4. **Farm and community Forestry**	Encouraging commercial forestry and involvement of forest based industries.
5. **Development of village common (non-forest) lands in fringe areas**	Increased production to meet local needs and to reduce dependence on Government forests.

4.3.4 Project Components

The Project has four main components:

- Management Development,
- Forest Development,
- Research & Extension, and
- Biodiversity Conservation.

1. Management Development

The strategy for the future development of the forestry sector in M.P. requires significant changes in sector management with thrust on:

- A change in approach and vision of MPFD for institutionalizing participatory forest management;
- Development of new management systems to implement the new role of MPFD, based on support rather than command structures;

workshops and staff training. Changes in the management system would aim to make the system client oriented and adaptable i.e. designed to respond to the needs of the users of the forest resources. The Department has already entered into a contract agreement for consultancy to assist MPFD to review existing management procedures and institutional structures, and to develop new management systems. Improving the management skills and policy analysis capabilities of senior staff in MPFD through appropriate training, and introduction of improved planning, monitoring and evaluation procedures will be given priority. Introduction of Management Information System (M.I.S.), and Geographical Information System (G.I.S.) throughout the state would be another significant feature of the Project.

Provision of training materials and consultants' services for in-service training of MPFD staff,

upgrading of State Forest Research institute's training and hostel facilities; improvement of resource assessment and inventory capabilities of the Department through the provision of filed survey instruments, equipment and vehicles, and technology development studies to identify and implement improved forest resource survey techniques will be taken up under this component.

2. Forest Development

This is the largest component of the Project with approximately 60% of outlay. The main objectives of this component are:

- the restoration of natural ecosystems and the preservation of biodiversity;
- reduction in land degradation;
- sustainable production; and
- improvement of natural regeneration through better forest floor management.

The strategy for forest development in degraded (Open) areas is slightly different from that of well stocked (Closed) forests. Community involvement in detailed planning and implementation of proposed forestry programmes has been adopted by MPFD as the cornerstone of the strategy in both areas. In closed forests, improved productivity would be achieved through natural regeneration and enrichment planting with a variety of species, including those of importance to local communities, and by adopting soil and moisture conservation measures.

In open forest areas, the species providing benefits to the community would be given priority. Here JFM arrangements would be integrated with measures to provide alternative resources and income to reduce unsustainable exploitation of the forest. JFM has been defined as the sharing of products, responsibilities, control and decision making authority over forest lands between Forest Department and local user groups, based on a formal agreement. This process of empowering the villages in conformity with the process of decentralization that has begun in the State with the introduction of the **Panchayati Raj.** Participatory planning methods have been adopted for forest management as well as village resource development. Efforts will be made, through JFM, to increase the stake of neighbouring communities in the management and utilization of forest; and to create alternative sources of income and employment for villages to reduce their dependence on the forest. JFM has already gained momentum in the state and currently around 4000 village level forest committees are in operation.

Two main types of forest development technologies were adopted under the Project:

- Assisted Natural Regeneration (ANR), and
- Rehabilitation of Degraded Forest (RDF).

Under ANR, promotion of natural forest regeneration, supported by enrichment planting, improved silvicultural practices, soil-moisture conservation works and forest floor management works were proposed to be undertaken over an area of about 1,61,000 ha. It included rejuvination of flowered bamboo areas also.

In RDF, an area of about 74,000 ha. were proposed to be managed by involving about 1140 villages under JFM. A unique **Village Resource Development Programme** (VRDP), based on participatory planning is to be implemented in these villages situated in forest fringe areas with an aim of generating alternative incomes or resources for villages. These works were proposed to be taken by the Village Forest Committees constituted within 5 Km. periphery from the boundaries of the degraded forests and were to be as per a microplan prepared through participatory rural appraisal.

NGOs have an important role to play in implementing the VRDP component. It was proposed to make efforts to associate committed voluntary agencies/NGOs with proven track record as interface between State Forest Department and the local village communities. Such organizations may prove well suited for motivation and organizing village communities for protection, afforestation and

development of degraded forest land, especially in the vicinity of habitations. Such institutions were proposed to be encouraged to share their experience of gender specific planning with the communities and the Forest Department in formulation VRD plans.

The Project proposes to support Village Resource Development Programme through providing funds and promoting the process of institution building at the village level and with MPFD. Eco-development Centres were to be created in each Forest Division where a VRDP spearhead team will be developed to impart participatory planning skill to field staff.

1. Changing traditional working pattern to reduce the gap between the professional forester and local communities.
2. To motivate and organize forest communities to become members in the system of participatory forest management.

Table 14. A summary of Forest Development component

Forest Type	Forest Development Technology		Area to be covered (in Ha)
Open Forests (Crown Density<0.4)	Rehabilitation of Degraded Forest (RDF)	100% Coppice resuscitation	6610
		50% Coppice resuscitation & 50% planting	39690
		100% Planting	6610
		Silvipasture-reforestation with fodder trees legumes and grasses	13230
		Replanting with bamboo	8270
		Sub Total RDF	**74410**
Closed Forets (Crown Density>0.4)	Assisted Natural Regeneration (ANR)	Coppice management	56000
		High Forest Management	84000
		Rejuvenation of flowered bamboo areas	21000
		Sub Total ANR	**161000**
GRAND TOTAL	**FOREST DEVELOPMENT**		**235410**

4.3.5 Strategies of the Forest Department of Madhya Pradesh for People's Participation in Resource Management

Consistent efforts have been made by the Forest Department in Madhya Pradesh to involve local forest communities in the protection of forest. Developing an effective institution for participatory forest management involving two fold approach-

The various activities undertaken in the Managed Forest Divisions of Betul division are as follows

4.3.6 North Betul Managed Forest Division

- Construction of low cost housing
- Construction of Stop Dams
- Poultry rearing
- Forest Protection Committees Nurseries
- Ensuring fair price to NTFP collected by local people
- Active Participation in forest protection

4.3.7 South Betul Managed Forest Division-

- Development of Fisheries
- Construction of Stop Dams

- Distribution of fuel efficient '*chullas*'
- Rehabilitation of Degraded Forests

4.3.8 West Betul Managed Forest Division-

- Road side Plantaions
- Collection of NTFP and ensuring fiar price to the local people.
- Income –generating schemes like flour mills
- Support for opening grocery shop

The activities taken up by the Managed Forests Division of Hoshangabad are more or less same. A majority portion of the Hoshangabad District is covered by the Bori and the Pachmarhi Sanctuary and the Satpura National Park. However the remnant managed forest division of Hoshangabad is a stressed ecosysyem on account of tremendous biotic pressure and a high frequency of man – animal conflicts.

4.3.9 Pachmarhi Wildlife Santuary:

Rehabilitation Programme and Socio economic development of local communities.

The villagers inside the sanctuary depend on forest for grazing fuel wood and also for nistar requirements. Collection of Minor Forest Produce is also a source of income for the villagers. Grazing by cattle of adjoining areas is a problem. Encroachments are quite common in northern area of the sanctuary. Collection of NTFP for commercial porpose has been stopped by Government in the interest of Wildlife. The free fuel wood and nistar concession as existing today may not be possible and may be curtailed in near future. However, grazing may be controlled and regulated in the interest of Wildlife. Pachmarahi sanctuary includes 44 villages and the cattle population is estimated to be 10,000. The northern boundary of the sanctuary almost reaches the thickly populated Narmada plains. Separated by a thin buffer of Protected Forest adjoining to the sanctuary, the sanctuary as well as the Protected Forests suffer heavy onslaught of grazing, and illicit fellings. To reduce this pressure on the sanctuary area it is necessary to improve the condition of the people in the adjoining area by an integrated development that will combine short term and long term measures to safeguard the natural resources. These might include the reduction of livestock numbers, increasing the efficiency of food production by intensive cultivation, employment of local people in plantation and social forestry works. Full understanding and participation of local people in the formulation and implementation of these plans is crucial for the success. But such a huge work cannot be shouldered by Forest Department alone. It will have to be done by the District Rural Development Authority as well. Only help for social forestry can be provided by the Forest Department if the people are interested to adopt it.

4.3.10 Bori Wildlife Sanctuary:

There are 17 forest villages inside the sanctuary with human population of around 4000 and livestock population of about 7000. Presssure of grazing is not significant. The sanctuary is well buffered with vast expanse of Reserve Forest on the southern and eastern boundaries and inaccessible from western and northern side. As a result dependence of the adjoining population on this sanctuary is low. Minor Forest Produce collection has been stopped in the sanctuary since July 1982.

4.3.11 Satpura National Park:

There is no significant habitation in the Satpura National Park and hence biotic interference is negligible.

4.3.12 Melghat Tiger Reserve

In the Melghat Tiger Reserve the objectives of Eco Developmet Plan (1992-1995) were as follows:

1. To mitigate resource dependence of the local inhabitants on wildlife habitat
2. To win the trust of local inhabitants by reducing damages due to wildlife and by improving their socio economic status and inturn obtain their participation to achieve conservation objectives.
3. Enhancing Productivity of buffer zone and cultivation areas by ameliorating the damages already caused by human activities.

The Eco- Developmental activities are broadly divided into two categories-

Type A – These were areas which are main cause of concern and are to be immediately relocated outside or are to be relocated outside in near future and are not intended to grow. Thus the eco-developmental activities in these areas woud not include creation of permanent infrastructure. They will be indirectly reducing the pressures on the wildlife habitats by restricting the human use to village limits and compensating for losses in their uses by providing direct inputs (i.e. for stall feeding, provision of grass etc.)

Type-B – These were taken up so as to provide incentives to inhabitants. They would serve as attractive centers for remotely placed ones to shift. Since the pressures of demands will be relatively high in these areas, by virtue of their size, meeting of the demands may not be possible directly. So the development works will be to alleviate the socio-economic condition through higher yields from lands, provision of better basic amenities like health, education, communication etc. The ecodevelopment activities are as follows:

1. Soil and moisture conservation works.
2. Provision of improved quality fruit trees for planting.
3. Training for Poultry farming.
4. Developing fishery by provision of fish seed and small tanks.
5. Provision of improved oil seeds.
6. Weed eradication in village watershed to improve fodder availability of village surrounds.
7. Grazing control.
8. Improving grazing lands by reducing weed infestation, improving moisture regime by soil and moisture conservation works.
9. Encouraging stallfeeding by provision of cut grass and transport of cut grass.
10. Provision of drinking water for human beings and water tanks for cattle.
11. Human health care and provision of medicines.
12. Veterinary care and medicines.
13. Provision of equipments for entertainment (sports/ TV).
14. Use of solar powered energized fencing.
15. Provision of watch and ward during cropping season.
16. Programme with NGOs for awareness.

The above excerpts are derived from Ecodevelopment Plan for Melghat Tiger Reserve (Thosre *et. al*,1995).

Under the Maharashtra Forestry Project, the eco-development Programme was taken up with emphasis on providing alternate source of livlihood, soil and moisture conservation; reducing dependance on Protected Areas by promoting biogas, fuel efficient chullahs etc.

4.4 Intensive Study Area

4.4.1 Communities living within the protected areas

"Both Melghat and Bori regions are mostly inhabited by tribes (80%), who with the establishment of British administration in the region in the 19th century, were encouraged to give up shifting cultivation and settle down. Korku is the predominant tribe. Melghat Tiger Reserve has Gond, Nehal, Thatia, Burad and Rathiya tribes apart from the Korku tribe. Bori Wildlife Sanctuary however, has only Korku, Gond and Thatia tribes. The remaining 20% population in the two PAs is non-tribal, i.e., scheduled castes and other backward classes. Most of them belong to agropastoralist communities (15%), viz., Gawli. The remaining 5% belong to scheduled castes and other backward classes, majority of which are the *Balai, Vanjari* and *Lohar*. Bori Wildlife Sanctuary however, has only Gawli caste in addition to the tribal community."

"Various tribes and castes co-existing in MTR and BWLS displayed a basically patriarchal structure. Tribes and non-tribes mostly lived in nuclear family

units, that is to say, husband and wife, along with their unmarried children. Within the community, in general, and the family in particular, the division of labour was traditional to a certain extent i.e., women were necessarily responsible for performing all the household chores like cooking, rearing and nurturing the children, etc. Festivals like Holi and Diwali also were occasions when the young and the old as well as the men and the women joined in drinking mahua (country liquor) and dancing and generally having a good time. The solidarity of the tribal community is perhaps expressed through their dancing and drinking as has been observed by other anthropologists/ sociologists like Durkheim (1976) and Radcliffe-Brown (1979)."

4.4.2 Classification of community groups

"In earlier anthropological studies "methods of securing of food" have been used for the classification of societies into broad categories, e.g., food gatherers, hunters and fishers; pastoralists; agriculturists; and artisans (Firth 1956). For the purpose of this study however, different communities living in MTR and BWLS have been classified into three major categories depending on their social group and lifestyle. While 'social group' may be defined as tribal, backward or scheduled caste and others; 'lifestyle' may be defined as the way of living and earning livelihood, values, practices and activities (Park and Park, 1991). For this study, the activities and practices of each social group were taken into consideration to define 'lifestyle'.

i) Scheduled tribes: traditional forestry related labourers

These people are culturally and ethnically distinct, but over the years have adopted some ways of the mainstream contemporary urban Indian society through the process of acculturation. All the major tribal communities studied, i.e., *Korku, Gond, Nihal, Burad (Basor)* and *Rathiya* have been grouped in this category. While *Korku, Gond, Nihal* (considered an offshoot of the Korku tribe) had been original hunters and shifting cultivators before the British took over these forests, the *Burad / Basor* tribe were original bamboo basket makers. The British encouraged the tribal communities living in these forests to settle down in villages so that they could provide labour for timber extraction activities. Consequently with the advent of forestry operations in this region, these tribes have been involved in logging and forestry related activities as labourers. Earning from employment in forestry sector has formed a major source of income for these people since income flow continues almost throughout the year. Families belonging to the *Rathiya* tribe however, have only recently settled in the Melghat region. They were originally from Madhya Pradesh and had come to Melghat as labourers. Most of these families are without land. They grow cash crops on rented land. Agriculture is primarily for subsistence although some landholders especially in MTR are engaged in a limited amount of cash cropping.

ii) Scheduled and backward classes: assorted professions

The other major community group is a large mix of various scheduled and backward classes, who practice agriculture in addition to being employed in jobs or being engaged in commercial activities. *Balais* who form majority of this group were originally weavers (Bunkars). *Balai*, Vanjaris, *Lohars* and *Gaolan* were grouped under this category, as these people were generally practising agriculture, but have also taken up various jobs and professions over the years due to facilities and concessions provided to them.

iii) Agropastoralists

The third major community group comprises of the caste of cowherds, milkmen and cattle-breeders, i.e., *Gawli*. Their lifestyle is agropastoralist in nature. Originally the agropastoralists did not belong to these areas, but over the years have migrated into these forests from adjoining regions due to increasing population pressure and depleting resources."

4.5 Socio-economic scenario

"There are 61 revenue villages within the Melghat Tiger Reserve, with a human population of 25196 and 26499 livestock heads and another 20 villages outside the reserve within a distance of 5-10 km of the boundary. In addition to the people living in and around the Tiger Reserve, over 3000 migratory cattle from Gujarat and Madhya Pradesh pass through it annually. Most of the people living in and around Melghat Tiger Reserve are dependent on it for subsistence, as a source of income from forestry works, which are continuing in adjoining reserved forests; and collection of NTFP and commercial head-loading of fuelwood."

"Bori Wildlife Sanctuary has 17 enclaved villages in addition to 4 villages within a distance of 10 km of the southern boundary. There are about 4000 people and 7000 heads of livestock living in the forest villages situated within the sanctuary."

"With the stoppage of forestry operations within the Melghat Tiger Reserve the major source of income for the people has been lost. However, people are still able to find alternative employment in and around Melghat, primarily because Melghat region is fairly well connected by roads with the adjoining townships of Paratwada and Dharni. Moreover, being revenue villages they benefit from the employment generation and welfare schemes of different government agencies working in the region, in addition to various forestry activities (other than logging) being carried out by the territorial forest units and the tiger reserve. Still, quite a few people, especially landless tribes migrate to adjoining areas for major part of the year in search of labour employment and return to their homes / villages only during festivals and monsoons when there is a demand for labour in the agricultural fields. Despite the dependence on forests and subsistence agriculture, labour employment forms the major source of income for most of the people, except the agropastoralists, whose main livelihood is derived from dairy activities. The non-availability of employment opportunities within the PAs and the consequent seasonal migration of the landless and unemployed, especially those belonging to the tribal community, to nearby townships leads to hardships for the entire family as at times even the children have to be taken along. This not only leads to frequent displacement from the environment they are used to, it also makes it difficult for the children to take up regular schooling or benefit from other welfare activities. Similar is the case of the agropastoralists, some of whom migrate with their cattle to areas outside the reserve in the dry season in search of agricultural fields or pastures for grazing. However, on the whole, because of its location and being supported by the programmes of tribal welfare department and other organs of the Zilla Parishad, the area is much better off than Bori Wildlife Sanctuary in terms of schools, dispensaries, animal husbandry activities and public distribution systems. The forest department has earmarked 5% of the forest revenue for the welfare of the people in Melghat, which is channelized through the programmes of the Zilla Parishad. This being one of the most timber rich areas in Central India, not withstanding the considerable reduction in forestry operations, the 5% grant build up over the years is quite significant. There however is little awareness of the forest department's contribution to the welfare of the forest dwelling community."

"Bori Sanctuary on the other hand is quite remote because of which the people living in these villages do not have an easy access to the nearby towns and markets. Consequently, in the absence of alternative sources of employment, the people completely depend on whatever little is produced in their fields and whatever timber and non-timber forest produce they can get from the forest, both for domestic consumption and for earning some income. However, the tribals periodically go to adjoining townships and agricultural areas for short periods, especially during the harvest, the cash crop harvest season, as they are able to secure temporary employment in the fields for that period. As far as the role of government agencies in the villages in Bori is concerned, except for few residential schools, local dispensaries and annual visits by the animal

husbandry staff in the sanctuary, not much can be said. Moreover, the means of public transport and communication are non-existent, leaving the villagers completely stranded during the monsoons especially due to the flooding of many of the streams which drain the area. This results in great deal of hardships to the people especially in times of illness and food shortage."

"The intervention of all these agencies over the years and the change in the status of these forests into PAs and conservation reserve has resulted in significantly changing the lifestyles/livelihood of the resident communities. In Melghat Tiger Reserve, the government agencies have provided civic and medical facilities for the local people, which have helped in fighting illness and infant mortality. In fact there is incontrovertible evidence that infant mortality of tribal children within the limits of the Melghat tiger reserve is minimal and normal as compared to the situation in the outlying degraded areas. Moreover, these agencies have also helped by giving loans and technical inputs to these people. This however, has resulted in raising people's aspirations and increasing human and livestock populations."

"The closing down of logging operations in Bori Wildlife Sanctuary, since October 1991 has however resulted in loss of livelihood for majority of the indigenous communities; especially the traditional labourers (tribals), who have been involved in these operations since the British times. This has resulted in increasing their dependence on the forest-based resources and agriculture. At the same time, better protection of forests and wildlife and restrictions on hunting or killing and commercial exploitation of forest produce, has helped in restoring the forests, wildlife habitats and wild plants and animal communities. There is greater security for the all the important watersheds. This has resulted in conflicts between people and wildlife in the form of a perceived higher incidence of crop raiding by wild ungulates, cattle lifting by large carnivores and injuries to humans. This leads to growing antagonism towards the forest officials and wildlife, resulting in sporadic killing of wild animals as a form of retaliation. This is a very peculiar situation. Prima facie, the fundamental disenchantment is on account of loss of income due to stoppage of forestry operations as a result of constitution of PAs and legal provisions. The negative wild animal-people interactions over the ages is now being seen in a different light. Compensation schemes have led to better awareness and data maintenance. All these together have resulted in a complex situation of negative politics, unsubstantiated beliefs and antagonism, the cause for which is not necessarily the increasing populations of some wildlife species."

"In addition to all this, there are the agropastoralists, who have gained uncontrolled access to the forests for grazing their large herds of cattle. Their economy, which revolves around dairy-farming and dairy products, is heavily dependent on the forests. It is likely that these people would irreversibly damage the ecosystem, as pastoralists are doing elsewhere in the country."

"In view of the above observations it appears that people's dependence on forest resources and the consequent pressures on the forest have been increasing over the years due to increasing population and non-availability of alternatives (income sources like forestry operations and other remunerative employment opportunities). This makes it necessary to look at the existing situation in greater detail and to examine the underlying factors responsible for the degradation of forest resources.

The study summed up and broadly concluded that:

(1) Majority of the people depend on the forest because of their traditions, lifestyles or inability to purchase alternatives.

(2) 80% of all the families are genuinely dependent on the forest, but their dependence is limited to seasonal demand for fuelwood and NTFP.

(3) Agropastoralists exert more pressure because of their large livestock holding and grazing pattern.

(4) Existing practice of resource extraction results in higher weed abundance and adversely affects the ground cover and rate of regeneration.

(5) Majority of families feel deprived of employment opportunities.

(6) Agropastoralists in MTR resent restrictions on grazing in UF.

(7) Most of the blocks / rounds in the Multiple-use area and the sanctuary showed high biotic pressure, whereas the rounds in the NP and southern portion of MTR were under comparatively low pressure.

(8) Although the NP is mostly free of pressure, there is high pressure almost all along its boundary and at times in the compartments just inside the park from villages in the sanctuary as there is no alternative forest available.

(9) Legal restrictions on resource-use result in people's perceptions of their problems being intensified as opposed to direct costs due to damage by wild animals.

Management Issues

On the basis of the findings of the study, three major management issues that have emerged are socio-economic, administrative and protected area-people relationships.

The socio-economic issues for the management are:

(1) Employment opportunities, especially for those without land and livestock. These 8% of the families are genuinely dependent on the forest resources for their livelihood.

(2) Grazing by large number of livestock within the PAs and the associated fires. This activity is a major cause for weed proliferation and soil compaction leading to decrease in ground cover and rate of regeneration.

(3) Fuelwood requirement of the people living within the PAs. In the absence of alternative sources, fuelwood is a major source of energy for the people living within the PAs.

The administrative issues are:

(1) Inadequate coordination between district administration and the forest department.

(2) Inadequate training and motivation of the forest staff, especially in terms of people related issues.

The other issues for management regarding protected area-people relationships are:

(1) Conflict (in people's perceptions) with the objectives of conservation. On one hand it is the struggle for day to day survival for subsistence for the socio-economic class dependent on the forest resources and on the other hand it is the unsustainability of this resource-use which is undermining the conservation efforts.

(2) Negative attitude of the people towards the Forest Department due to the crop damage and livestock predation by wild animals. The reality is not appreciated or understood.

Implications for Management

Most of the protected areas today are facing a number of problems with respect to the people living within and adjacent to them, their dependence on these forests and their rights. Most of these problems require different management strategies as the protected area policy and management also has its implications for rural development of the local people (Schelhas, 1991 and Brechin et al., 1991). IUCN's World Conservation Strategy (IUCN, 1980) has emphasised the concept of joining economic development with conservation ('ecodevelopment') for the better management of PAs. Such a holistic, people friendly and inter-agency approach can contribute to environmental security, higher productivity and the well being of people (Panwar, 1992)."

"The issues that have emerged from this study have implications for the management of Melghat Tiger Reserve and Bori Wildlife Sanctuary. The various management recommendations, which take into consideration the issues before the management of the two protected areas are:

(1) Provision of alternatives to the genuinely dependent families, in terms of both alternative resources and sources of income, so as to reduce the pressure on the forest and make the local forest-based economies sustainable in the long run. Women deserve special attention when providing alternatives, as they spend a major portion of their time in collecting fuelwood and water for the family as well as doing other domestic chores.

Local subsistence communities spend considerable time in collecting fuelwood for meeting their energy requirements, both for cooking and heating purposes. Although dry wood is collected for daily fuelwood requirements, live wood is harvested especially before the monsoons. It was seen that despite prohibitions, local communities continue to harvest wood from the forests mainly because of lack of alternatives. Therefore, efforts should be made to provide readily available and appropriate viable alternatives. The forest department is already thinking and acting in this direction. Moreover, incentives should be given to reduce present level of consumption in addition to better management of the existing and newly created resources.

The forest department along with local NGOs can introduce fuel-efficient devices and smokeless stoves. This will not only conserve fuel but would also win them the support of the women, as it would lessen their ordeal of cooking in dark smoke-filled rooms. Other alternatives can be biogas plants, especially for the agropastoralist families and others with large livestock holdings.

Alternative sources of income can be generated by providing preferential employment to at least one member of the genuinely dependent families, in any forest related activities, e.g., fire watchers, watchmen, trekkers, nursery and silvicultural works, road-making, etc. Thus, the focus should be to address those who have the least range of sustenance opportunities, i.e., 8% of the families, who are landless and also do not own any livestock.

Also emphasis should be on decreasing the bio-dependence of the local people through alternate non-forest based occupations like poultry farming, pig-rearing, fish ponds and other small-scale enterprises.

(2) Incentives could be like- permission to cut grass from Tourism Zone and supply of the cut grass from Gugamal National Park of MTR which become available as a result of management activities during post monsoon period and before the fire season to the livestock owners in MTR; incentives should be given to livestock owners of both the PAs, for adopting both stall feeding and resolving to maintain smaller number of more productive livestock. The animal husbandry department needs to adopt a more people friendly approach so as to be more successful in these remote areas.

Moreover, livestock owners from both protected areas should be encouraged to stall feed their livestock on cut grasses and fodder especially during monsoons and early winter, as this is the period when grazing causes damage to the new seedlings that are coming up. With help of local participation village zones can be demarcated, especially for the purpose of livestock grazing. This may help in restricting effects of grazing to the areas around the villages and leaving larger areas of the forest undisturbed. Also, the concept of rotational grazing can be introduced, with the help of local planning and participation.

Relations between parks and their immediate neighbours have always been a major problem everywhere, especially in the tropics, as the local people want to continue to exercise their traditional rights. Allowing local people 'controlled access' to certain resources of the protected areas may be necessary for meeting their critical resource-needs. Moreover, permitting such uses can also build local support for these protected areas (Lehmkuhl *et al.*, 1988 and Schelhas, 1991). Such experiments have been

successfully tried in Amboseli National Park, Kenya (Shelton, 1983), Royal Chitwan National Park, Nepal (Shelton, 1983; and Lehmkuhl *et al.*, 1988) and Kosi Tappu Wildlife Reserve, Nepal (Heinen, 1993). Local participation would be more successful in creating social fencing of the forests rather than policing of large areas by a few forest guards. It is necessary to test such hypothesis rigorously.

(3) Introduction of indigenous fast growing timber and fodder species- Within village boundaries and on fallow lands this may be tried so as to eventually take at least some pressure off the forest. Care needs to be taken that non-invading species are selected. The villagers need to be enabled to take proper care of these trees. The villagers need to be independent in this respect. Wherever, private lands are used for planting trees or growing fodder, the owners may be provided site specific suitable incentives to encourage them. While all kinds of available wood was collected by the local people in both MTR and BWLS, there was a preference for fuel-efficient species like *saj, tiwas, dhaora, aonla,* etc. While planting trees for the purpose of fuelwood such preferences may be kept in mind. However, the need is to raise the fuel reserve over 'short time' the native species may not accord with this need. Similarly, while planting fodder species care should be taken to plant those species, that are native and which can supply fodder for greater part of the year. Moreover pasture improvement works should also be taken up, wherever possible.

(4) Forest Department may undertake the initiative for providing conservation and vocational education to the local youth and women, through short term training camps. NGOs and media options can play a significant role by spreading the message of conservation and motivating the local people to take up small conservation projects at the village level.

Quite a few of the youth in the villages were found interested in acquiring vocational skills like, tailoring, maintaining automobiles, machinery, electrical repairing, shorthand and typing, etc. However, majority of them lacked financial resources to obtain these skills. The Forest Department may involve NGOs to help deserving and interested candidates in obtaining vocational training so as to eventually help them to be self-sufficient. In the long run it may help to reduce the number of unemployed people who would have otherwise been completely dependent on the forests. Apart from this, women may be provided with the necessary help to take up horticultural activities on a small scale on their own land. The forest department along with NGOs may help the women to take up processing and cooperative marketing of collected NTFPs and other cultivated products, for value- addition. This will not only provide opportunities for gainful employment to the women, but would also empower them by providing financial security. Besides, this could help the forest department to gain crucial support of the women for any conservation-oriented activities. Such activity ecologically could however raise a concern such enterprise could lead to excessive collection and local extirpation of the concerned species. A balance needs to be struck.

(5) 'Trust building activities' need to be identified by the Forest Department in consultation with the local people. While taking up these activities, the Forest Department may make the linkages very clear to the people, so that people are able to understand that the department is willing to help them provided the people are willing to co-operate in the department's conservation efforts. A few examples which are worth mentioning are:

(i) Free health and medical facilities- To quote the example of MTR, where 3 days free medical camps were organised by Mr P. J. Thosre, who was then the Field Director of the Reserve during the period of this study. This was really a big step towards gaining people's trust, as a lot of families living in the villages in MTR mentioned during the

interviews, how their family members and neighbours had benefitted from these annual camps. Similarly annual mother and child health camps and immunization programmes may be organised for the benefit of the local population. Also, health squads, especially in BWLS and remote villages in MTR, should be mobilised during monsoons as these villages are completely cut off during this period.

(ii) Although facilities for primary and secondary education were available in quite a few villages, the management was very poor. Consequently, both the children and the parents felt dissatisfied leading to a high drop-out rate. The Forest Department may take the initiative in ensuring better educational facilities to the village children. This will not only help impart primary education to the people and build their trust in the Forest Department, but also provide employment to the educated youth within the villages. Also, the effort of the Department in helping the unemployed youth to obtain vocational training is also an important trust-building activity.

All these activities would help the local youth in being self sufficient, and will make the new generation less antagonistic towards the Forest and Wildlife officials and more aware of its responsibilities towards conservation.

(6) Forest Department has a potential to play a major role in developing an institutional set up for inter-departmental coordination, across agencies operating in the area, with the former acting as the nodal agency, as they best know what can be beneficial or detrimental to the objectives of conservation. Only it needs to be provided the enabling situation. Here again Melghat has set an example in initiating a workshop in 1995 of all government agencies in the area (e.g., tribal welfare, irrigation, soil and moisture conservation, agriculture) and various local NGOs, to help in developing greater coordination between the departments.

These agencies collectively, under a synergised agenda can help local people to adopt improved and appropriate techniques of dry farming, water harvesting, soil conservation, animal husbandry, agro-forestry, etc., aimed at enhancing their income from on- and off-farm activities, so as to reduce their economic dependence on the forest. Moreover, the local units of the agriculture department may be involved in helping the local farmers to adopt organic farming within the protected areas, by choosing appropriate crops, keeping in mind the size of land, availability of irrigation and the financial constraints. This is a long-term view. A start needs to be made. These agencies need to promote co-operative farming; the marginal and small farmers are of particular concern.

(7) Immediate attention to the blocks in the southern portion of MTR is needed. Efforts need to be made to reduce the anthropogenic pressures as these blocks have significant wildlife densities. Moreover, although the pressure in the NP is on the periphery with increasing human and livestock population in these villages and consequently depleting forests, the only alternative to these villagers would be the NP forests. However, as there is no alternative forest available outside MTR as the pressures outside are much higher. It is suggested that these villages need to be relocated to other suitable areas.

Since significant *gaur* density is encountered in Hatru round in the MTR, efforts may be made to reduce biotic pressures and adequate protection should be given to the habitat despite de-notification. The draft plan does intend this. The Kuwapati and Kolkaz rounds need immediate attention as more than 70% of the area was affected despite only a few villages being located in it and parts of it are under the tourism zone.

Lastly, although Khongda block is mostly free from biotic pressure, the comparatively low

wildlife densities in it need to be investigated. Probably it is on account of the existing attributes.

(8) Appropriate training needs to be provided to the forest staff. In respect of people living within their jurisdiction so as to help build improved relations between the two, which would lead to better management of the area. Moreover, incentives may be given to the field staff for staying in the remote areas and working in difficult situations. It is easier said than done. The management is competent to resolve this.

(9) Micro-planning with local participation needs to be taken up in representative villages of various categories. After the initial findings the micro-planning exercise may be followed up in the remaining villages in each category. It is important to ensure representation.

The National Forest Policy of 1988 promotes the concept of forest management with the active participation of the local people. Madhya Pradesh is one of the states, which has adopted collective forest management by forming village forest protection committees (Bahuguna et al., 1994). People's participation in management of forest and its resources has already shown positive results in certain forest divisions of West Bengal and Madhya Pradesh (Malhotra, 1993; Dhar, 1994 and Bahuguna et al., 1994). Although, so far these committees have not been formally formed in villages within wildlife sanctuaries, it is time that necessary steps were taken towards creating awareness and bringing about greater involvement of the local people in the protection of such areas. The most significant difference is that there cannot be usufruct sharing. It has to be off-site and the department is the best judge."

"Local communities residing within and adjacent to protected areas, in most of the developing countries of Asia and Africa, depend on these forests for their sustenance. Several studies in both India and Nepal (Moench, 1989; Singh and Singh, 1989; and Heinen, 1993) have focused on local people's dependence on forest resources like fuelwood, NTFPs, timber and fodder / grasses. Although the local people may be permitted to collect some of these resources for their bonafide use, this dependence will not be sustainable in the long run due to rapid increase in human and livestock populations, wealth disparities and natural calamities like floods and drought which cause large scale damage to the forests. Moench (1989) in his study on the Himalayas has stated that even subsistence-use of forest products such as fuelwood and fodder, can over time degrade the resource-base. So far no intensive studies have been carried out on the sustainability of this resource-use in the protected areas (e.g. sanctuaries and Tiger Reserves) of Central Indian Highlands. Such studies are urgently needed for most of India's protected areas as most of them have people living both within and adjacent to them. The greatest challenge is to define sustainability."

"The present study was an attempt to understand the complex relationship between the protected areas of MTR and BWLS and the people living and to a lesser extent around them. It was found that both the tribals and non-tribals were dependent on the forests of MTR and BWLS for their sustenance. However, this dependence does not appear to be sustainable in the long run due to the growth in population and change in lifestyles of these communities over the time. The study suggests that for better management and long-term conservation of MTR and BWLS the forest department ought to win people's support and co-operation through trust-building activities and educational programmes aimed at convincing people about the need for and benefits of conservation. This needs to be followed up with providing appropriate alternatives and incentives to the local people for reducing their dependence on the forest, as well as encouraging the active participation of local governmental and non-governmental bodies in their conservation efforts. This reiterates the protractive struggle, the gaps in awareness between those who cherish the cause of conservation and the stark ground realities."

Various biotic pressures and its distributions over spatial scales have been depicted in maps as follows:

Table 15. List of maps depicting various biotic pressures and its distribution in Melghat Tiger Reserve

Plate 50	Administrative Units of Melghat Tiger Reserve
Plate 51	Distribution of grazing pressure in Melghat Tiger Reserve
Plate 52	Distribution of lopping pressure in Melghat Tiger Reserve
Plate 53	Distribution of fuelwood collection pressure in Melghat Tiger Reserve
Plate 54	Distribution of illict felling pressure in Melghat Tiger Reserve
Plate 55	Distribution of grass cutting pressure in Melghat Tiger Reserve
Plate 56	Waterhole use by livestock in Melghat Tiger Reserve
Plate 57	Fire incidence in Melghat Tiger Reserve
Plate 58	Distribution of fishing pressure in Melghat Tiger Reserve
Plate 59	Distribution of hunting pressure in Melghat Tiger Reserve
Plate 60	Encroachment in Melghat Tiger Reserve
Plate 61	Landuse map of Melghat Tiger Reserve

Note: The above excerpts and maps are drawn from the study titled "A socio-economic study of tribes and non tribes in Melghat Tiger Reserve and adjoining areas" by Dr. Azra Musavi.

4.6 An overview of developmental activities proposed/ undertaken in Melghat Tiger Reserve

4.6.1 History of water management

One of the interesting features of historic origin noted by Shri Ravi Wankhede, former Research Officer and Deputy Director, Melghat Tiger Reserve in and around Melghat Tiger Reserve is the technique of 'Rain Water Harvesting" from roof tops at various places. The earliest record found is that of 1867 at the Forest Departments office with a tank of capacity of one Lac liters. Another such tank exists on the office roof of the Treasury office with a capacity of 3, 75,000 liters. The other sites are as mentioned in Table 16.

The development of such 'Rain Water Harvesting Techniques' in the past is an indicator of water being a limiting factor in the area. If these are revived they can still serve as an efficient way of capturing natural rainwater.

4.6.2 Economic Development Model in Melghat (Pardeshi, 1992)

"The pressure imposed by human population and cattle on forests in terms of fuel wood, fodder, minor forest produce, is immense. At the rate of 400 kg. per person per year, the requirement of fuel wood would be more than 8000 tonnes per year. Similarly the requirement of fodder for cattle, at rate of 8.90 kg. per adult animal per day comes to nearly 67,000 tonnes per year. The annual increment of wood of Melght Project Tiger sanctuary area comes to 1.3 lakh tones (assuming 1 Ha. of forest = 76 cu. m. of wood and annual increment per Ha. is 2 cu. m. at rate of 2.58 standard indication percent). Thus annual demand of fuel wood comes to 68% of increment of forest. However, as the demand for firewood is not imposed uniformly on the forest area, the fringes near the forest villages are rapidly retreating. Moreover,

Table 16. Areas in Maharashtra cmpoonent of SCA where Rain Water Harvesting was done in the past.

Location	Capacity in Lac Liters
a. Maharashtra State electricity Boards Office-	1.0
b. Dr. Watane's Bungalow-	1.0
c. Baptist Mission	1.0
d. Zilla Parishd Old Public School Building	3.40
e. Vairat Wireless Office	0.5
f. Sainik School (Two Tanks)	0.75x2
(Two Tanks)	0.55x2
g. Maharashtra Forest Rangers College	0.75

apart from fuel wood, requirements of local people, the demand for construction timber and other villages would also fall on these forests. Unless we fulfill these demands of fuel wood and fodder, no amount of policing will prevent the local people from drawing their requirements from the Melghat forests. In a democratic set up, no regulatory/ policing Govt. Organisation can prevent local people from meeting their demands. Hence alternatives have to be provided."

4.6.2.1 Policy Instruments

"Theoretically, any public policy objectives can be most efficiently achieved if the member of policy instruments is equal to the member of separate policy goals (to objectives) to be achieved. Above we have outlined two major goals for management plan of Melghat Project Tiger. A separate policy instrument should be matched to each goal (as below)

Policy Goal	Policy Instruments
1) To preserve biodiversity of Melghat forests	1) Forest Department and legal frame work of (i) Wildlife (Protection) Act, 1972 (ii) Indian Forest Act,1927 and (iii) Forest Conservation Act 1980 (iv) Forest Policy Statement 1988
2) To generate biomass needs of all local people inhabiting the forest or toe provide alternatives/ substitutes to the biomass needs.	2) Rural Development machinery (in Maharashtra it is Zila parishad) through the large number of Development programmes and funds available under (a) 5% Forest grants (i) Employment Guarantee Programmes (ii) Jawahar Rojgar Programmes (iii) Integrated Rural Development Programme (iv) Agricultural Tribal Subplan (v) Primary Education (vi) Minor Irrigation Dept.

1. Forest Department – Preservation of Biodiversity: In Melghat the Forest Department can create a stake of the local people in the survival of forests, by giving a direct claim over some annually harvestable forest resources. The case study of bamboo is interesting. At present most of the bamboo is sold (as per an old lease) to Ballarpur Paper Mills at rate of 16 paise per bamboo. However, the same bamboo is available to local tribals at Rs. 2 (even on Nistar rights). It is no wonder then that the local tribals do not have any stake in protecting forests against forest fires or illicit felling. If the villagers could be given a direct saleable right over locally growing bamboo (they would have a stake to prevent forest fires and illict felling)."

   "At present the cost of wildlife conservation is paid by the local people e.g. restrictions on rights of grazing, cattle lifting by leopards etc.This restrictions on their traditional rights has to be compensated by granting of other benefits e.g. stake in wildlife tourism revenues etc."

2. "Biomass alternatives and Rural Development programmes: The existing Government programmes and huge developmental funds available slant by proper planning. First listing of many development programmes being made available every year for Melghat will indicate the huge kitty available for eco development."

"Rs. 3.5 to 4 crores are available each year to Zila Parishad to be spent on development programmes for Melghat area (Dharni and Chikhalda blocks). Zila Parishad has great flexibility in allocating these for specific schemes. With proper planning and imagination, these can be used for eco-development programmes."

4.6.2.2Forest Grant Revenue

"In Maharashtra 5% of forest revenue generated in the area is allocated to Zila Parishad for development of forest villages. For Melghat area this revenue amounts to Rs. 70-80 lakhs per annum. At present it is in the process of completing the backlog of schools and road construction programme and subsidizing biogas. It should be widely published that these grants are coming from Forest Revenue."

4.6.2.3Jawahar Rojgar Yojana (J.R.Y.)

"Under Jawahar Rojgar Yojna the Government gives a grant of Rs. 97.11 per Tribal and Rs. 18.00 per person (non S.T.) to each *Grampanchayat*. This fund can be utilized by *Grampanchayats* for ecodevelopment works, like water harvesting structures, and afforestation of waste land. For 1990-91 grants received amounted to Rs. 1.8 crores. With these huge resources ecodevelopment works can be given a big-push."

4.6.2.4Integrated Rural Development Programme (I.R.D.P.)

"To enhance the incomes of below poverty line families, Melghat block gets nearly Rs. 25 lakhs (50%) loan + 50% subsidy."

"Under the Tribal Sub Plan, in the agricultural sector, Melghat receives another Rs. 8 Lakhs. Formerly, these funds were utilized to give cows/ bullocks and goats to below poverty line families. However, from 1992 distribution of goats in forest has completely been stopped. Local resources like bamboo, wild life touism can be exploited and individual tribals can be financed to set up self-employment ventures. Ultimately unless they stand to gain directly from forest produce or wildlife, local people will have no interest in survival of forest. With help of the above funds and schemes, an integrated Eco Development Model was prepared for Melghat."

4.6.2.5Eco Development Model for Melghat

"This model is a presentation of policy measures which have been initiated in the Melghat Tiger Reserve Buffer Zone to provide alternatives to fulfil biomass needs of local people without adversely affecting forests and wild life. For this model, the complete forest area of Melght of 2613 sq. km. and

total population of overlapping tribal blocks of Dharni and Chikhaldara are considered."

"First there is a need to identify the basic needs of forest dwelling people which are likely to impinge upon the forest. Then these needs have to be provided for in a manner which does not destroy forests and wild life.

Food and Agriculture

Two Tribal Blocks of Dharni and Chikhaldara have the cropping pattern as follows –

Crop	Area & Per cent
(i) Rice (Kharif)	12, 200 Ha (20%)
(ii) Jawar	14, 100 Ha (23.1%)
(iii) Other leser millets i.e. Kodo, Kutki, Sawa, Gadmal	699 Ha (11.3%)
(iv) Pulses	10, 900 Ha (17.8%)
(v) Cotton	5, 400 Ha (8.8%)
(vi) Gram	5, 500 Ha (9%)
(vii) Other Pulses	400 Ha (0.65%)
(viii) Wheat	1, 900 Ha (3.5%)

It is primarily the marginal farmers, who are cultivating

i. Lesser Millets (11.3%)

ii. Unirrigate wheat (3.1%)

(These are on the margin of low productivity and poverty)"

"Further nearly 7.8% of lands are fallow/ uncultivated wastes nearly 17 % of land of Melghat Forests is low yielding, marginally productive, has fluctuating yield, and used for raising rain dependent crops. Farmers dependent upon such lands are on the brink of poverty. These people are forced to supplement their incomes by selling fuel wood from forests to nearby urban areas, poaching meat, collecting honey, edible gum and M.F.P. or by selling stolen timber. If the productivity of these lands can be increased, then the dependence of these marginal farmers on forest biomass products would be much lesser."

"Changing the cropping pattern:

i) To high value non-conventional crops like Soyabeans which has added advantage of atmospheric nitrogen fixation and high protein value is an ideal protein substitute for venison. This can be achieved by proper motivation and distributing free mini-kits under training and visit scheme.

ii) Conversion from seasonal field crops to permanent horticultural tree crops – of the total geographical area of Melghat of 4, 42, 400 Ha. nearly 61, 025 ha. area is cultivated (i.e. 13.8 %). These cultivations appear as gaps in forests making the distribution of forests discontinuous. This discontinuity of forests, hinders –

(i) Movement of wildlife

(ii) Creates conflict between farmer and wildlife because of crop damage caused by wild life.

(iii) Prevents the growth of climatic vegetation as open patches allow more light/ prevent dispersal of seeds etc.

(iv) Leaves the soil open for part of the season, causing loss of soil/ and underground water."

"To make (i) the tree cover more continuous (ii) prevent soil erosion (iii) conserve soil moisture and (iv) create humus for soil, cultivation of local fruit trees needs to be encouraged. Under the Employment guarantee Scheme, Mango, Tamarind, Jamun, Charoli, Chinch and Aola are promoted under 100% subsidy programme. The farmer is supposed to dig pits as prescribed by Horticulture deptt. He is provided saplings free of cost. He is given cost of fertilizer, pesticides and costs for compound in the first year. For the next two years, he is paid wages for

looking after the trees subject to condition that 75% of trees survive. During 1989-90 nearly 130 Ha. of cultivated land has been brought under horticulture on experimental basis." However, during 1990-91, 640 ha of cultivated land (10% of the low yielding lands) was brought under horticulture, especially mangoes.

"By the end of 8th Plan, it was envisaged to bring 1800 Ha under Horticulture – by diverting 900 ha of land from lower millets and 900 Ha of fallow lands. This will reduce conflict between man and wild life on account of crop damage. This will also create a more favourable habit for wildlife, partifularly birds, civets, bats, and reduce dependence of people on forests for fuelwood and fodder. Mango cultivation is also economically viable. One hectare of Mangoes yields Rs. 9000/- (Rs. 12000/- minus Rs. 3000/- costs) while yield from traditional farming i.e. lesser millets is Rs. 3000/- to Rs. 4000/- per hectare."

Biological Controls

Instead of chemical pesticides which are harmful to micro organisms, birds and human health, biological control can be propogated. Some possibilities are listed below:

Pest	Biological Control
1. Cotton Heliothis	P.V.P Virus
2. Tur	Tur pod Powder
3. Sugarcane pyrilla	Apipvvelta
4. Stem borer	sprigogam

Fuel wood

"While calculating the fuel wood requirements, the total population of Dharni and Chikhalda blocks was considered. L.P.G. or any alternative non biomass based energy is not available. Therefore, the population depends upon fuel wood from forests. Total fuel wood requirement is 57000 tonnes per annum at rate of 400 kg. per person. However, the total incremental wood produced in Melghat Forests (Area 261339 Ha) is 2.37 lakhs tones (at the rate of 2.5% growth). Thus 24% of annual increment is eaten away by fuel wood. However, all areas are not equally well stocked (only 80% has 76 cu. m. per ha). Further as all parts are not tapped evenly the collection of fuel wood tends to get concentrated on fringes near villages. Here there would be definite shrinking and retreat of forests. Hence fuel wood has to be substituted with some easily available alternatives."

Biogas

"Melghat area has 1, 86, 000 heads of cattle. At the rate of 10 kg per animal nearly 18,60,000 kg of cowdung is produced. A 2 cu. m. biogas plants can be constructed in Melghat. However taking the limiting factor as number of families having 5 heads of cattle, nearly 3000 biogas plants can be constructed. Of these nearly 313 plants have been constructed. Further potential for nearly 2697 biogas plants exists. This will save nearly 5400 tonnes of fuel wood. Thus this will prevent nearly 156 ha of forests from being cleared per year. While collecting fuel wood people do not collect dead and fallen wood. Instead, they girdle a growing tree or lop branches. However, fuel wood is so cheap that tribal farmers living in forests areas are not so keen to construct biogas. Proposal to construct nealy 2600 biogas plants was made and subsidy was increased form nearly 50% to 90% for tribals living in forest areas. The additional 40% subsidy was provided under the 5% forest grants made available to the Zila Parishad for development of forest villages. Other alternatives are:

- Fuel Efficient Chulas
- Solar Cookers

Fodder and Cattle

According to 1987 cattle census Dharni and Chikhalda have nearly 1, 15, 000 cattle (cow and buffaloes). At the rate of 9-10 kg of fodder per animal, total requirement of dry fodder amounts to 9 lakh tonnes. Only about 2 lakhs tonnes is available from

grain crops like straw/ *kadba* and 3 lakh tonnes as hay. There is net shortage of 4 lakh tonnes. This demand is being met from free grazing in forest area and collecting fodder. To relieve this pressure, the productivity of E class Govt. lands/ Village Panachayat Pature lands must be enhanced. In Dharni and Panachayats there are nearly 32,300 ha of E class lands. At present due to uncontrolled grazing and incorrect management, these lands give very poor return. These E class lands can be developed for

(1) Kusumbe Plots Schemes – under funds available form I.R.D.P. infrastructure irrigated fodder plots for *Grampanchayats* can be developed.

(2) Planting *Styllosanthus hamata* which yields nearly 30 tonnes per ha.Planting of Jamun, ber and anjan will also be helpful.

(3) Under J.R.Y. fodder and fruit tree plantation was undertaken on these lands. More than 100 villages were covered during 1990-91.

Controlling the Population of Cattle

The percentage of scrub cattle is very high in Melghat. On the other hand proportion of productive milch cattle is only 12950 (cross-bred and dairy cows and milch buffaloes) only 11.26% of total cattle population is milch yielding. Even these yields less than 50% of State average. Hence it is imperative to control the growth of cattle population if the grazing pressure is to be controlled."

"In the Melghat sanctuary the cattle population is nearly 2.5 times, the wild ungulate population.

(1) Special focus is given to castration of scrub bulls by the Animal Husbandary Department in Project Tiger area. During 1989-90, nearly 2,000 castrations were carried out. In a joint meeting with Project Tiger staff and Animal Husbandary staff, intensive castration campaign was undertaken in the Project Tiger villages. (178 castrations were carried out in 1990-91 and during 1991-92, 100% of scrub bulls were planned to be castrated).

Castration is carried out by blunt or surgical methods. After discussion with the Field Director, Project Tiger, Izzatnagar Veterinary Institute was requested to supply chemical drugs for sterilizing feral cattle. Use of Talsur for chemical sterilization will further reduce growth of feral cattle.

(2) 100% innoculation against rinder pest, foot and mouth disease in Project Tiger Area was carried out to. During 1989-90, 56, 000 innoculations were carried out in Melghat area.

Water

"During summer months there is moisture stress for human beings, cattle and wildlife. The permanent water holes in Melghat Sanctuary get monopolized by cattle and human being, who prevent the wildlife from having access to these water holes. Under a series of schemes it was planned to develop small anicuts, Vasant Bandharas, percolation tanks for surface storage. There are unlimited funds under E.G.S Scheme similarly, under Jawahar Rohgar Yojana, 5 % Forest grants and Tribal Sub Plan funds, sufficient flexibility is available to locate such bandharas in areas which suit both human needs and supplement water for wildlife. In Vairat, a village near core-zone, villagers used to take cattle to the core area due to shortage of water. On request of Field Director Project Tiger, a local anicut was repaired and alternative small bandharas were provided."

Fishing on Minor Irrigation Tanks

"The zilla parishad has 8 M.I. tanks in Project Tiger area. The fisihing rights were formerly auctioned, thus disrupting an important wetland ecosystem. After request of Field Director Project Tiger, the Zilla Parishad voluntarily foregone the revenue from fishing rights and has passed a resolution to prohibit auctioning of fishing rights."

Education

"There are 282 Primary Schools in Melghat forest areas having 616 teachers. It is the students and

teachers of Melghat who can exercise popular pressure to manage wildlife and forest resources wisely. Hence inculcating the right values in them are of utmost importance. The Nature Interpretation Centre of Project Tiger was utilized to train 240 primary school teachers of Zilla Parishad covering all the villages located in the Melgthat Tiger Sanctuary. After 3 days orientation course these teachers were asked to carry the message to students. Subsequently the Adiwasi School children were brought to Nature Interpretation Centre for 2 days camp. To systematize this programe, Rs. 40, 000 were allocated for orientation courses of all school teachers and students from class IV to VII under the intensive area Education project at Nature Interpretation Centre, Project Tiger. These educational programmes will enable tribal children to appreciate their natural heritage. The alienation cause by modern eduction and the push created to migrate to big cities will be prevented."

The Economic Developnment Model illustrated above gives an indepth insight as to what kinds of pressures exist on the natural resourses especially forests and wildlife and the probable ways and strategies to handle these issues. It general it can be seen that the entire SCA is subjected to varying disturbance regimes and lots of developmental activities have been undertaken over the years. The Forest Department has been continuously struggling to evolve and develop strategies for the management of socio-economic and human aspects and it has been successful to various extents depending upon the local stuations and resources available. Hence there is need for Integrated Planning at Landscape Level incorporating all the smaller units working in isolation.

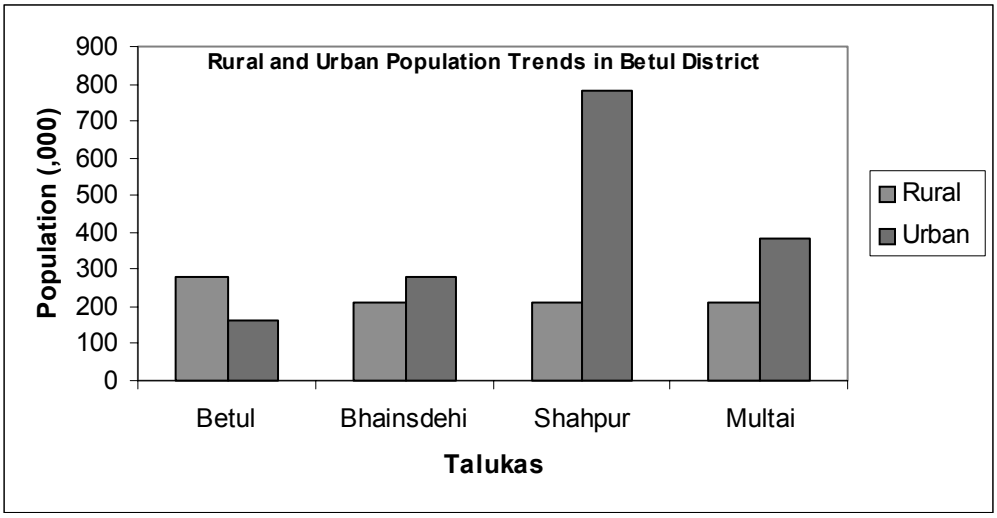

Rural and Urban Population Trends in Betul District
Population (,000)
900
800
700
600
500
400
300
200
100
0
Betul
Bhainsdehi
Shahpur
Multai
Talukas
Rural
Urban

Fig. 21.

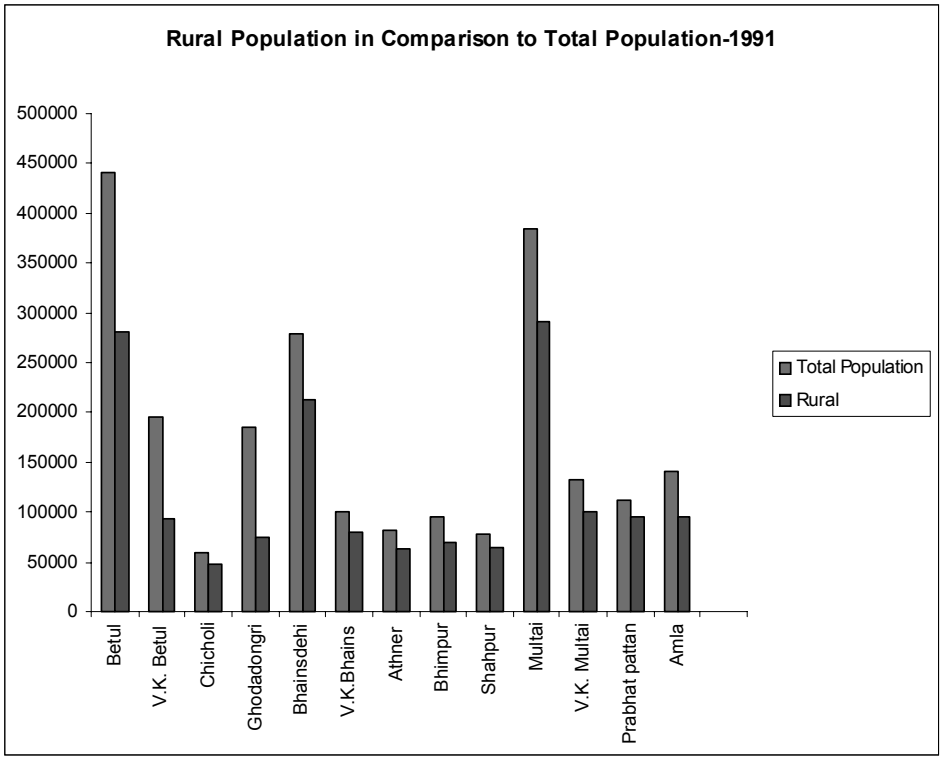

Rural Population in Comparison to Total Population-1991
500000
450000
400000
350000
300000
250000
200000
150000
100000
50000
0
Betul
V.K. Betul
Chicholi
Ghodadongri
Bhainsdehi
V.K.Bhains
Athner
Bhimpur
Shahpur
Multai
V.K. Multai
Prabhat pattan
Amla
Total Population
Rural

Fig. 22.

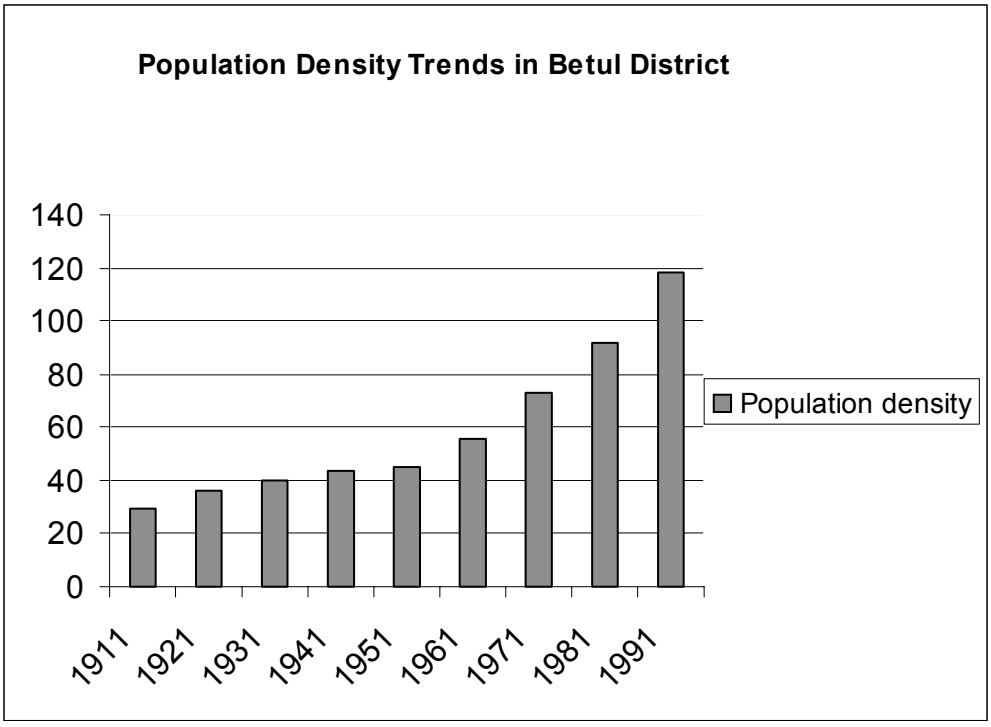

Population Density Trends in Betul District
140
120
100
80
60
40
20
0
1911
1921
1931
1941
1951
1961
1971
1981
1991
Population density

Fig. 23.

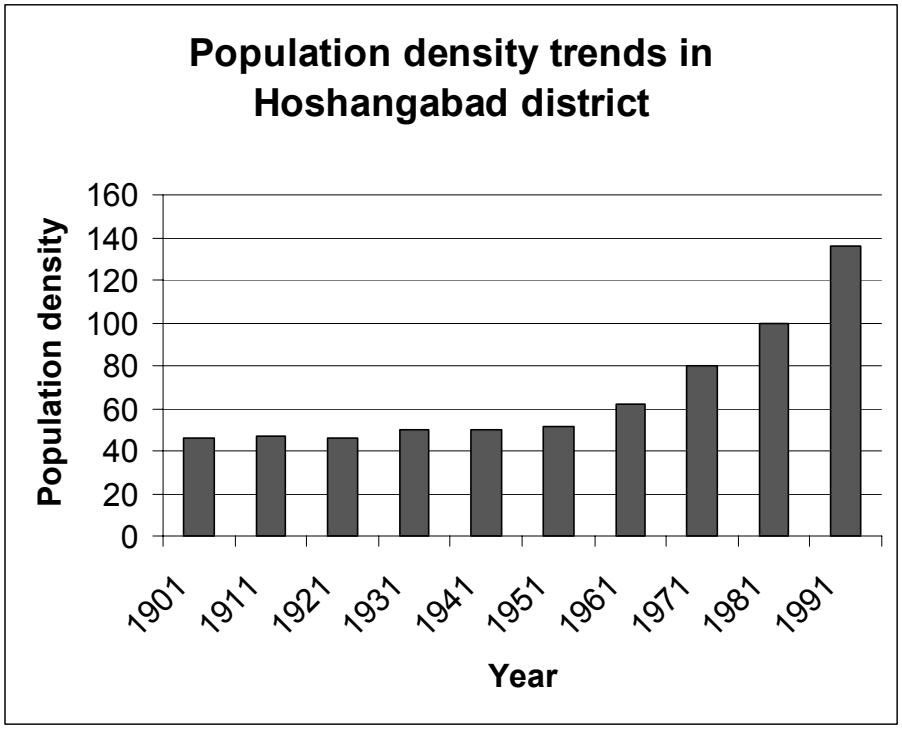

Population density trends in Hoshangabad district
Population density
160
140
120
100
80
60
40
20
0
1901
1911
1921
1931
1941
1951
1961
1971
1981
1991
Year

Fig. 24.

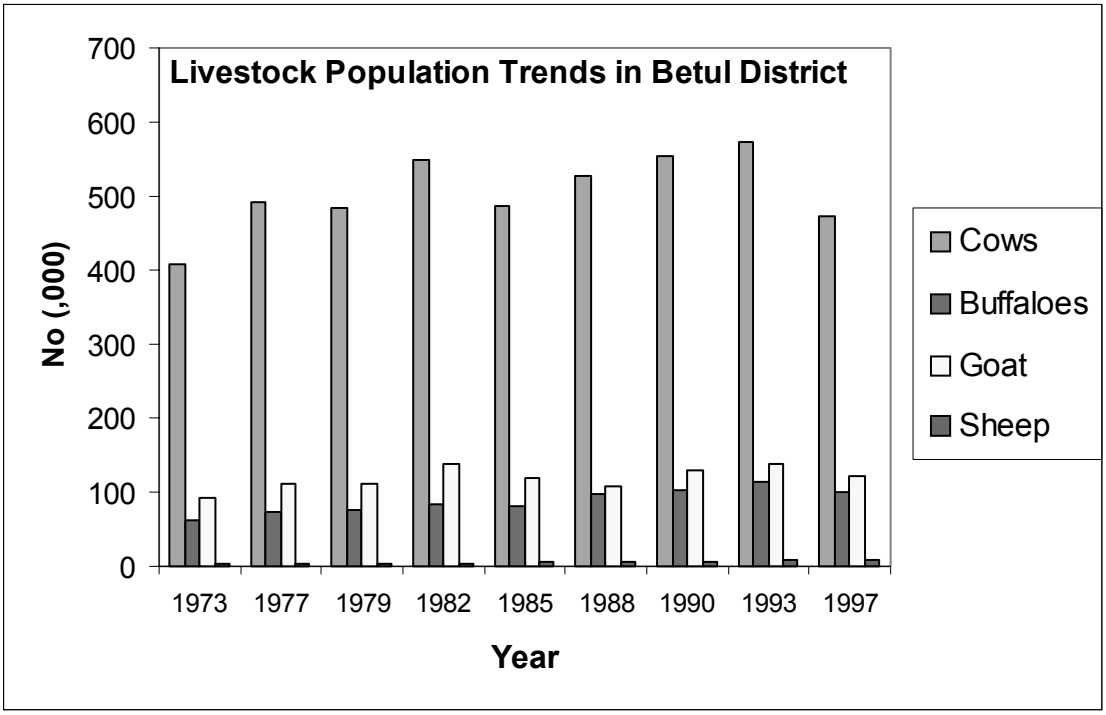

Livestock Population Trends in Betul District
700
600
500
400
300
200
100
0
No (,000)
1973
1977
1979
1982
1985
1988
1990
1993
1997
Year
Cows
Buffaloes
Goat
Sheep

Fig. 25.

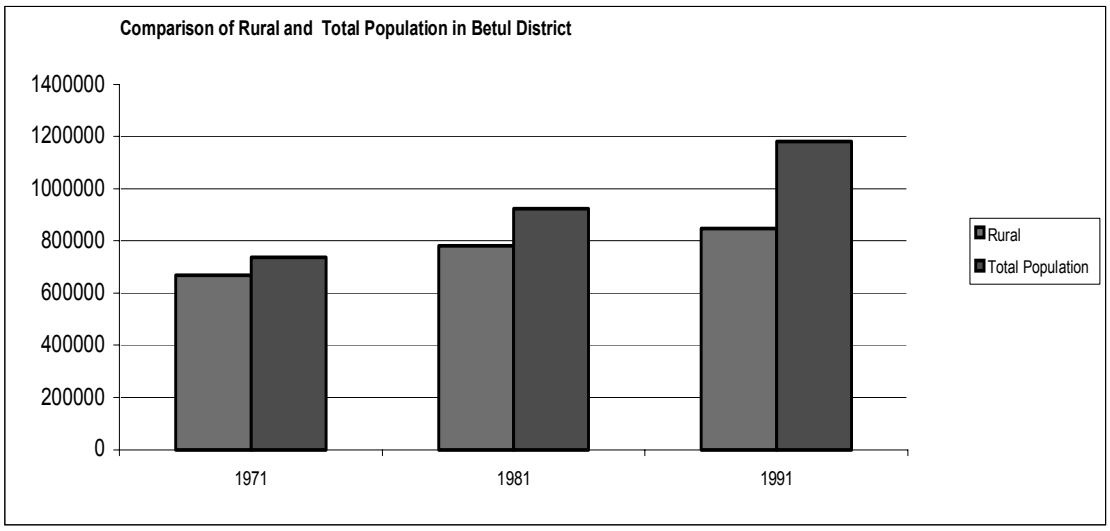

Comparison of Rural and Total Population in Betul District
1400000
1200000
1000000
800000
600000
400000
200000
0
1971
1981
1991
Rural
Total Population

Fig. 26.

Plate 43 Satpura Conservation Area - Fragmentation

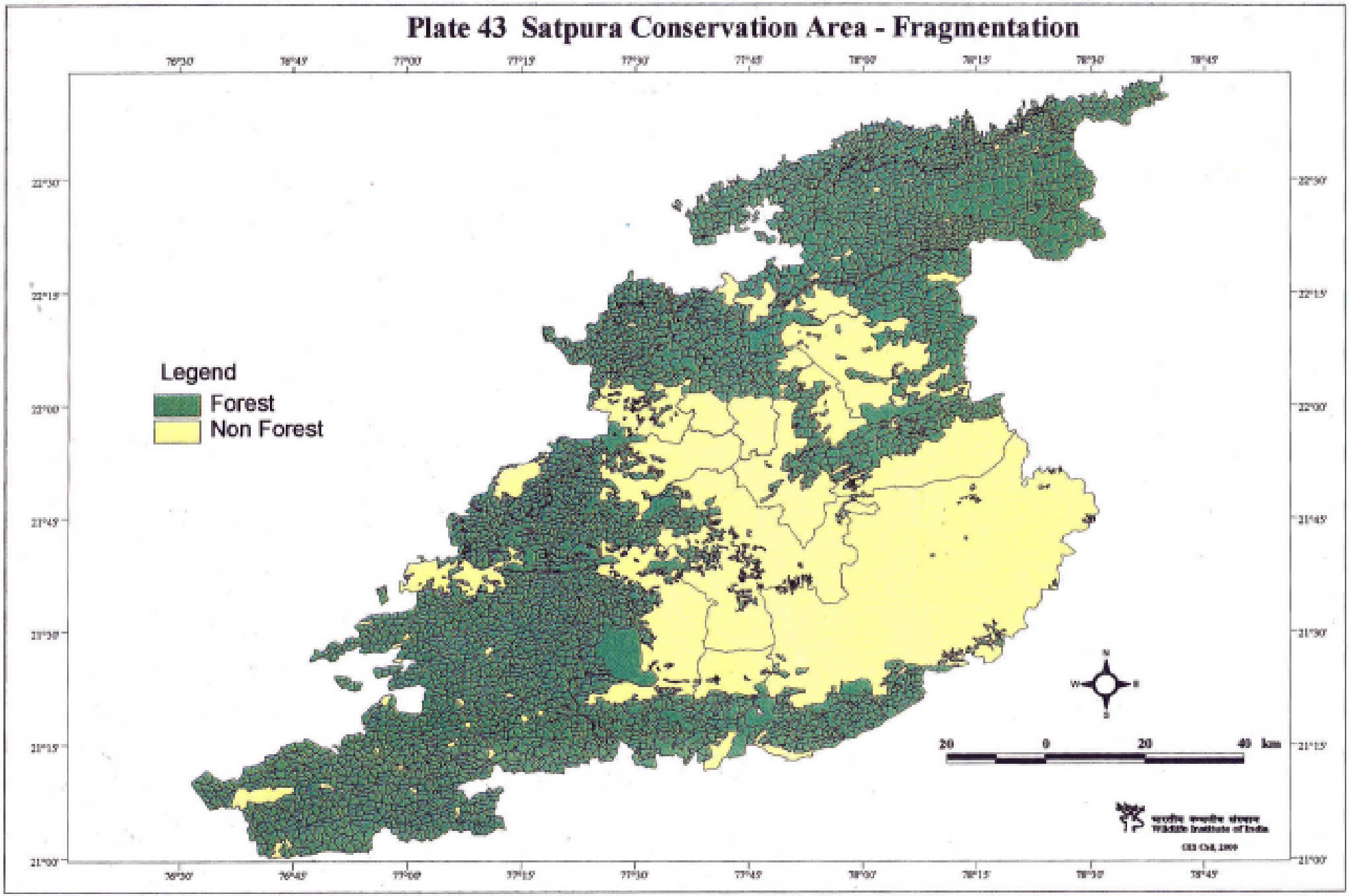


Plate 44 Map showing North, South and West Betul Managed Forest Division in Satpura Conservation Area,MP

Plate 45 Map showing distribution of Protected and Reserved Forest Map of Managed Forest Divisions of Betul District, Madhya Pradesh

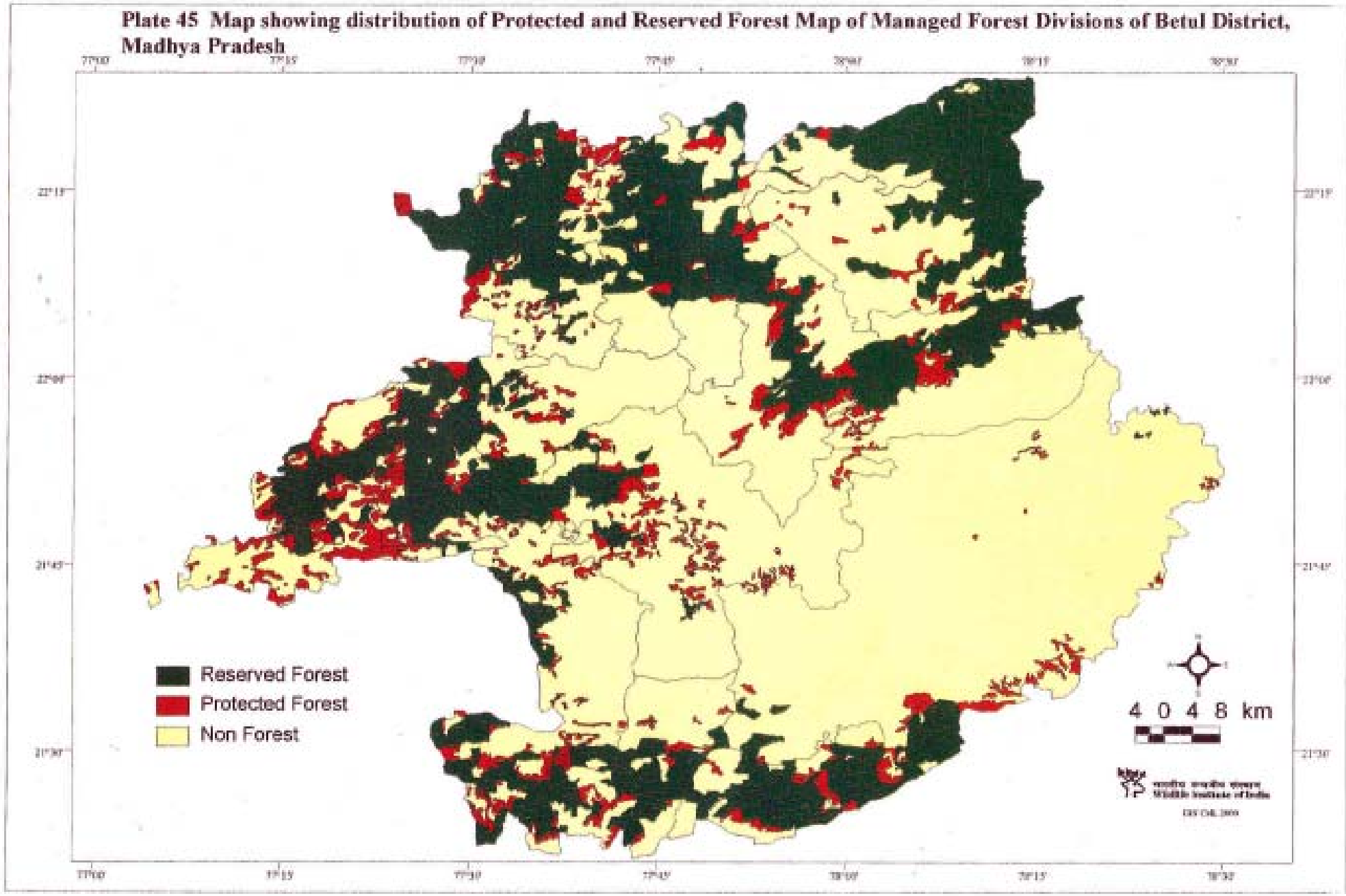


Plate 46 Village Map of Managed Forest Divisions of Betul District , Madhya Pradesh

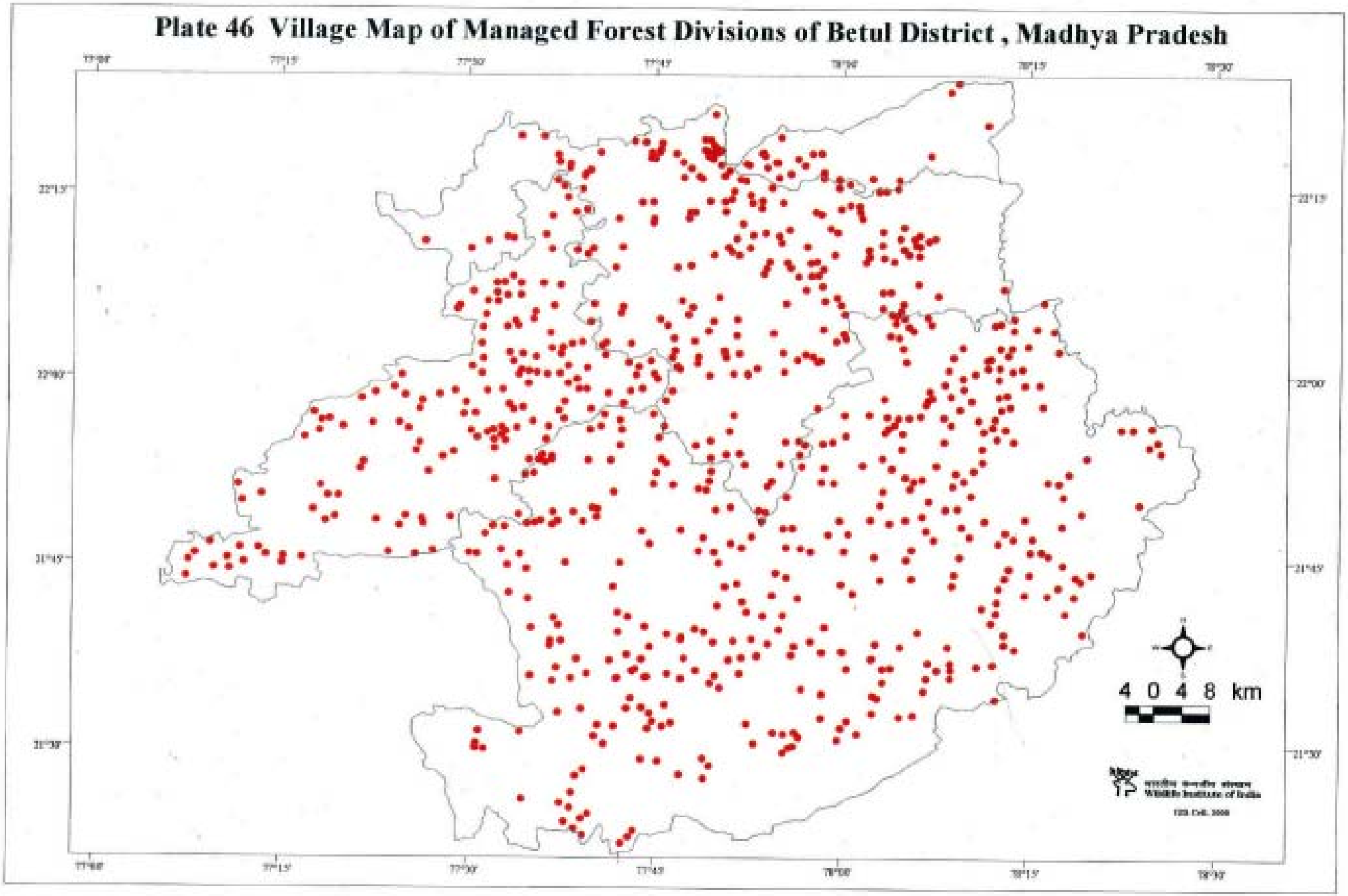


Plate 47 Village Map of Satpura Conservation Area

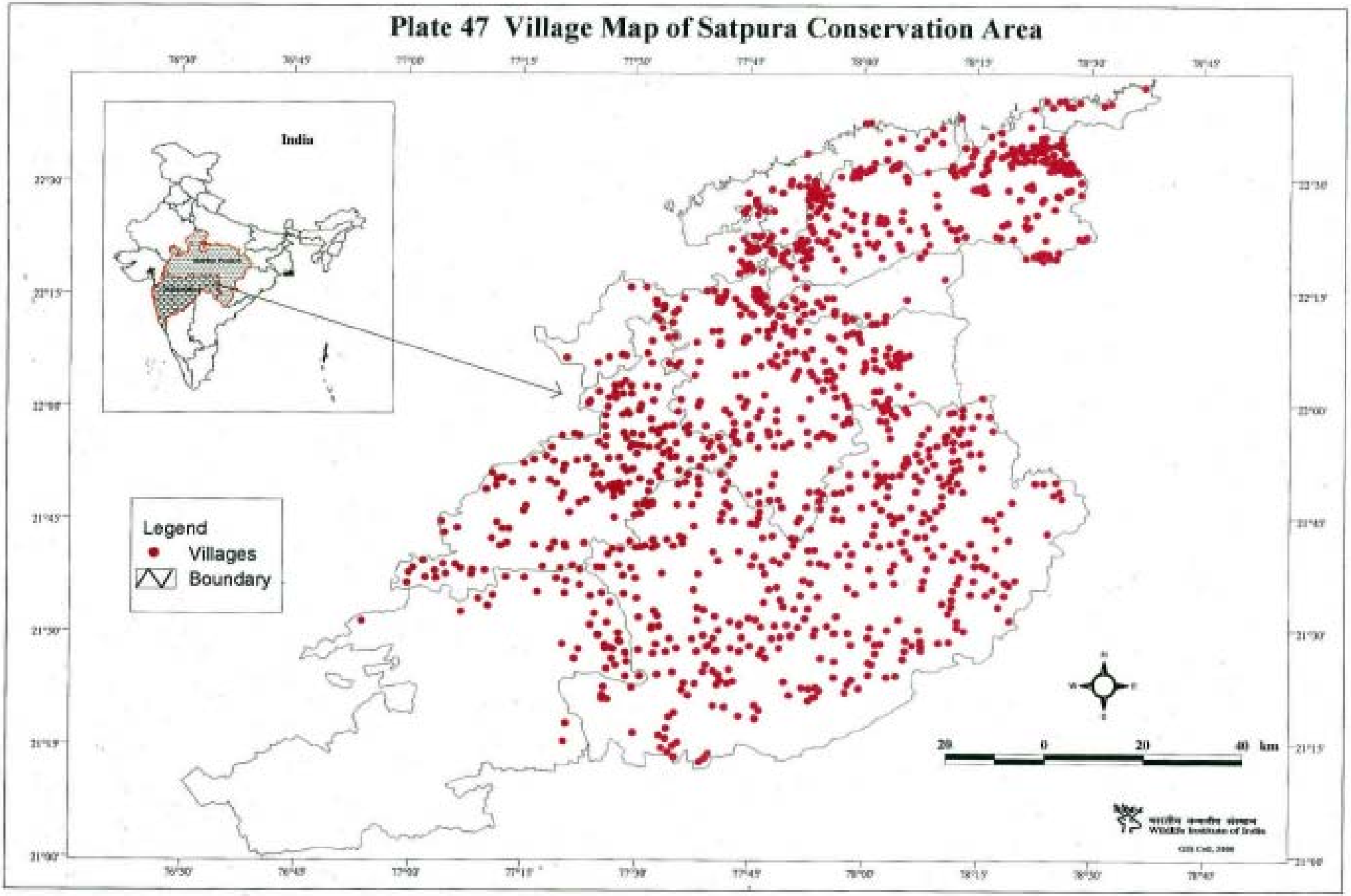


Plate 48 Road Network Map of Managed Forest Divisions of Betul District, Madhya Pradesh

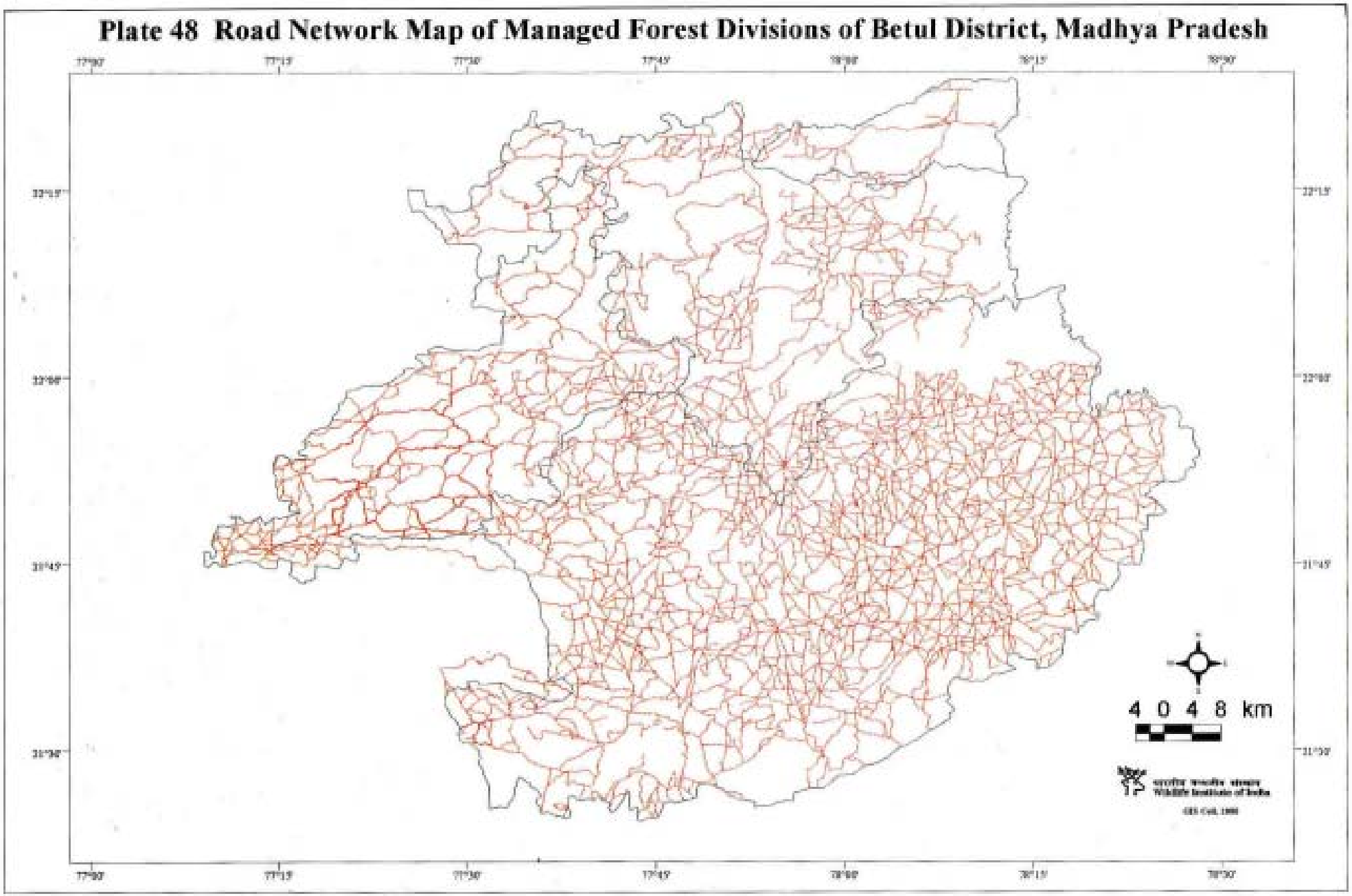
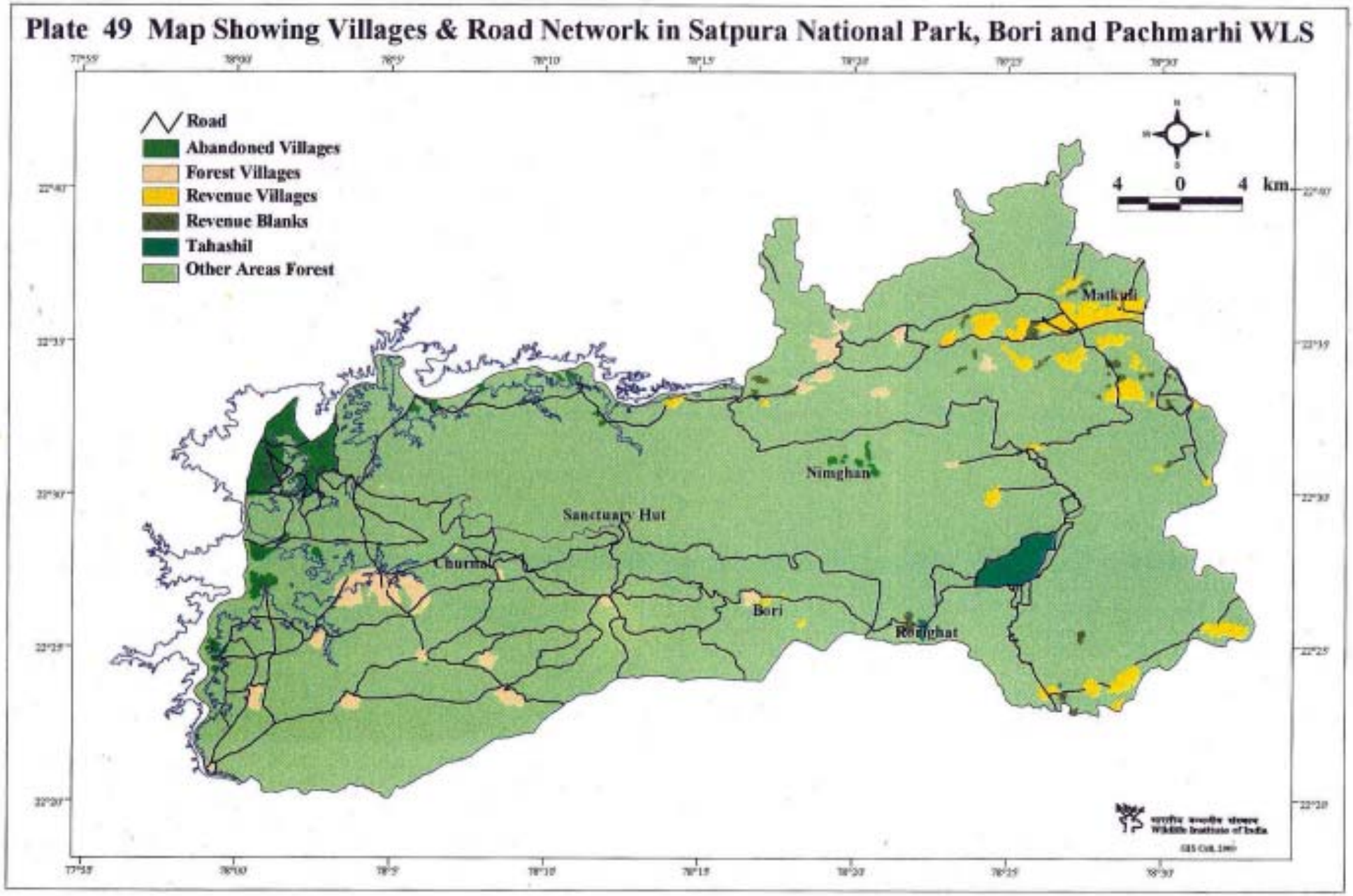


Plate 49 Map Showing Villages & Road Network in Satpura National Park, Bori and Pachmarhi WLS



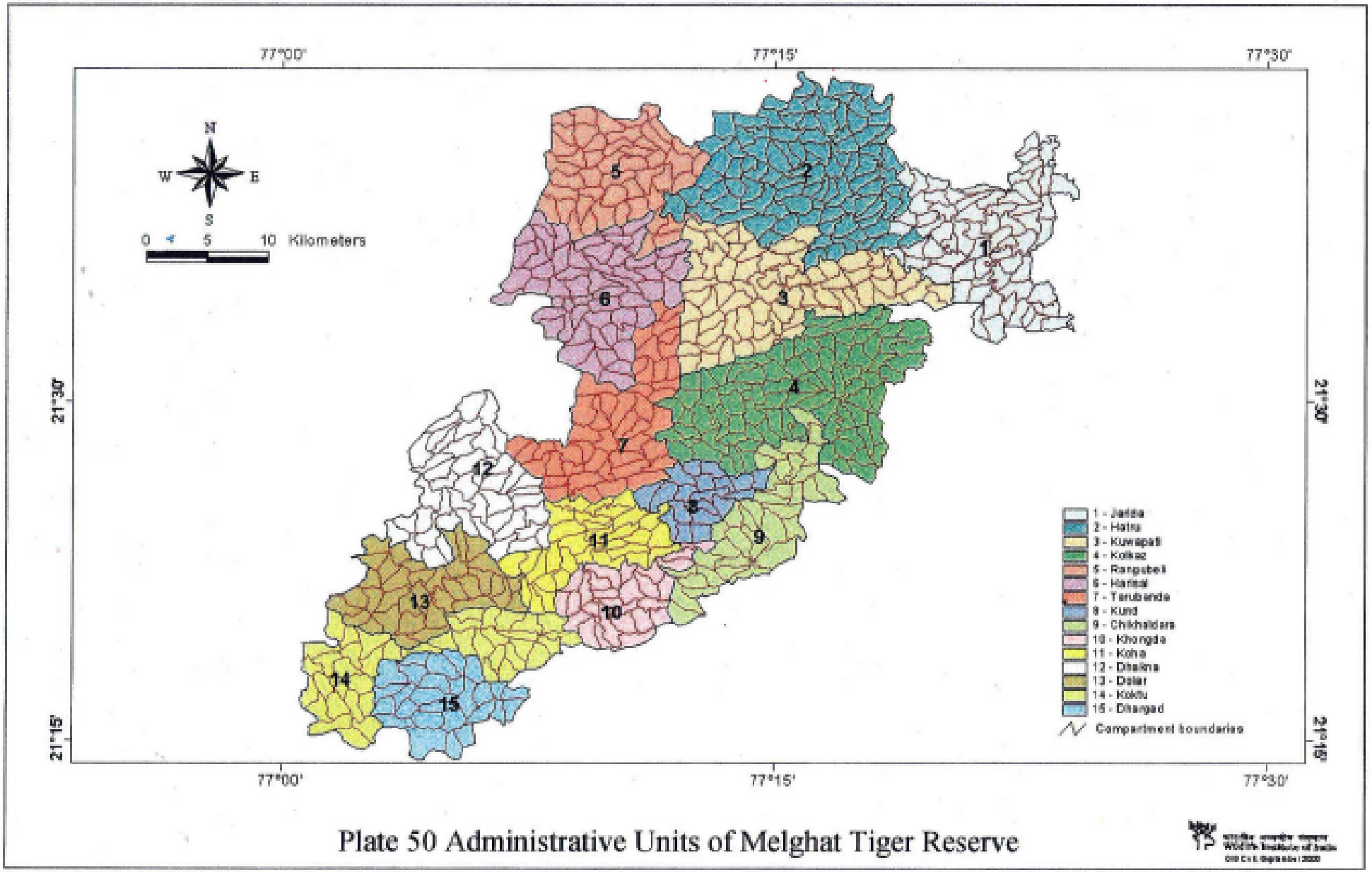


Plate 50 Administrative Units of Melghat Tiger Reserve

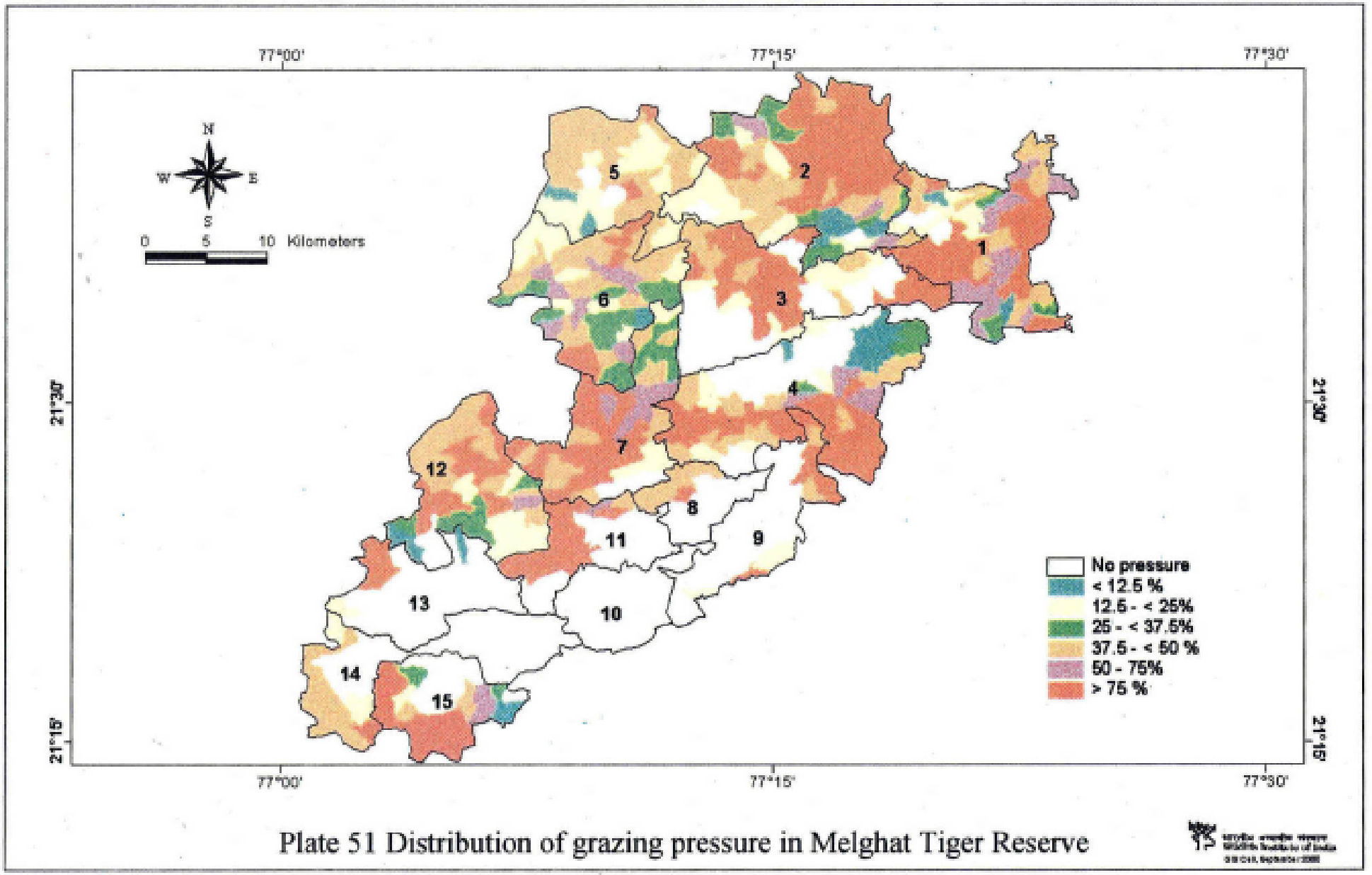


Plate 51 Distribution of grazing pressure in Melghat Tiger Reserve

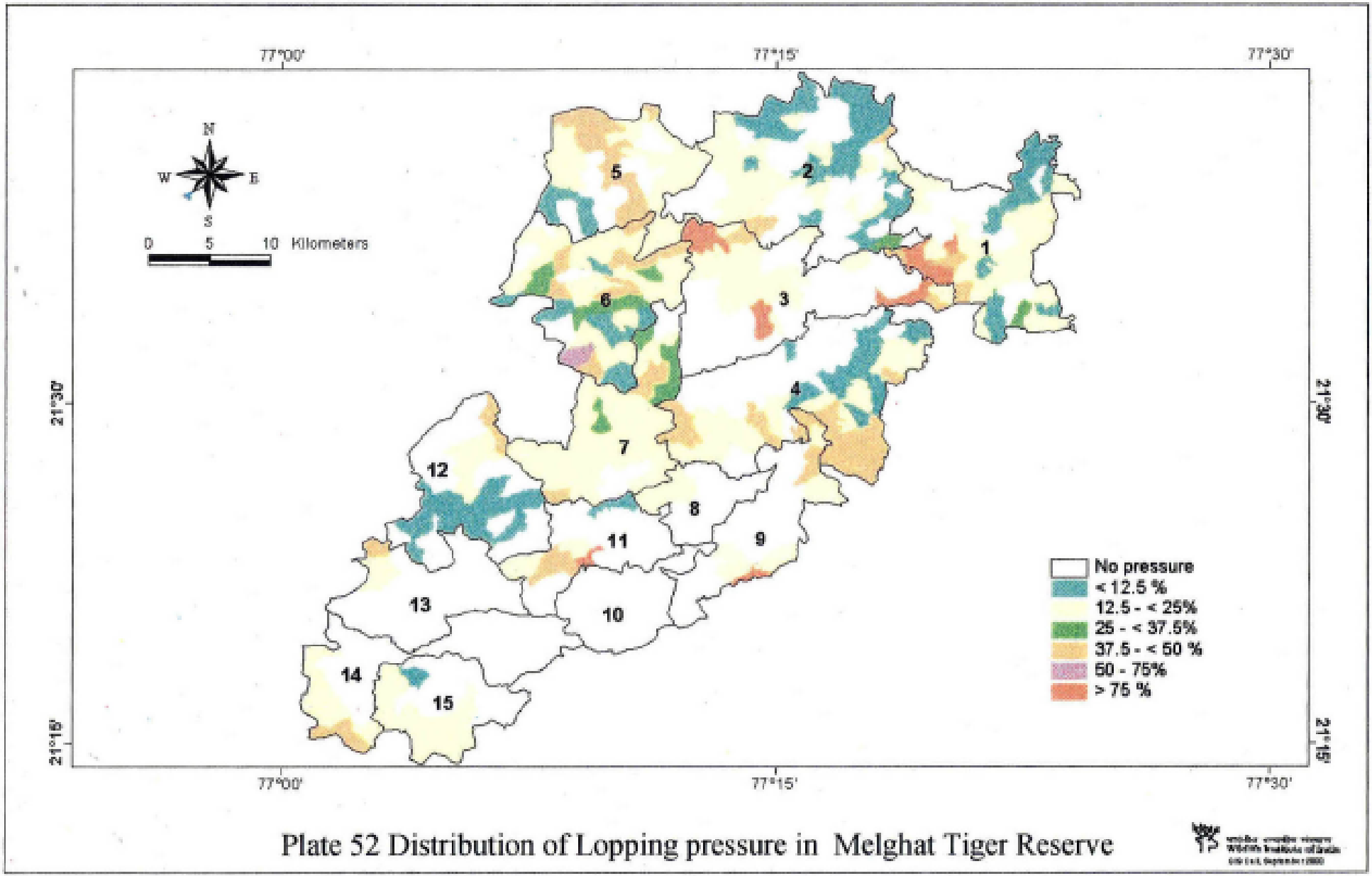


Plate 52 Distribution of Lopping pressure in Melghat Tiger Reserve

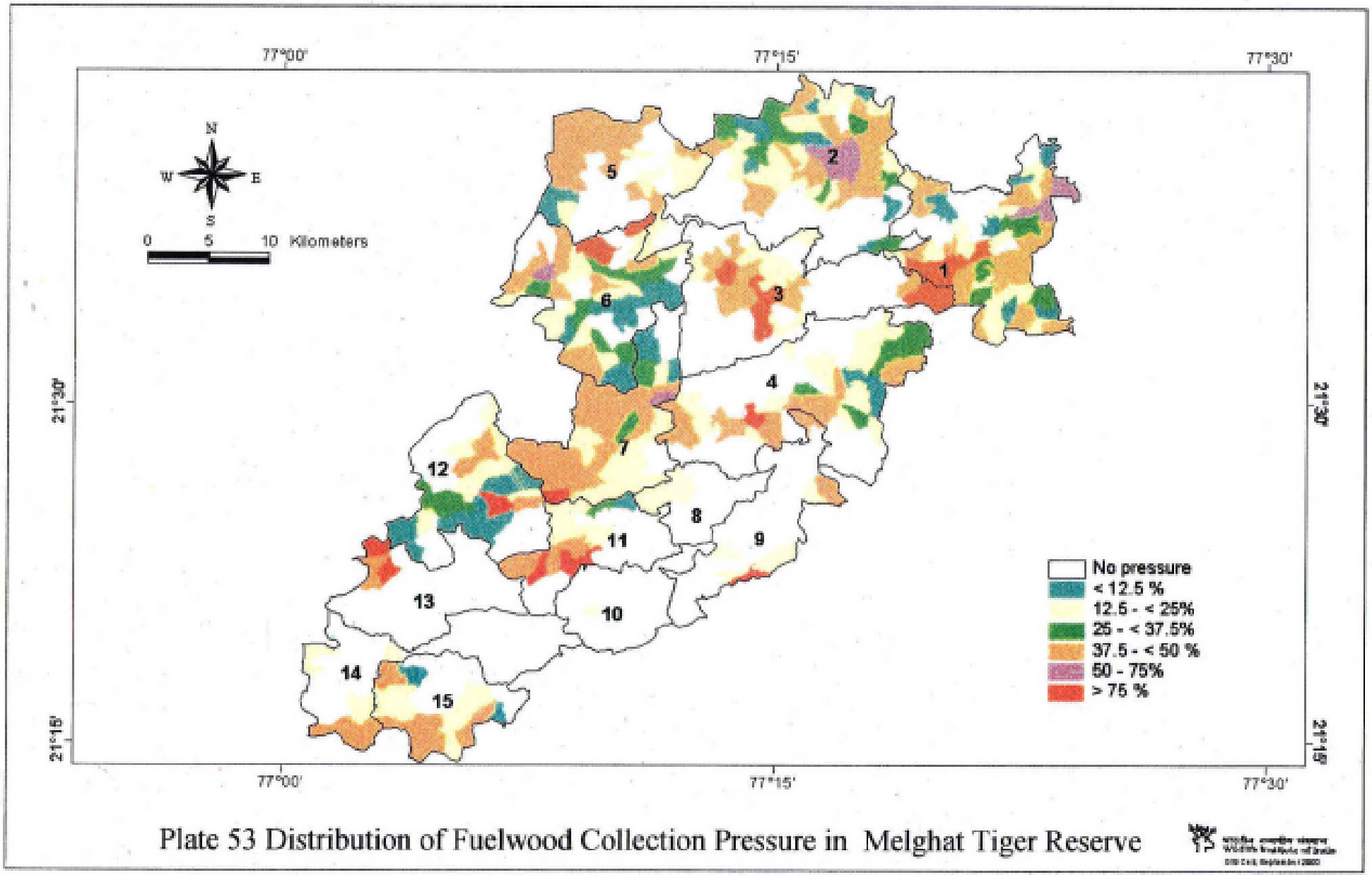


Plate 53 Distribution of Fuelwood Collection Pressure in Melghat Tiger Reserve

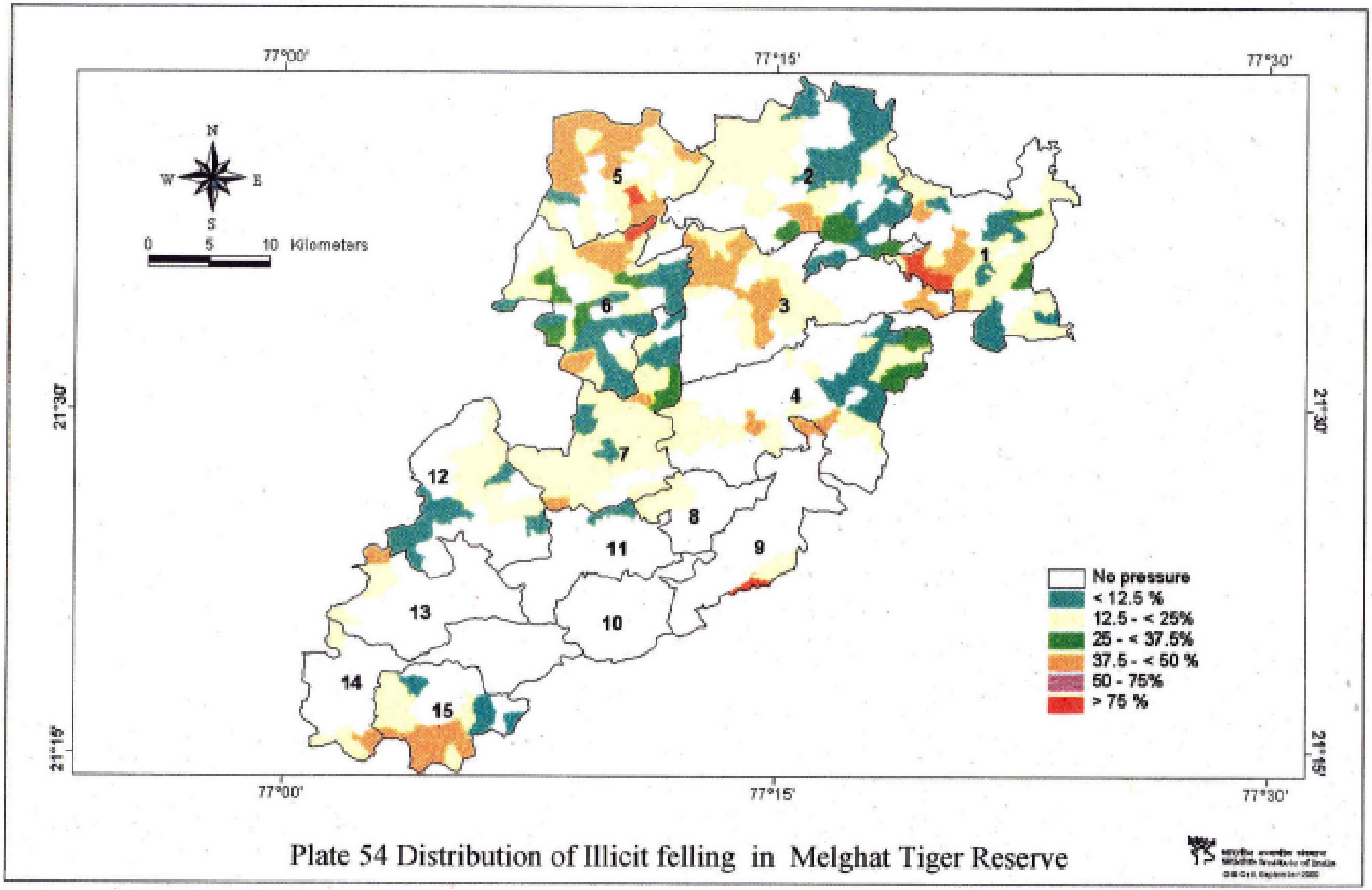


Plate 54 Distribution of Illicit felling in Melghat Tiger Reserve

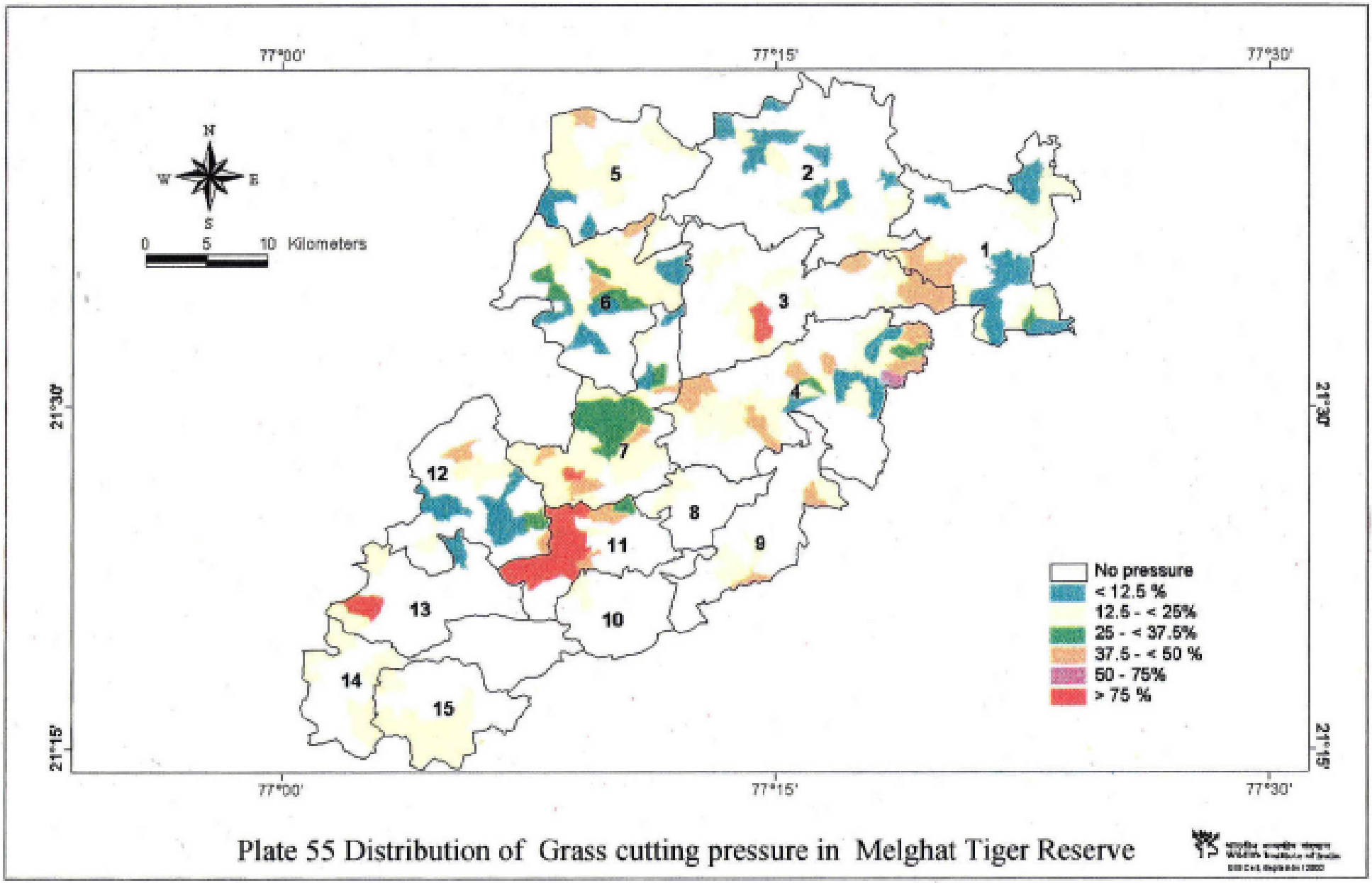


Plate 55 Distribution of Grass cutting pressure in Melghat Tiger Reserve

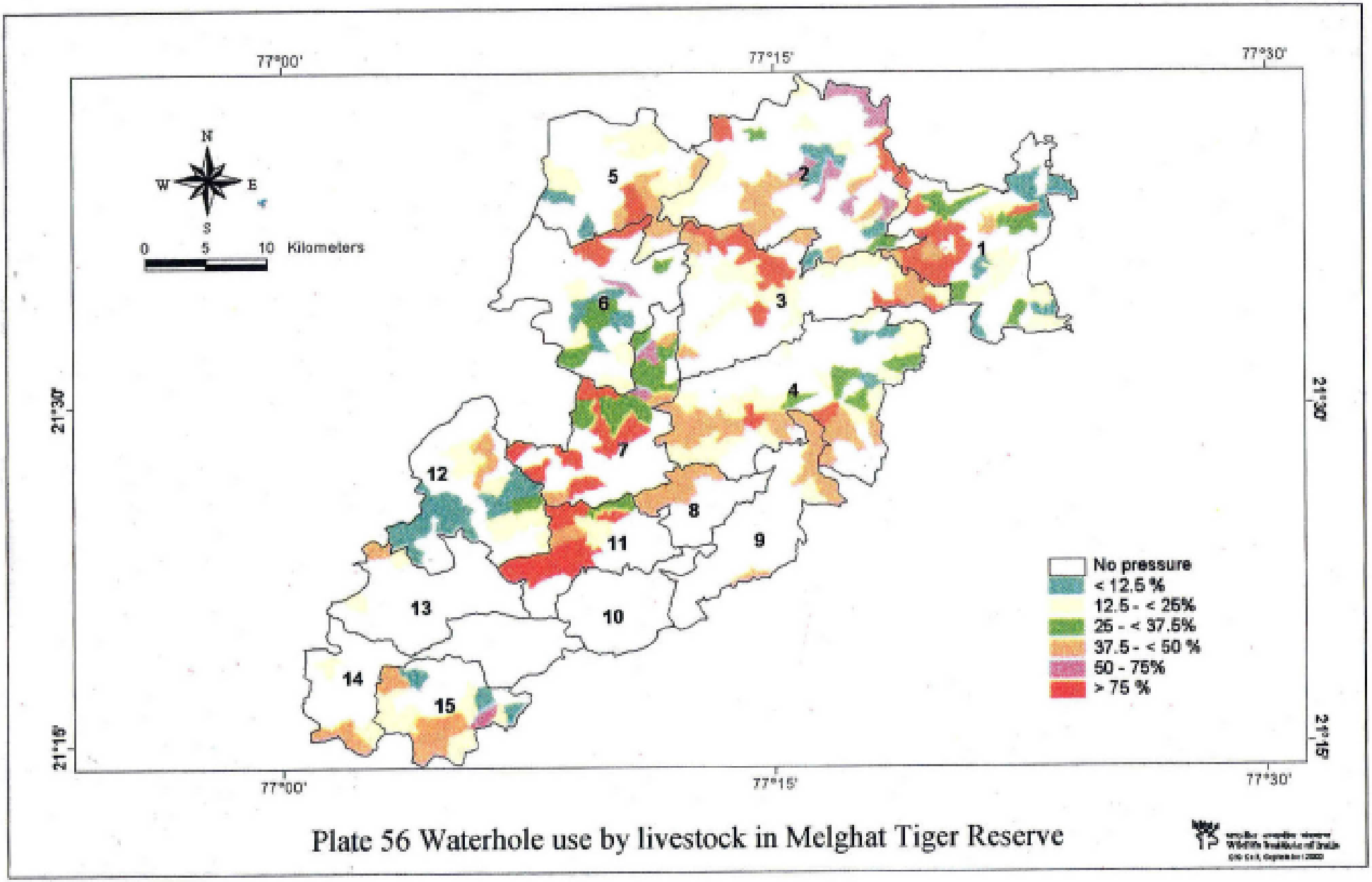


Plate 56 Waterhole use by livestock in Melghat Tiger Reserve

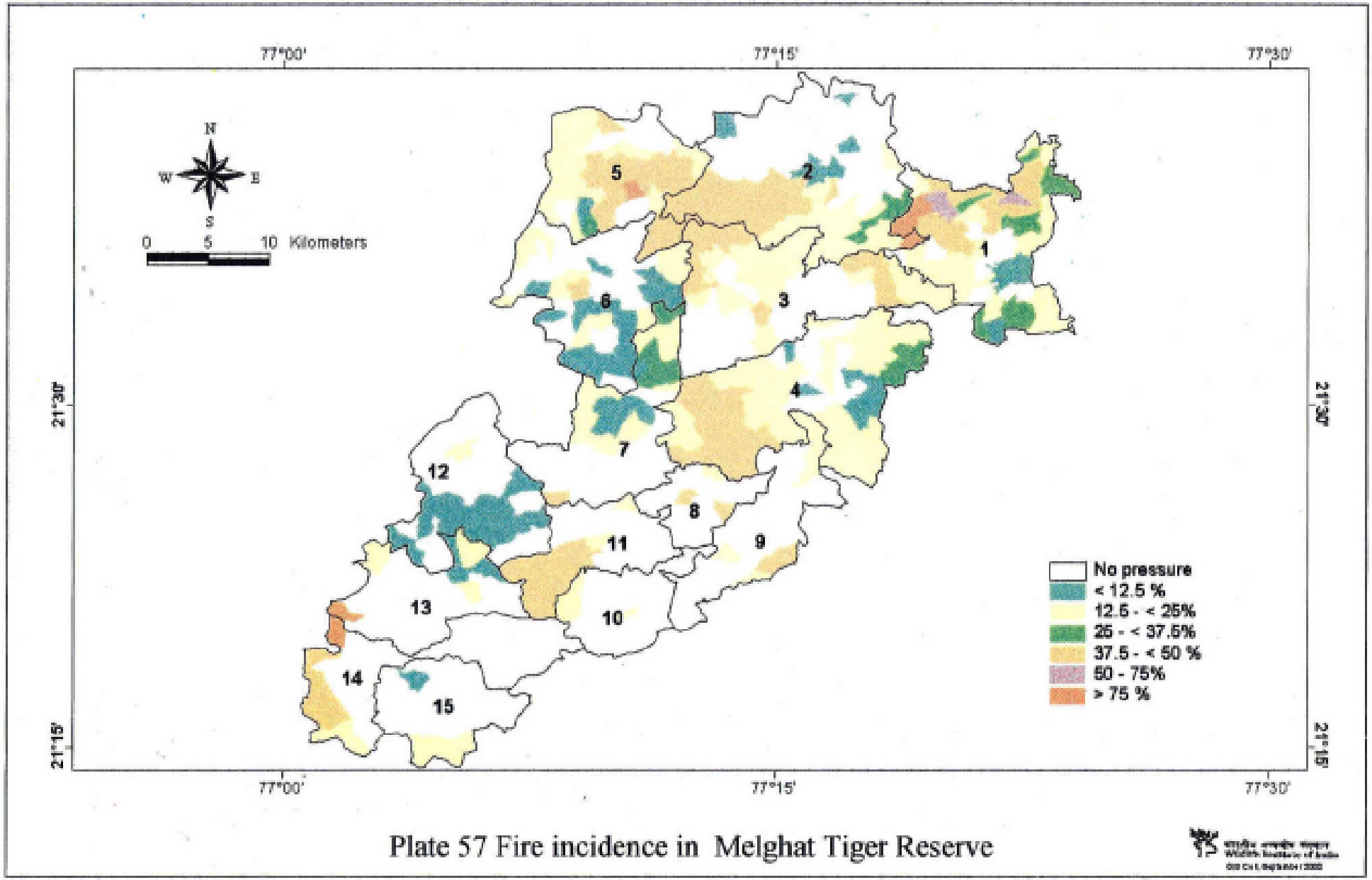


Plate 57 Fire incidence in Melghat Tiger Reserve

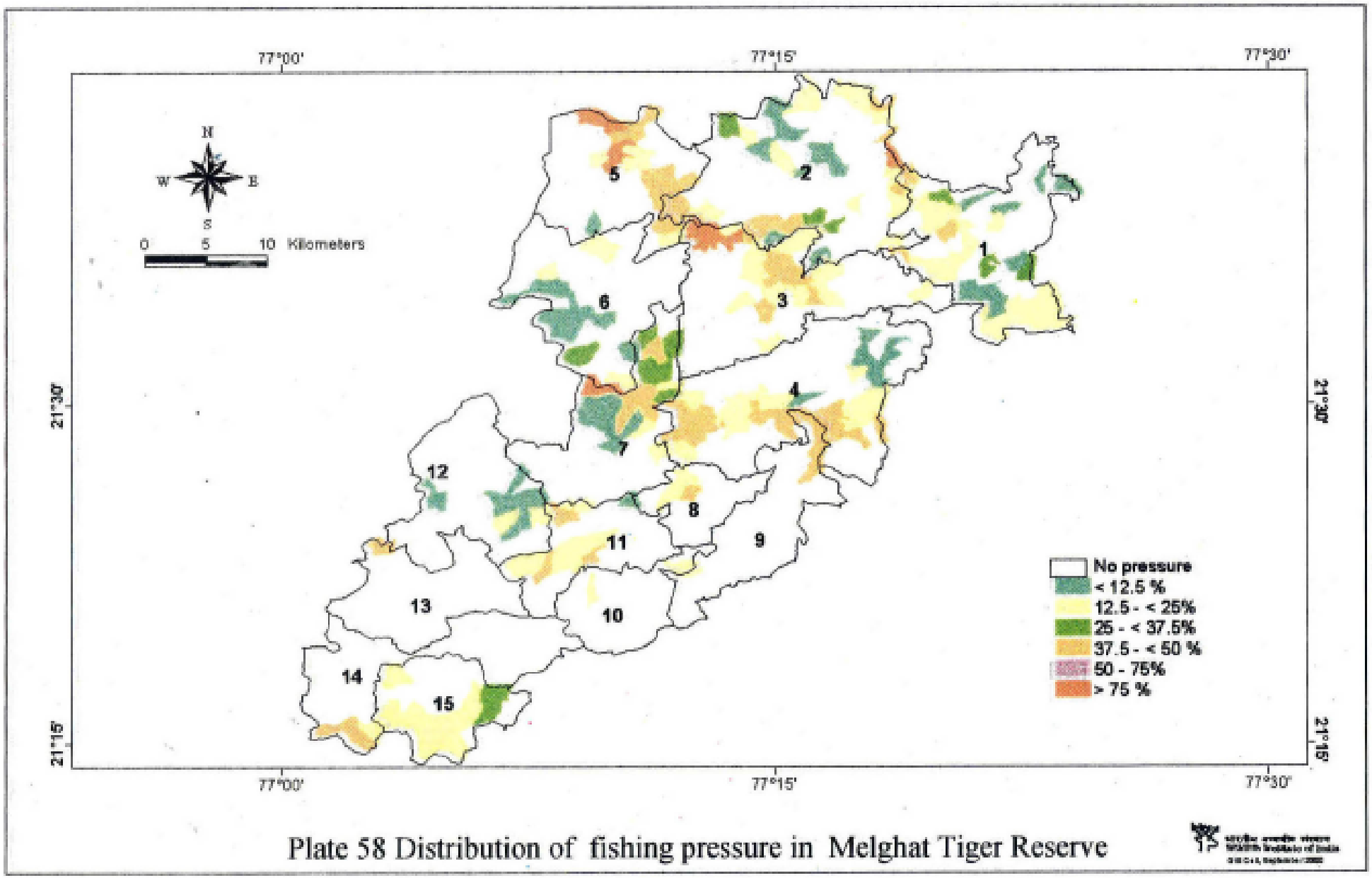


Plate 58 Distribution of fishing pressure in Melghat Tiger Reserve

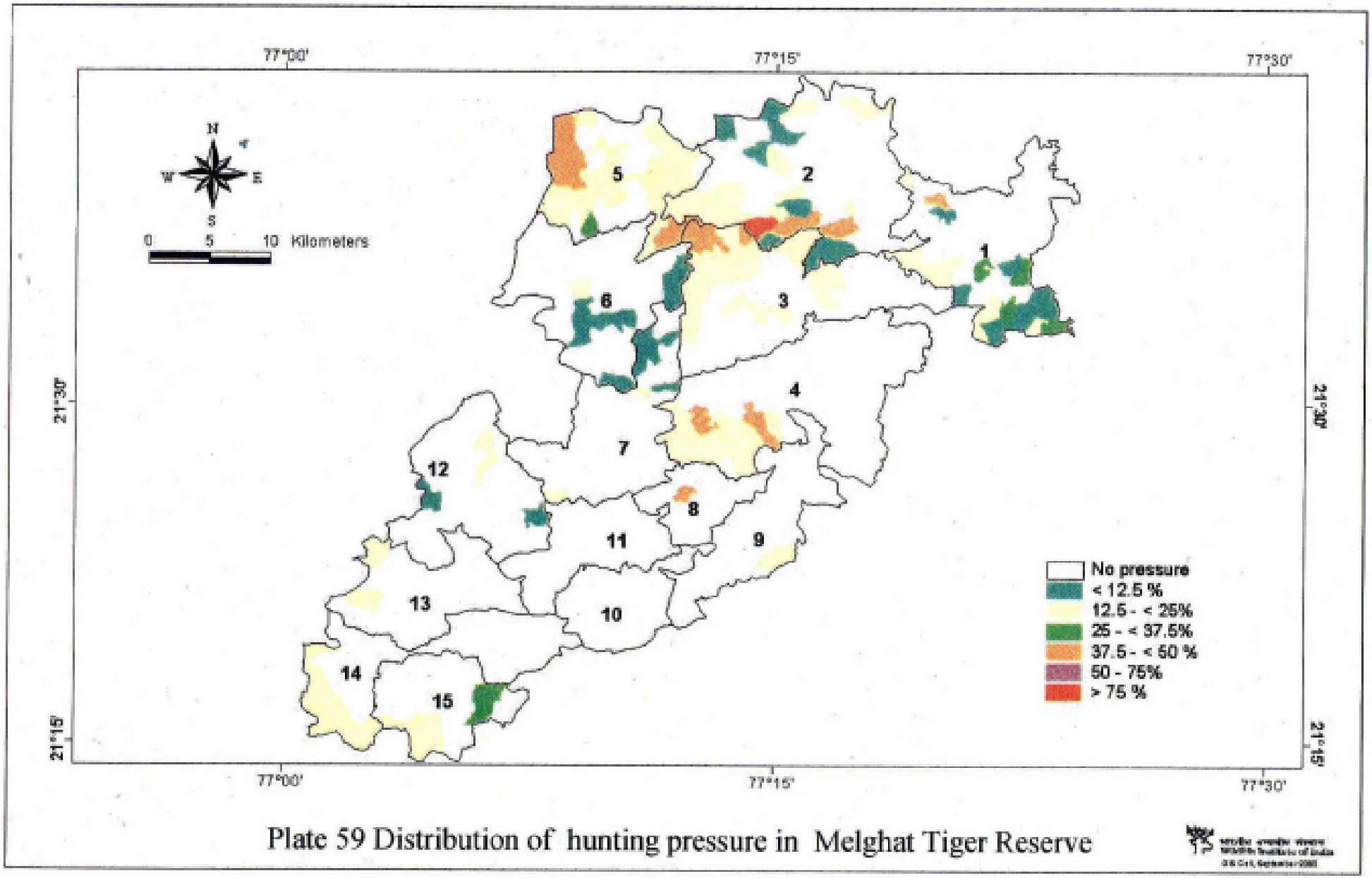


Plate 59 Distribution of hunting pressure in Melghat Tiger Reserve

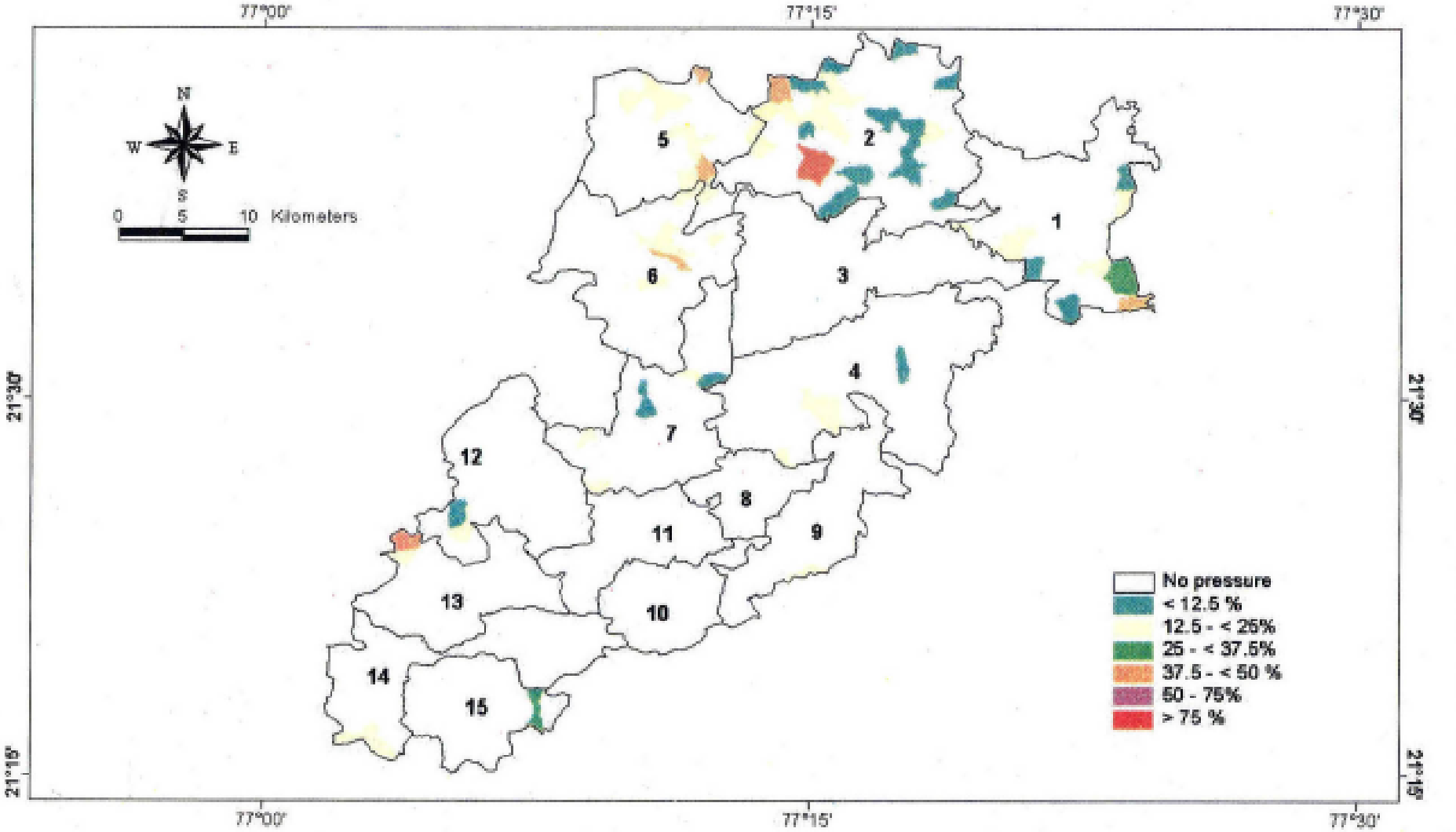


Plate 60 Encroachment in Melghat Tiger Reserve

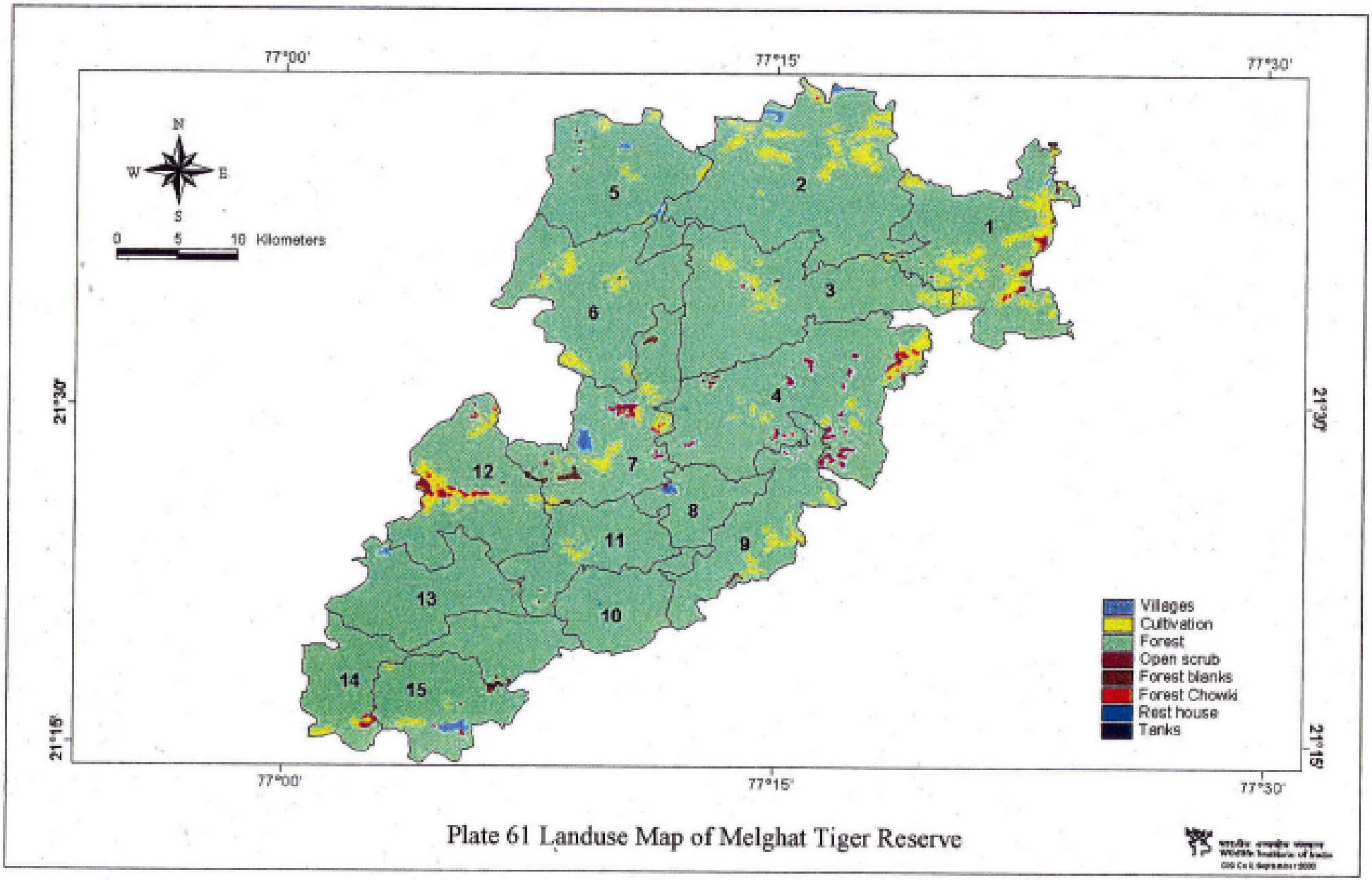


Plate 61 Landuse Map of Melghat Tiger Reserve

Chapter 5

Conclusion and Management Recommendations

5.1 Key issues and opportunities identified in the analysis

This assessment identified many factors in the SCA that act as stressors, affecting elements of biological diversity, human, social and economic systems in the Satpuras. This chapter summarizes the major stressors, and the opportunities that have been identified to mitigate effects of those stressors. Additional positive actions that could contribute to restoration of ecological conditions and conditions in human communities in the SCA are also identified. The stressors are described below within 6 major categories. It is impossible to neatly categorize these stressors, so there is some unavoidable overlap among the categories.

5.1.1 Issues related to roads and transportation

A significant network of roads has been developed within the SCA. These include both local roads that are used for access to villages, and a national highway that traverses the northern part of the SCA. In Betul district in the year 1992-93 the road length of all weather roads (metalled and motorable throughout the year) was 1289 kms and by the year 1996 it was 1337.38 kms. As regards the seasonal roads that is roads which are motorable only during the dry seasons the road length was 3808 kms, in the year 1992-93 and by the year 1996 it was 2401.45 kms. The reduction in length of the seasonal roads may be on account of conversion of these roads to all weather roads. In case of Hoshangabad District, the Panchmari Sanctuary has a road lengh of around 171 Kms and these are basically forest roads and cart tracks. The total road length in Bori Santuary and Satpura National Park is 441 Kms and these are also all unmetalled forest roads. In the Hoshangabad division the length of roads is 496.6 km and these are again basically forest roads. The length of Public Works Department roads, a majority of which most are metalled, is around 35 kms. (Plate 42, 48 and 49). In the Melgaht Tiger Reserve and the manged forest areas the constructions of roads have been discouraged. The present working Plans of East and West Melghat Divisions prescribe that width of the road should not allowed to be increased but the standard of the road surface may be improved. No additional road construction other than temporary extraction roads of modest specifications should be allowed. All such roads should be broken by taking trenches when the work is over. In Gugamal National Park the total existing road length is 110 kms. No traffic is allowed in this area and hence Management Plan prescribes that the roads will continue to have modest specifications. These raods become unserviceable during monsoon because of fast moving streams running across the road at number of places. In order to keep these roads open to wildlife managers the existing roads would be strengthen by constructing retaining walls, breast walls and crossed drains. Roads may have a variety of negative effects on biological diversity and function including direct reduction of habitat area, degradation of habitat conditions, reduction of the use made by animals of habitats adjoining roads, direct injury and killing of animals by vehicles, isolation of populations of a species, facilitation of poaching and illegal collecting, facilitation of invasion by exotic species, and introduction of other disturbances such as human-caused fire.

5.1.2 Issues related to riparian areas and reservoirs

A large number of stressors affect riparian areas and reservoirs. These stressors include grazing; road alignment, construction and use; fishing, including the practice of using pesticides to kill fish that are then collected; other forms of water pollution; farming and invasion of exotic species (e.g., Parthenium) in the draw-down areas of reservoirs; collection of sand; the placement of tourist camps in riparian areas; setting up livestock camps and other temporary occupancy of riparian areas (e.g., construction crews). Such activities have negative effects on a wide array of species including fish, amphibians, crocodiles, terrapins, otters, insectivorous plants, Indian giant squirrels, osprey, grey-headed fishing eagles, and fish owls.

5.1.3 Issues related to tourism

Tourism is a growing issue in the SCA. Stressors related to tourism include water pollution in the town of Pachmarhi, which affects drainages coming off the Pachmari plateau, and the siting of tourist facilities in riparian areas. Species that are affected by these activities are discussed under issues related to riparian areas.

5.1.4 Issues related to rare and locally-distributed species

Many rare and/or locally-distributed species occur in the SCA. While there is not just a single stressor affecting all these species, they are identified as a group because they are inherently at greater risk of extirpation. The species of concern include ratel, pied hornbill, stork-billed kingfisher, black-capped kingfisher, osprey, green munia, caracal, Rusty Spotted Cat, Eurasian cocoos, and forest spotted owlet.

5.1.5 Issues related to managed forests

Forest management activities have changed the structure, composition, and extent of forests within the SCA. Reduction in the amounts of late succession stage and old-growth forests, including riparian old-growth forests, have reduced the amount of habitat available to species like the mottled wood owls, brown wood owls, Indian giant squirrels, flying squirrels, a variety of woodpecker species & eagles. Additionally, woodpecker species are negatively affected by removal of snags from managed forests. The removal of hollow (dead or partially dead) trees from managed forests also reduces habitat for several species of birds, reptiles & smaller mammals. Forest management activities have also resulted in low populations of ungulate species as inferred through dung counts in managed forests and protected areas. Activities that have likely contributed to low populations include replacement of native forests with plantations, replacement of open area with plantations, disturbance of understorey vegetation, reduction in tree density in managed forests (chapter 3), and increased levels of disruption caused by human activity. As populations of these species serve as prey for tiger and other large predators, there is a likely secondary effect on populations of those species.

Overall, the change in structure & composition of managed forests, development of roads, and many activities associated with villages interspersed throughout those forests, have resulted in reduced habitat quality for many species throughout the Betul forest divisions. These forests separate the Melghat tiger reserve from the Pachmari protected area complex (refer to appropriate figure in Chapter 2). This likely results in severely reduced interactions among populations of species including tigers, large ungulates, and species that are associated with old forests.

5.1.6 Issues related to collection of plant parts & plants, poaching of wild animals and other consumptive human activities

A great array of both legal and illegal human activities affect population & distribution of species

and diversity within the SCA. Several of these, including tourism, road development, fishing, farming in draw-down areas, and forest management have been mentioned in the previous sections. The remaining activities are related primarily to the legal and illegal collection or poaching of species and non-timber forest products (NTFP). These include:

- Collection of rare plants.
- Extensive collection of medicinal plants like *Chlorophytom tuberosum*
- Collection of fruits of *Semicarpus anacardium, Terminalia bellerica, Terminalia chebula, Emblica officinalis,* and *Buchnania lanzan*
- Collection of tendu leaf and mahua flowers, and fires set to facilitate that collection
- Fires set to facilitate collection of antlers
- Some illegal cutting and removal of timber from managed forests
- Extensive illegal and tapping of *Sterculia urens* gum leading to death of trees
- Fuelwood collection
- Shared use of water sources by domestic livestock and wild animals
- Honey collection
- Poaching of tigers, leopards, prey & several other species

These activities negatively affect a large number of species. Collection of rare and medicinal plants threatens populations of those plants. Collection of fruits reduces the population & productivity of the trees that produce the fruits, and negatively influence frugivore species. Illegal fires disrupt wildlife populations, disturb forest understories, and significantly reduce dead wood from the forest. Firewood collection also removes dead wood and snags. Smuggling of timber results in a loss of tree cover and density. Shared use of water sources results in competition and spread of diseases among wild animals and reducing habitat of crocodiles & others. Poaching directly affects tigers, leopards, other large predators, population of pray & other target species.

5.2 Opportunities to enhance conservation of biological diversity

Information and data analysis for the SCA provided insight into potential mitigation opportunities. Provided insight into possible mitigation for the stressors identified above, and other opportunities to enhance conservation of biological diversity. These are described below.

5.2.1 Managed forests

Improved coordination of management between the managed forests and the protected areas in the SCA could provide significant biodiversity benefits. Specific objectives of this improved coordination would be to maintain/ restore old forest conditions, improve habitat conditions for those species that are prey for large predators, and maintain and/ or restore corridors for movement of animals across the Betul forest divisions. Specific measures could include the following:

- Maintaining existing old-growth forests.
- Maintain the largest diameter snags, a minimum of 5 per hectare.
- Maintain significant den trees.
- Maintain natural grassy openings.
- Provide for weed control in natural openings.
- Balance removal of lantana with restoration of native shrub habitat.
- Identify existing and potential movement corridors between Melghat and the Pachmarhi protected area complex, and institute comprehensive management measures to maintain habitat conditions that are conducive to successful movement by species through management of corridors.

5.2.2 Riparian areas and reservoirs

Riparian areas are key sites for biodiversity, and also the focus of many conflicts between human activity and biodiversity. Reservoirs, although artificially created, have attained significant biodiversity values, and are subject to conflict. Comprehensive measures for management of riparian areas and reservoirs would provide great benefits for biodiversity in the Satpuras. The overall objectives for such management could be to improve both terrestrial and aquatic habitat quality, and to reduce the direct impacts of human activities. Specific measures could include:

- Establish a no disturbance buffer along significant stream channels. Width of the buffer to be 3 times the average height of riparian stands. Buffer should include stream headwaters.
- Maintain large woody debris/fallen trees in streams, eg. 4 per running k.m. equitably spaced as practicable.
- Maintain native grasses, sedges herbs & shrubs, in riparian areas.
- Establish specific guidelines for human activites that impact riparian zones, such as construction of roads, watchtowers, picnic spots, cattle camps, labor camps and cattle resting areas. Specifics could include the following:
  - (i) Allow camping and picnicking only in designated sites
  - (ii) Ban cattle & labour camps within the designated buffer
  - (iii) Design new roads when essential away from riparian zones, reduce roadlength along riparian zones by closures
  - (iv) Eliminate use of pesticides and other toxic chemicals in streams and riparian area catchments
  - (v) Review pesticides being permitted and establish guidelines that will avoid use of impactive pesticides in catchment areas. This has to be a higher level policy decision
  - (vi) Develop alternative water sourcss for cattle withing village areas
- Eliminate agriculture in reservoir draw-down areas
- Provide opportunities for fish culture within village tanks

5.2.3 Roads and transportation

The transportation system within SCA could be managed so that existing roads create less impact on biodiversity. Future transportation planning could be designed to minimize negative impacts. Specific guidelines and actions could include the following:

- Reduce speed of vehicles on the existing fair weather roads & highway along significant sections through speed brakers, check points, more patrols, etc.
- Examine the possibility of using under passes and overpasses to reduce vehicle/ animal conflicts on national highway, and providing dispersal opportunities.
- Conduct ecological assessments on proposed alignments for new roads. Seventy percent of stream channel length to be free of associated roads.
- Design a centralized road system to provide access to villages
  - (i) Use buses and other appropriate conveyance to reduce the dependence on large number of small vehicles
  - (ii) Use check posts and night closure to regulate traffic

5.2.4 Tourism

Coordination among those agencies responsible for tourism development is essential in order to

reduce negative effects on biodiversity and generating positive influence for greater public awareness of the values of wild lands. Within the SCA, there needs to be coordination with the Cantonment Board in Pachmarhi to mitigate potential impacts of growing tourist development withing Pachmari. A specific immediate concern is increasing levels of water pollution generated within Pachmarhi that contaminates catchments in the Satpuras.

5.2.5 Rare and locally-distributed species

Specific measures are necessary for some rare and locally-distributed species. These may include (Some of the following measures overlap with strategies stated above);

Tigers (leopards will be benefited by these same measures)

- Provide year-round pug mark based monitoring in protected areas and annual surveys in managed forests
- Survey & map caves and dens to protect such sites from impacts of human activities including Forest Management Programmes.
- Strengthen intelligence network targeted at poachers. Augment enforcement capability.
- Manage habitats to maintain geographical native range of prey species.
- Control human use of water sources (includes livestock use).
- Maintain integrity of identified corridors.
- Restore corridors between Melghat and BSP Protected Areas Complex.

Species using snags & den trees

- Maintain 3-5 hollow trees, per ha. in managed forests
- Manage for old forest conditions and snags as recommended in the managed forest section.

Otters, Crocodiles & Terrapins

- Maintain pool habitats within streams.
- Protect stream headwaters.
- Manage large woody debris in streams.
- Protect sandy banks and sand pits, known resting habitats of crocodiles & terrapins.
- Ban the use of pesticides for fishing.
- Control use of gill nets for fishing.
- Encourages development of village-based fish culture in village tanks.
- Discourage cultivation in draw-down areas of reservoirs.

5.3 Collection of plants & parts, poaching of animals and other contact of impactive human activities

A variety of measures designed to reduce the impacts as discussed need to be considered

5.3.1 Grazing

- Initiate grazing settlement that considers needs of wild herbivores and its implementation.
- Reduce cattle kills by large predators through intensive and responsible herding and penning of livestock. Reduce unproductive cattle.
- Do not allow summer grazing of livestock in riparian areas.
- Close dry grasslands to livestock grazing.
- Eliminate grazing in areas known to have assemblage of rare and endangered species, eg. mesic sites, stretches of riparian areas
- Provide incentives to controlled livestock grazing.

5.3.2 Sand collection

- Do not allow sand collection in protected areas.

- In managed forests collection under permits needs to have sensitivity to known nesting sites of crocodilians, terrapins and habitat of otters.

5.3.3 Collection of rare and endangered plants, including medicinal plants

- Require permits.
- Requires practical monitoring.
- Protect specific areas.
- Initiate outreach awareness programmes. Include citizen groups, panchayats and educational institutions.
- Monitor population & distribution of such species.
- Train staff to identify species.
- Monitor markets to develop protection strategies

5.3.4 Collection of fruits

- Provide incentive programs to maintain a reasonable proportion of fruits on trees, protecting trees, and regeneration. Use village microplans and involve village protection committees.
- Assess market forces and influence of middleman to develop mitigation prescriptions in favour of conservation. Explore cultivation on village areas.

5.3.5 Illegal bamboo extraction

- Provide incentives to raise bamboo in nurseries and on village and non-forest land.
- Improve enforcement by filling vacant forest protection positions, improving intelligence operations, and training.

5.3.6 Degradation of forest areas around villages

- Establish unambiguous demarcation of forest boundaries.
- Make forest restoration part of the charter of village protection committees & incentive package

5.4 Methods and tools developed to identify key issues

a. **Spatial Scales- Remote Sensing and GIS**

- Vegetation Mapping- Vegetation map of the BSP Complex and the three Managed Forests Divisions of Betul has been prepared using remotely sensed data IRS LISS II IB at a scale of I: 50,000.
- Field Data collection to fine tune maps.
- Spatial Transfer of data at different thematic and spatial scales.
- Developing spatial databases in consonance with the actual field needs.

b. Data base for-

- Working Plan Officers
- Protected Area Management Planning Officers
- Logging Plans and restoration strategies for Forest Departments and Forest Development Corporations. Focus on marking rules, use of WHR information to integrate habitat requirements of representative species.
- Identifying suitable areas for plantations with sensitivity to ecological attributes.
- Appropriate Site Selection of Check Dams.
- Identifying appropriate sites for soil and Moisture Conservation strategies.
- Planning Social Forestry Plantations, integrating ecological considerations.

c. **Wildlife Habitat Relationships**

i. **Planning & generating information for WHR**

- Field Observation of birds and animals to supplement published data on Wildlife Habitat Relationships
- Planning for field methodology for data collection for WHR.
- Developing a data dictionary.
- Choice of spatial layers for WHR.
- Picking up appropriate parameters for identifying habitat needs.
- Developing a Wildlife Habitat Relationship matrix for use of Working Plan Officers.

ii **Utilization of Information in WHR - A Realistic Approach**

- Consider vegetation change as analyzed through working plan process.
- Improve skills of data collection through objectively designed sampling strategy.
- Develop silvicultural prescriptions to serve WHR profiles.

d. Learnings during the Project Period

- Developing large and medium scale spatial database
- Handling of large database in GIS domain.
- Use of local and traditional knowledge to build tools.
- Lessons from Rural Self help schemes.
- Transparency and inter agency cooperation. Need to solicit help of credible NGOs and NGIs.
- Focus on frontline staff capabilities and facilitation. Use of traditional and professional knowledge.
- Association of religious organizations in support of conservation through their edicts.
- Institutionalizing documentation.

e. Application of concepts

- Overarching principles of Conservation Biology and Landuse Ecology
- Human Impacts – what they portend
- Landuses, contradictions and opportunities
- Values of Wilderness
- Integrating traditional knowledge with modern ecological concepts
- Ecological resiliance through species conservation.
- Landscape based conservation planning through complementing PA & Managed Forest Plan.
- Changing cultural ethos, social change and opportunities for conservation

APPENDIX I

PLANTS OCCURING IN THE SCA

(A) BIG TREES

S.No.	Local Name	Botanical name	Family
1.	Babool	*Acacia nilotica*	Leguminaceae
2.	Khair	*Acacia catechu*	Leguminaceae
3.	Gadkhair	*Acacia ferruginea*	Leguninaceae
4.	Rimjha	*Acacia leucophloea*	Leguminaceae
5.	Hardu	*Adina cordifolia*	Rubiaceae
6.	Bel	*Aegle marmelos*	Rutaceae
7.	Maharukh	*Ailanthus excelsa*	Simarubuceae
8.	Chichola	*Albizzia odoratissima*	Leguminaceae
9.	Chichwa	*Albizzia procera*	Leguminaceae
10.	Gurar	*Albizzia lebbek*	Leguminaceae
11.	Dhaora	*Anogeissus latifolia*	Combretaceae
12.	Kala Dhaora	*Anogeissus pendula*	Combretaceae
13.	Neem	*Azadirachta indica*	Meliaceae
14.	Salai	*Boswellia serrata*	Burseraceae
15.	Kasai	*Bridelia retusa*	Euphorbiaceae
16.	Palas	*Butea monosperma*	Leguminaceae
17.	Kumbhi	*Careya arborea*	Myrtaceae
18.	Bhirra	*Chloroxylon swietenia*	Meliaceae
19.	Lasora	*Cordia dichotoma*	Boraginaceae
20.	Shisham	*Dalbergia latifolia*	Leguminaceae
21.	Sissoo	*Dalbergia sissoo*	Leguminaceae
22.	Phansi	*Dalbergia paniculata*	Leguminaceae
23.	Suarukh	*Dillenia pentagyna*	Dilleniaceae
24.	Tendu	*Diospyros melanoxylon*	Ebenaceae
25.	Pangar	*Erythrina suberosa*	Leguminaceae
26.	Aonla	*Emblica officinalis*	Euphorbiaceae
27.	Bar	*Ficus benghalensis*	Moraceae
28.	Gulaar	*Ficus glomerata*	Moraceae
29.	Pakar	*Ficus lacor*	Moraceae

30.	Pipal	*Ficus religiosa*	Moraceae
31.	Kawit	*Feronia limonia*	Rutaceae
32.	Kekad	*Garuga pinnata*	Burseraceae
33.	Gamari	*Gmelina arborea*	Verbenaceae
34.	Dhaman	*Grewia tillifolia*	Tiliaceae
35.	Anjan	*Hardwickia binata*	Leguminaceae
36.	Chirol	*Holoptelia intogrifolia*	Ulmaceae
37.	Baranga	*Kydia calycina*	Malvaceae
38.	Lendia	*Lagerstroemia parviflora*	Lythraceae
39.	Jhingan	*Lannea grandis*	Anacardiaceae
40.	Mahua	*Madhuca latifolia*	Sapotaceae
41.	Am	*Mangifera indica*	Anacardiaceae
42.	Kaim	*Mitragyna parviflora*	Rubiaceae
43.	Tinsa	*Ougeinia dalbergioides*	Leguminaceae
44.	Karanj	*Pongamia pinnata*	Leguminaceae
45.	Bija	*Pterocarpus marsupium*	Leguminaceae
46.	Khajur	*Phoenix sylvestris*	Pedaliaceae
47.	Semal	*Bombax ceiba*	Malvaceae
48.	Jamun	*Syzygium cumini*	Myrtaceae
49.	Kari	*Saccopetalum tomentosum*	Anonaceae
50.	Ritha	*Sapindus emarginatus*	Sapindaceae
51.	Kusum	*Schleichera oleosa*	Oleaceae
52.	Mokha	*Schrebra swietenioides*	Oleaceae
53.	Sal	*Shorea robusta*	Dipterocarpaceae
54.	Rohan	*Soymida febrifuga*	Meliaceae
55.	Amra	*Spondias pinnata*	Anacardiaceae
56.	Kulu	*Sterculia urens*	Sterculiaceae
57	Padari	*Steriospermum personatum*	Bignoniaceae
58.	Padar	*Steriospermum suareoclens*	Bignoniaceae
59.	Imli	*Tamarindus indica*	Leguminaceae
60.	Sagon	*Tectona grandis*	Verbenaceae
61.	Arjun	*Terminalia arjuna*	Combretaceae
62.	Bahera	*Terminalia bellirica*	Combretaceae
63.	Harra	*Terminalia chebula*	Combretaceae
64.	Saj	*Terminalia tomentosa*	Combretaceae

S.No.	Local Name	Botanical name	Family
65	Akol	*Alangium salvifolium*	Cornaceae
66.	Sitafal	*Anona sqamosa*	Anonaceae
67.	Hingkot	*Balanites roxburghii*	Zygophilaceae
68.	Keolar	*Bauhinia purpurea*	Leguminaceae
69.	Asta	*Bauhinia racemosa*	Leguminaceae
70.	Kachnar	*Bauhinia variegata*	Leguminaceae
71.	Semla	*Bauhinia retusa*	Caesalpineae
72.	Achar	*Buchnania latifolia*	Anacardiaceae
73.	Gilchi	*Casearia tomentosa*	Samydaceae
74.	Tondri	*Casearia graveolens*	Samydaceae
75.	Amaltas	*Cassia fistula*	Leguminaceae
76.	Daiyar	*Cordia macleodoii*	Boraginaceae
77.	Galgal	*Cochlospermum*	religiosum
78.	Barna	*Cratava unicularis*	Capperideae
79.	Tarwar	*Cassia auriculata*	Caricaceae
80.	Jamrasi	*Elaeodendron glaucum*	Celastraceae
81.	Datranga	*Ehretia laevis*	Boraginaceae
82.	Jhaur	*Euphorbia nerifolia*	Euphorbiaceae
83.	Kakai	*Flacourtia indica*	Bixaceae
84.	Papra	*Gardenia latifolia*	Rubiaceae
85.	Phetra	*Gardenia turgida*	Rubiaceae
86.	Dikamali	*Gardenia lucida*	Rubiaceae
87.	Dudhi	*Holarrhera antidysentrica*	Apocynaceae
88.	Maidalakri	*Litsaea chinensis*	Lauraceae
89.	Sindhuri	*Mallotus phillippinensis*	Euphorbiaceae
90.	Ranjana	*Manilkara hexandra*	Sapotaceae
91.	Khirni	*Mimusops elengii*	Sapotaceae
92.	Aal	*Morinoa tinctoria*	Rubiaceae
93.	Madhukamini	*Murraya exotica*	Rutaceae
94.	Mithinim	*Murraya koengii*	Rutaceae
95.	Mainphal	*Randia dumetorum*	Rubiaceae
96.	Katul	*Randia uliginosa*	Rubiaceae
97.	Mokha	*Schrebera switenioides*	Oleaceae
98.	Kusum	*Schleichera oleosa*	Sapindaceae
99.	Bhilma	*Semecarpus anacardium*	Anacardiaceae
100.	Majni	*Trema*	orentalis
101.	Dudhi	*Wrightia tinctoria*	Apocyanaceae
102.	Kali Dudhi	*Wrightia tomentosa*	Apocyanaceae
103.	Ber	*Zizyphus jujuba*	Rhamnaceae
104.	Chatber	*Zizyphus xylopyra*	Rhamnaceae

(C) SHRUBS AND UNDER-SHRUBS

S.No.	Local Name	Botanical name	Family
105.	Sitaphal	*Anona squamosa*	Anonaceae
106.	Chilati	*Caesalpinia sepiaria*	Leguminaceae
107.	Aak	*Calotropis gigantia*	Asclepiadaceae
108.	Karonda	*Capparis opaca*	Apocynaceae
109.	Panwar	*Cassia tora*	Leguminaceae
110.	Tarwar	*Cassia auriculata*	Leguminaceae
111.	Bhant	*Clerodendron infortunatum*	Verbenaceae
112.	Bhandar	*Colebrookia oppositifolia*	Labiatae
113.	Chirpat	*Desmodium pulchellum*	Leguminaceae
114.	Kharent	*Dodonea visocosa*	Sapindaceae
115.	Kopadulli	*Embelica robusta*	Myrsinaceae
116.	Kath jamun	*Eugenia heyneana*	Myrtaceae
117.	Thuar	*Euphorbia neriifolia*	Euphorbiaceae
118.	Baikal	*Gymnosporia montana*	Celastraceae
119.	Gursakri	*Grewia hirsuta*	Tileaceae
120.	Marorphali	*Helicteris isora*	Sterculiaceae
121.	Dudhi	*Holarrhena antidysenterica*	Apocynaceae
122.	Neel/Jeerola	*Indigofera pulchella*	Leguminaceae
123.	Raimunia	*Lantana aculeata*	Verbenaceae
124.	Chilati	*Mimosa rubicans*	Leguminaceae
125.	Hathikand	*Leea macrophylla*	Vitaceae
126.	Harsingar	*Nyctanthes arbor-tistis*	Verbenaceae
127.	Nagphani	*Opuntia dillenii*	Cactaceae
128.	Karail	*Petalidium barlerioides*	Acanthaceae
129.	Karhai	*Pogostemon plectranthoides*	Labiatae
130.	Bhander	*Strobilanthus callosus*	Acanthaceae
131.	Jhau	*Tamarix dioica*	Tamericaceae
132.	Bankapas	*Thospesia lampas*	Malvaceae
133.	Gokurru	*Tribulus terrestris*	Zygophyllaceae
134.	Chikto	*Triumfetta rotundifolia*	Tiliaceae
135.	Harjudi	*Woodfordia fruiticosa*	Lythraceae
136.	Dhawai	*Waltheria indica*	Sterculiaceae
137.	Gukhura	*Xanthium rotundifolia*	Tiliaceae
138.	Churna	*Zizyphus rugosa*	Rhamnaceae
139.	Jharberi	*Zizyphus rotundifolia*	Rhamnaceae
140.	Nirgudi	*Vitex negundo*	Verbenaceae

(D) CLIMBERS

S.No.	Local Name	Botanical name	Family
141.	Comchi	*Halix precatorius*	Leguminaceae
142.	Chilati Bari	*Acacia caesia*	Leguminaceae
143.	Chilati Choti	*Acacia pennata*	Leguminaceae
144.	Mahul	*Bauhinia vahlii*	Leguminaceae
145.	Palasbel	*Butea superba*	Leguminaceae
146.	Kukranji	*Calycopteris floribunda*	Combretaceae
147.	Malkangani	*Celastrus paniculata*	Rannunculaceae
148.	Banda	*Clematis triloba*	Celastaceae
149.	Nagbel	*Cryptolepis buchananii*	Asclepiadaceae
150.	Amarbel	*Quscuta reflexa*	Convolulaceae
151.	Baichandi	*Dioscorea daemona*	Dioscoraceae
152.	Gathalu	*Dioscorea bulbifera*	Dioscoraceae
153.	Gudmar	*Gymenma sylvestris*	Asclepiadaceae
154.	Dhimarbel	*Ichnocarpus frutescens*	Apocyanaceae
155.	Golahari	*Milletia auriculata*	Leguminaceae
156.	Kewanch	*Mucuna prurita*	Leguminaceae
157.	Ramdaton	*Smilax macrophylia*	Liliaceae
158.	Nasbel	*Spatholobus roxburghii*	Leguminaceae
159.	Dudhbel	*Vallaris hoynei*	Apocynaceae
160.	Keoti	*Ventilago calyculata*	Rhamnaceae
161.	Lalbel	*Ventilago madrasputana*	Rhamnaceae
162.	Dokarbel	*Vitis*	latifolia
163.	Gurbel	*Viscum orientale*	Loranthaceae
164.	Makoy	*Zizyphus oenoplia*	Rhamnaceae
165.	Bans	*Dendrocalamus strictus*	Graminae
166.	Chind	*Phoenix acaulis*	Palmae

(F) GRASSES

S.No.	Local Name	Botanical name	Family
167.	Palwal	*Andropogon bladhii*	Graminae
168.	Palwal	*Andropogon pertusus*	Graminae
169.	-	*Anthistiria scandens*	Graminae
170.	Lamb	*Aristida deprossa*	Graminae
171.	Gandhi	*Apluda aristida*	Graminae

172.	Katang	*Bambusa bambos*	Graminae
173.	Dhaman	*Cenchrus montanus*	Graminae
174.	-	*Chloris roxburghiana*	Graminae
175.	Bans	*Dendrocalamus strictus*	Graminae
176.	-	*Eragrostis tenella*	Graminae
177.	-	*Eragrostis ciliaris*	Graminae
178.	Sabai	*Eulaiopsis binata*	Graminae
179.	Kural	*Heteropogon contortus*	Graminae
180.	-	*Ischaemum laxum*	Gramnae
181.	Sheda	*Ischaemum pilosum*	Graminae
182.	Kunda	*Ischaemum sulocatus*	Graminae
183.	Mushal	*Iselema laxum*	Graminae
184.	Chhir	*Imperata cylindrica*	Graminae
185.	Kodon	*Paspalum scrobiculatum*	Graminae
186.	Ghamor	*Panicum antidotale*	Graminae
187.	Kuri	*Panicum helopes*	Graminae
188.	Takri	*Panicum sanguinale*	Graminae
189.	Dhaman	*Pennisettum cenchroides*	Graminae
190.	-	*Panicum distachyum*	Graminae
191.	Kari	*Sacharum spontaneum*	Graminae
192.	Paeonia	*Sechina sulcatum*	Graminae
193.	Kotul	*Setaria glauca*	Graminae
194.	Palanji	*Sporobolus tenacissimus*	Graminae
195.	Gunher	*Themedia quadrivalvus*	Graminae
196.	Deobahari	*Thysanolaena maxima*	Graminae
197.	Khuri	*Vetiverria zizanioides*	Graminae

APPENDIX II

LIST OF NTFP SPECIES AVAILABLE IN THE STUDY AREA

S.No.	Botanical name	Local Name	Part	Uses	Collection Season
1.	*Abrus precatorius*	Gunja /ratti	climber (leaf,root,seeds)	Cough	Apr/May.
2.	*Agave sislana*	Kandhi /antibala	small plant (whole plant)	Contraceptive	Aug-Feb.
3.	*Achyranthus aspera*	Apamarg /chirchita	small plant (whole plant)	wounds and piles	Oct-Nov.
4.	*Aloe barbedensis*	Gwarpatha /ghritkumari	small shrub	liver, skin stomach disorders	Aug-Jun
5.	*Asparagus racemosus*	Satavar /satmuli	climber (root)	gout, weakness	Oct-Nov
6.	*Emblica officinalis*	Aonla	tree (fruit)	vitamin C, trifla churna, pickles, shampoo	Dec-Jan
7.	*Acalifa indica*	Kuppi/Indian Eclifa	plant (leaves)	Cough,cold	Oct-Dec
8.	*Anogeissus latifolia*	Dhaora	tree (gum)	colors, printing, medicine industry	Oct-June
9.	*Emblica tesgerium*	Bybarang	small plant (seeds)	powder taken with sugar as a wormicidal	Nov-Dec
10.	*Bauhinia variegata*	Kachnar	tree (bark, flowers)	haemorrhage	Apr-June
11.	*Boerhaavia diffusa*	Punarnava (red)	plant (root, leaves)	leaf extract for eyes; root for	Oct-March

APPENDIX III

LIST OF SPECIES OF ETNO-MEDICO IMPORTANCE

Sl. No.	Scientific Name	Family	Local name	Habit	Ethno-medico use
1	*Abrus precatorius*	Papilionaceae	Gunj (M	Climber	Roots-Cough, sunstroke
2	*Acacia farnesiana*	Mimoseae	Guababul (M)	Shrub	Leaves-Tender leaves for sperm concentration. Bark-Black magic
3	*Celastrus paniculata*	Celastraceae	Malkanguni (M) Pingwel (K)	Climber	Seed-Brain tonic, paralysis, rhumatism. Leaves Menstrul disorder. Root-Snakebite.
4	*Gloriosa superba*	Liliaceae	Kalalawi (M) Zagdaili (K)	Climber	Root-Activates delivery Seed-Cancer Leaves-Lice control
5	*Holorrhena pubescens*	Apocynaceae	Kalakuda (M)	Tree	Bark-Dysentery, Stomachache, Diarrhoea, Piles, chestache, Dermothereptic use
6	*Hymenodictyon excelsum*	Rubiaceae	Bhavarsal (M) Bhavarsal (K)	Tree	Innerbark-Antipyretic, Sis-congestant, Apetiser, Liquorfobia. Mixture of all parts of the tree for interal haemorrhage.
7	*Litsea glutinosa*	Lauraceae	Maidalakadi (M) Lenja (K)	Small tree	Leaves-Nutritious, Diabetes, Kidney stone Seed-Oil extract for sprains, Echzima.
8	*Oroxylum indicum*	Bignoniaceae	Tetu (M)	Tree	Roots-Pus formatin in ear Seed-Pancreatic disorder
9	*Pterocarpus marsupium*	Papilionaceae	Bija (M)	Tree	Leaves-Dermothereptic use. Gum-Toothache. Flowers-Acidity, Apetiser, urinary disorder. Latex-Sperm concentration, Bone fracture.
10	*Redermachera xylocarpa*	Bignoniaceae	Khadsinga (M) Tetu (K)	Tree	Oil-Dermothereptic use. Seed-Black magic against snake bite.
11	*Terminalia chebula*	Combrataceae	Hirda (M) Hila (K)	Tree	Fruits-to improve digestion, teeth strengthening

12	*Thespesia papulnea*	Malvaceae	Bhendi (M) (Paraspimpal)	Tree	Root & fruit-sterlity. Bark-Dermothereptic use. Leaves-Threadworm.
13	*Wrightia tomentosa*	Apocynaceae	Mudhi (M) Dudhi	Tree	Seed-Availabe as ayurvedic preparation int eh market.
14	*Adiantum lunulatum*	Polypodiaceae	Hansraj (M)	Shrub	Whole plant-Cough of infants, Elephantitis
15	*Adhatoda vasica*	Acanthaceae	Adulaa (M)	Shrub	Leaves-Theumatism. Leaves/flowers-Asthema
16	*Aegle marmelos*	Rutaceae	Bel (M)	Tree	Whole plant-Fever Fruit-Acidity, Diahorrea
17	*Aloe indica*	Liliacae	Korfad (M)	Shrub	Leaves-Indigestion, Blood purification.
18	*Argemone mexicana*	Papaveraceae	Piwala dhotra (M) Kallai (K)	Shrub	Root-Skin disease. Plant-Jaundice, Blisters and injuries. Leaves-Leprosy
19	*Asparagus racemosa*	Liliaceae	Shatavari (M) Dhota Sui-ellai (K)	Climber	Root-Weaning, Anti-Rabies, Blood purification, Acidity.
20	*Biophytum sensitivum*	Graniaceae	Lahan Lajau (M) Sharam-Etara (K)	Herb	Bulb-STDs/ Veneral disease
21	*Capparis zeylancia*	Capparidaceae	Ranwagat (M) Panchawa (K)	Climber	Fruit-Tubercuolosis
22	*Cardiospermum helicacabum*	Saindaceae	Kapalphodi (M)	Climber	Leaves-Menstrual disorder, Earache, Rheumatism.
23	*Carvia callosa*	Acanthaceae	Karvi (M) Bhandar (K)	Shrub	Leaves-Improve milk productivity of cattle.
24	*Cassine glauca*	Celastraceae	Aaran (M) Neru (K)	Tree	Leaves-Female hysteria Roots-Swelling and anti-venom
25	*Clematis triloba*	Ranunculaceae	Ranjai (M) Mogra (K)	Climber	Whole Plant-Leukoderma, Eczima, Goitre, Skin disease.

APPENDIX III (a)

PLANT COLLECTED AND RECORDED FROM PACHMARHI AREA, (M.P.)

Scientific Name	Habit	Status
Ranunculaceae		
Clematis triloba Heyne ex Roth	C	R
Naravelia zeylanica (L.) DC.	C	"
Dilleniaceae		
Dillenia pentagyna Roxb	T	O
Menispermaceae		
Cissampelos pareira L	C	O
Papaveraceae		
Argemone mexicana L.	H	"
Brassicaceae		
Cardamine scutata Thunb	"	C
Coronopus didymus (L.) J.E. Sm	"	O
Capparaceae		
Cleome monophylla L.	"	C
Cleome simplicifolia (Camb) Hk.f.	"	R
Violaceae		
Viola betonicifolia J.E. Sm.	"	"
Flacourtiaceae		
Casearia graveolens Dalz	S	O
Flacourtia indica (Burm.f) Merr.	"	"
Cochlospermaceae		
Cochlospermum religiosum (L.) Als.	T	R
Polygalaceae		
Polygala arvensis Willd	H	O
P. elongata Klein ex Willd	"	C
P. persicariifolia DC.	"	O
Caryophyllaceae		
Polycarpon prostratum (Forsk) Asch.	"	"

Malvaceae		
Hibiscus lobatus (J.A.Murr) O.Kunt	H	C
H. sabdariffa L.	"	O
H. vitifolius L.	"	R
Kydia calycina Roxb	T	O
Sida acuta Burm	H	C
S. cordata (Burm.f.) Borss	"	"
S. cordifolia L.	"	"
S. rhombifolia L.	"	"
Urena lobata L.	"	"
Bombacaceae		
Bombax ceiba L.	T	R
Sterculiaceae		
Firmiana colorata (Roxb) R.Br.	"	"
Helicteres isora L.	S	O
Sterculia villosa	T	R
Waltheria indica L.	H	O
Tiliaceae		
Corchorus aestuans L.	"	C
Grewia elastica Royle	T	O
G. rothii DC.	S	"
G. tilifolia Vahl	T	"
Triumfetta annua L.	H	C
T. pilosa Roth	"	"
T. rhomboidea Jacq	"	"
T. rotundifolia Lamk	S	O
Oxalidaceae		
Biophytum sensitivum (L.) DC.	H	O
Oxalis corniculata L.	"	C
O. corymbosa DC.	"	"
Balsaminaceae		
Impatiens balsamina L.	"	"
I. inconspicua Benth ex Wt & Arn	"	R
Rutaceae		
Chloroxylon swietenia DC.	T	O
Murraya koenigii (L.) Spreng.	"	C
M. paniculata (L.) Jack	S	O
Burseraceae		
Boswellia serrata Roxb ex Colebr.	T	"
Garuga pinnata Roxb.	"	"

Meliaceae		
Soymida febrifuga (Roxb) A. Juss.	"	"
Toona ciliata Roem	"	"
Celastraceae		
Cassine glauca (Rottb.) Kunt.	"	C
Celastrus paniculatus Willd	C	O
Rhamnaceae		
Helinus lanceolatus Brandis	S	C
Ventilago denticulata Willd	"	O
Ziziphus oenoplia (L.) Mill.	C	"
Z. rugosa Lamk.	S	C
Z. xylopyrus (Retz) Willd.	"	"
* *Z. mauritiana* Lamk.	"	"
Vitaceae		
Ampelocissus latifolia (Roxb) Pl.	C	O
Cayratia trifolia (L.) Domin	"	"
Cissus repanda (Wt & Arn) Vahl	"	"
Leea crispa Van Royen ex L.	S	"
Sapindaceae		
Dodonaea viscosa Jacq. Enum.	"	C
Schleichera oleosa (Lour) Oken	T	C
Anacardiaceae		
Buchanania lanzan Spreng	"	O
Lannea coromandelica (Houtt) Merr	"	"
Mangifera indica L.	"	C
Rhus parviflora Roxb	S	"
Fabaceae		
* *Aeschynomene indica* L.	H	O
Alysicarpus vaginalis (L.) DC.	"	C
Atylosia scarabaeoides (L.) Ba.	C	"
Butea monosperma (Lamk) Taub	T	"
B. superba Roxb	C	O
Crotalaria albida Heyne ex Roth	H	C
C. spectabilis Roth	"	O
C. trifoliastrum Willd	"	"
C. umbelatta Wight ex Wt & Arn	"	"
Desmodium laxiflorum DC.	"	"
D. motorium (Houtt) Merr.	"	R
D. rotundifolium Baker	"	"
D. velutinum (Willd) DC.	"	O
* *D. triflorum* (L.)D.C.	"	C
Erythrina suberosa Roxb	T	O

Flemingia bracteata (Roxb.)Wt.	H	"
F. macrophylla (Willd) Merr.	S	O
Indigofera cassioides Rottl.	H	"
I. linifolia (L.f.) Retz.	"	C
I. linnaei Ali	"	O
Millettia extensa Benth	C	"
Mucuna pruriens (L.) DC.	"	C
Pongamia pinnata (L.) Pierre	T	O
Pterocarpus marsupium	"	"
Pueraria tuberosa (Roxb) DC.	C	"
Sesbania bispinosa (Jacq) W.F.	H	"
Smithia conferta J.E. Smith	"	C
Sophora interrupta Bedd.	S	O
Tephrosia purpurea (L.) Pers.	H	"
Uraria rufescens (DC.) Schindl	"	"
Vigna trilobata (L.) Verdc.	"	"
Zornia gibbosa Span.	"	C
Caesalpiniaceae		
Bauhinia malabarica Roxb.	T	O
B. vahlii Wt. & Arn.	C	C
B. variegata L.	T	O
Caesalpinia decapetala (Roth) Als.	S	"
Cassia fistula L.	T	C
C. mimosoides L.	H	
C. occidentalis L.	S	O
C. pumila Lamk	H	C
C. tora L.	"	"
* *C. absus* L.	"	"
Mimosaceae		
Acacia catechu (L.f.) Willd	T	O
A. leucophloea (Roxb) Willd	"	C
A. pennata (L.) Willd	C	"
A. torta (Roxb) Craib	S	"
Albizia odoratissima (L.f.) Benth	T	O
A. procera (Roxb) Benth	"	"
Rosaceae		
Rubus ellipticus J.E. Sm.	S	C
Droseraceae		
Drocera burmanii Vahl	H	"
D. indica L.	"	R
Combretaceae		
Anogeissus latifolia (Roxb ex DC) Wall	T	C
A. pendula Edgew	"	"
Terminalia alata Heyne ex Roth	"	"

T. bellirica (Gaertn) Roxb	"	"
T. chebula (Gaertn) Retz.	"	"
T. arjuna Bedd.		
Myrtaceae		
Syzygium cumini (L.) Skeels	"	"
Lecythidaceae		
Careya arborea Roxb.	"	O
Melastomataceae		
Melastoma malabathricum L	S	"
Sonerila tenera Royle	H	R
Lythraceae		
Ammania baccifera L.	"	C
Lagerstroemia parviflora Roxb	T	"
Rotala rotundifolia (Roxb) Koeh.	H	O
Woodfordia fruticosa (L.) Kurz	S	C
Onagraceae		
Ludwigia octovalvis (Jacq) Raven	H	"
L. perennis L.	"	"
Cucurbitaceae		
Diplocyclos palmatus (L.) Jeffery	"	O
Momordica dioica Roxb	C	"
Solena heterophylla Lour.	"	"
Trichosanthes bracteata (Lamk) Voigt	"	"
Begoniaceae		
Begonia picta J.E. Smith	H	C
Aizoaceae		
Glinus oppositifolia (L.) A.DC.	"	O
Mollugo pentaphylla L.	"	C
Apiaceae		
Bupleurum wightii P.K. Mukh	S	"
Centella asiatica (L.) Urb.	H	"
Hydrocotyle sibthorpioides Lamk	"	"
Pimpinella diversifolia DC.	"	"
P. heyneana (DC.) Kurz	"	"
Trachyspermum ammi (L.) Sprague	"	R
Araliaceae		
Schefflera venulosa (Wt. & Arn) Harms	S	O

Rubiaceae		
Adina cordifolia (Roxb) Hk.f.ex Brandis	T	"
Borreria articularis (L.f.) F.N. William	H	C
B. pusilla (Wall) DC.	"	"
Gardenia latifolia Ait. Hort.	T	"
Knoxia sumatrensis (Retz) DC.	H	O
Mitragyna parvifolia (Roxb) Korth	T	"
Oldenlandia corymbosa L.	H	C
O. diffusa (Willd) Roxb.	"	"
Spermadictyon suaveolens Roxb	S	O
Xeromphis spinosa (Thunb) Koay	"	"
Asteraceae		
Acanthospermum hispidum DC.	H	C
Ageratum conyzoides L.	"	"
Artemisia nilagirica (Cl.) Pamp	"	"
Artemisia parviflora Buch-Ham ex D Don	"	O
Bidens biternata (Lour) Merr.	"	C
Blumea lacera (Burm.f.) DC.	"	O
B. oxyodonta DC.	"	C
Caesulia axillaris Roxb.	"	O
Centipeda minima (L.) A.Br & Ascher.	"	"
Cyathocline purpurea (Buch-Ham ex D.Don) O.Kuntze	"	C
Eclipta alba (L.) Hassk.	"	"
Elephantopus scaber L.	"	"
Emilia sonchifolia (L.) DC.	"	"
Gnaphalium luteo-album L.	"	O
Seigesbeckia orientalis L.	"	"
Tridax procumbens L.	"	C
Vernonia cinerea (L.) Less.	"	"
V. divergens (Roxb) Edgew.	"	O
Vicoa cernua Dalz	"	C
V. indica (L.) DC.	"	"
Xanthium strumarium L.	"	"
Plumbaginaceae		
Plumbago zeylanica L.	"	O
Primulaceae		
Anagalis arvensis L.	"	C
Lysimachia candida Lindl	"	"
Myrsinaceae		
Embelia tsjeriam-cottam (Roem & Schult) DC.	T	O
Sapotaceae		
Manilkara hexandra (Roxb) Dub.	S	C

Ebenaceae		
Diospyros melanoxylon Roxb	"	"
Jasminum roxburghianum Wall ex Cl.	"	"
J. sambac (L.) Ait	"	"
Apocynaceae		
Catharanthus pusillus (Murr.) G.Don	H	O
Icnocarpus frutescens (L.) R.Br.	S	C
Vallaris solanacea (Roth) Kuntz	"	O
Wrightia tinctoria R.Br.	T	C
W. tomentosa Roem & Schult	"	O
Asclepiadaceae		
Calotropis gigantea (L.) R.Br.	H	"
Cryptolepis buchananii Roem & Schult.	S	C
Gymnema sylvestre (Retz.) R.Br.	C	"
Hemidesmus indicus (L.) R.Br.	S	"
Sarcostemma acidum (Roxb) Voigt	H	"
Gentianaceae		
Canscora decurrens Dalz.	"	O
C. decussata (Roxb) J.A.	"	"
Exacum pumilum Griseb.	"	"
Swertia minor (Griseb.) Knobl.	"	"
Boraginaceae		
Cynoglossum zeylanicum Thunb	"	O
Helitropium brevifolium Wall.	S	"
Trichodesma indicum (L.) R.Br.	H	C
Convolvulaceae		
Argyreia nervosa (Burm.f.) Boj.	C	O
Cuscuta reflexa Roxb.	H	C
Evolvulus alsinoides (L.) L.	"	"
* *E. nummularis* L.	"	O
Ipomoea cairica (L.) Sweet.	C	"
I. eriocarpa R.Br.	H	C
I. hederifolia L.	C	O
I. nil (L.) Roth	"	C
I. pes-tigridis L.	"	O
Solanaceae		
Datura metel L.	S	"
* *Physalis minima* L.	H	"
Solanum indicum L.	"	"
S. nigram L.	"	C
S. torvum Sw.	S	O

Scrophulariaceae		
* *Bacopa procumbens* (Mill)Green.	H	C
Kickxia ramosissima (Wall) Janch.	"	O
Limnophila indica (L.) Druce.	"	C
Lindenbergia indica (L.) O.Kuntz.	"	O
Lindernia ciliata (Colsm.) Penn.	"	C
L. crustacea (L.) F. Muell.	"	O
L. hookeri (Cl.) Wettst.	"	R
Mazus pumilus (Burm.f.) Steenis	"	O
Scoparia dulcis L.	"	C
* *Sopubia delphinifolia* G.Don.	"	O
Striga gesneroides (Willd) Vatke	"	O
Lentibulariaceae		
Utricularia exoleta R.Br.	"	R
U. scandens Benj.	"	O
Bignoniaceae		
Oroxylum indicum (L.) Vent.	T	"
Tecoma stans (L.) Kunth.	"	"
Pedaliaceae		
Sesamum orientale (L.) Graham	H	"
Acanthaceae		
Andrographis paniculata (Burm.f.) Wall.	"	C
Barleria cristata L.	"	"
B. prionitis L.	"	O
Blepharis maderaspatensis (L.) Heyne ex Roth	"	C
Carvia callosa (Nees) Bremek.	S	O
Dicliptera roxburghiana Nees	H	C
Hygrophila auriculata (Schum.) Heine	"	O
Justicia betonica L.	S	C
Lepidagathis cristata Willd	H	O
Nelsonia canescens (Lamk) Spreng	"	"
Nilgirianthus campanulatus (Wt.) Bremek	S	"
Peristrophe bicalyculata (Retz.) Nees	H	"
Rostellularia japonica (Thunb.) Ellis	"	"
R. procumbens (L.) Nees	"	C
R. quinqueangularis (Koem ex Roxb) Nees	"	O
Rungia pectinata (L.) Nees	"	C
Strobilanthes walkeri Arn.	S	O
Thunbergia alata Bojer ex Sims	H	R
Verbenaceae		
Clerodendrum serratum (L.) Moon	S	R
Duranta repens L.	"	O
Gmelina arborea Roxb.	T	"

Holmskioldia sanguinea Retz.	S	R
Lantana camara L.	"	C
Nyctanthes arbor-tristis L.	T	O
Premna barbata Wall ex Sch.	S	"
Tectona grandis L.	T	C
Vitex negundo L.	S	O
Lamiaceae		
Anisomeles indica (L.) O.Kuntz.	H	C
Colebrookea oppositifolia J.E.Sm.	S	O
Hyptis suaveolens (L.) Poit	H	"
Lamium amplexicaule L.	"	R
Lavandula bipinnata (Roth) Kuntz.	"	O
Leonotis nepetifolia (L.) R.Br.	S	"
Leucas cephalotes (Roth) Spreng.	H	"
L. mollissima Wall ex Benth	"	"
L. montana (Roth) Spreng.	S	C
L. stricta Heyne ex Benth	H	"
L. zeylanica (L.) R.Br.	"	R
Micromeria biflora (Buch-Ham ex D. Don) Benth	"	C
Nepeta hindostana (Roth) Haines	"	O
Orthosiphon rubicundus (D.Don) Benth	"	"
Plectranthus mollis (Ait) Spreng.	"	"
Pogostemon benghalensis (Burm.f.) Kuntz	S	"
Amaranthaceae		
Achyranthes aspera L.	H	C
A. bidentata Blume	"	"
Aerva lanata (L.) Juss.	"	"
Allmania nodiflora (L.) R.Br.	"	"
Alternanthera sessilis (L.) R.Br.	"	"
Amaranthus viridis L.	"	O
Celosia argentea L.	"	C
Gomphrena celosioides Mart.	"	"
Pupalia lappacea (L.) Juss.	S	O
Polygonaceae		
Polygonum pedunculare Wall ex Wt.	H	C
P. stagninum Buch-Ham ex Meiss.	S	"
Lauraceae		
Litsea glutinosa (Lour) C.B. Rob.	T	O
Loranthaceae		
Dendrophthoe falcata (L.f.) Etting	SP	"
Scurrula cordifolia (Wall.) G.Don	"	"
S. parasitica L.	"	"

Viscum nepalense Sprang.	"	"
Euphorbiaceae		
Antidesma acidum Retz.	S	"
Bridelia retusa (L) Spreng	T	"
Emblica officinalis Gaertn	"	C
Euphorbia hypericifolia L.	H	"
E. nivulis Buch-Ham	S	"
E. nerifolia L.	T	"
E. prostrata Ait	H	"
* *E. geniculata* Orteg.	"	O
Glochidion velutinum Wt.	T	C
Mallotus philippensis (Lamk Muell	"	"
Phyllanthus amarus Schum.	H	"
P. debilis Klein Willd	"	"
Securinega leucopyrus (Willd) Muell	S	"
Ulmaceae		
Trema orientalis (L.) Bl.	T	"
Boehmeria scabrella Gaud.	S	"
Girardina zeylanica Decne	"	O
Ficus benghalensis L.	T	C
F. exasperata Vahl	"	"
F. hispida L.	S	"
F. microcarpa L.	T	"
F. religiosa L.	"	"
F. tomentosa Roxb ex Willd	"	"
Morus alba L.	"	O
Salicaceae		
Salix tetrasperma Roxb.	"	"
Pinaceae		
Pinus longifolia Roxb.	"	"
Orchidaceae		
Aerides multiflora Roxb.	H	"
Dendrobium crepidatum Lindl.	"	C
D. herbaceum Lindl	"	O
Nervilia prainiana (King&Pantl.) Seidenf.	"	R
Platanthera susannae (L.)Lindl.	"	R
Vanda testacea (Lindl.) Reichb.f.	"	C
Zingiberaceae		
Zingiber roseum (Roxb.) Rosc.	"	"
Costus speciosus (Koen.) Smith	"	"

Hypoxidaceae		
Hypoxis aurea Lour	"	O
* *Curculigo orchioides* Gaertn.	"	"
Dioscoreaceae		
Dioscorea bulbifera L.	C	C
D. oppositifolia L.	C	O
D. pentaphylla L.	"	"
Liliaceae		
Asparagus racemosus Willd	H	C
Chlorophytum laxum R.Br.	"	"
Gloriosa superba L.	"	R
Commelinaceae		
Commelina benghalensis L.	"	C
C. hasskarlii Clarke	"	O
C. suffruticosa Bl.	"	"
Cyanotis cristata (L.) D.Don	"	C
Murdania spirata (L.) Brueckn.	"	O
Arecaceae		
Phoenix acaulis Roxb.	"	R
P. sylvestris (L.) Roxb.	"	O
Araceae		
Arisaema tortuosum (Wall.) Schott	H	"
Eriocaulaceae		
Eriocaulon polycephalum Hk.f.	S	"
E. xeranthemum Mart.	"	"
Cyperaceae		
Carex cruciata Wahlenb.	"	"
Cyperus compactus Retz.	"	"
C. distans L.	"	"
C. esculentus L.	"	"
C. iria L.	"	C
C. kyllinga (Rottb.) Endl.	"	"
C. nutans Vahl.	"	O
C. rotundus L.	"	"
C. triceps Endl.	"	"
Fimbristylis dichotoma (L.) Vahl	"	"
Poaceae		
Alloteropsis cimicina (L.) Stapf.	G	C
Apluda mutica L.	"	"

Aristida setacea Retz.	"	"
Capillipedium assimile (Steud) A.Camus	"	"
Chloris dolichostachya Lagasca	"	"
Coix gigantea Koenig ex Roxb	"	O
Cymbopogon martinii (Roxb) Wats	"	C
Cynodon dectylon (L.) Pers.	"	"
Dactyloctenium aegypticum (L.) P.Beauv	"	"
Dendrocalamus strictus (Roxb.) Nees	"	O
Dichanthium annulatum (Forsk) Stapf	"	C
Digitaria setigera Roth & Roem.	"	"
D. stricta Roth ex Roem	"	O
Echinochloa colonum (L.) Linl.	"	C
Eragrostiella bifaria (Vahl) Bor.	"	"
Eragrostis diarrhena (Schult.) Steud.	"	"
E. gangetica (Roxb) Steud.	"	O
E. unioloides (Retz.) Nees ex Steud	"	C
E. viscosa (Retz.) Trin	"	"
Hemarthria compressa (L.f.) R.Br.	"	O
Heteropogon contortus (L.) P.Beauv	"	C
Imperata cylindrica (L.) P.Beauv	"	"
Ischaemum indicum (Houtt) Merill	"	"
Narenga prophyrocoma (Hance ex Trin) Bor	"	"
Oplismenus burmanii (Retz.) P.Beauv	"	"
O. compositus (L.) P.Beauv	"	"
Oropetium roxburghianum (Steud.) S.M.	"	"
Paspalidium flavidum (Retz.) A. Camus	"	"
Paspalum scrobiculatum L.	"	"
Phargmites karka (Retz.) Trin ex Steud.	"	"
Rottboellia exaltata L.f.	"	"
Saccharum spontaneum L.	"	"
Setaria intermedia Roem & Schult.	"	"
S. pallide-fusca (Schum.) Stapf.	"	"
S. verticillata (L.) P. Beauv	"	"
Sporobolus indicus (L.) R.Br.	"	O
Themeda quadrivalvis (L.) O.Ktze	"	C
T. triandra Forsk.	"	"
Thysanolaena maxima (Roxb.) O.Kuntze	"	O
Vetiveria zizanioides (L.) Nash	"	"
Pteridophytes		
Adiantum lunulatum Burm.	F	O
Cheilanthes furinosa (Forsk)Kaulf.	"	"
Ophioglossum sp.	"	"
Para leptoch sp.	"	"
Blechnum sp.	"	"
Isoetes panchananii Pant & Srivastava	"	C (E)

* Additions to the existing flora.

Habit : **H**=Herb, **S**=Shrub, **C**=Climber, **T**=Tree, **S**=Sedge, **SP**=Semi-parasite and **G**=Grass. **F**=Fern.
Status: **O**=Occasional, **R**=Rare , **C**=Common and (**E)**=Endemic.

AMPHIBIANS

1.	Skipper frog	Rana cyanophlyctis
2.	Indian bullfrog	Rana tigrina
3.	Slender tree frog	Rhacophorus maculatus
4.	Common toad	Bufo melanostictus

APPENDIX V

LIST OF FISHES

S. No.	Species	Order	Division	Family	Common Name
1	Barilius bendelisis (Ham.)	Cypriniformis	Cyprini	Cyprinidae	
2	Danio acquipinnatus (mc. Cell)	Cypriniformis	Cyprini	Cyprinidae	
3	Danio devario (Ham.)	Cypriniformis	Cyprini	Cyprinidae	
4	Rasbora daniconius (Ham.)	Cypriniformis	Cyprini	Cyprinidae	
5	Pantius conchonius (Ham.)	Cypriniformis	Cyprini	Cyprinidae	
6	Punctius sarana (Ham.)	Cypriniformis	Cyprini	Cyprinidae	
7	Punctius ticto (Ham.)	Cypriniformis	Cyprini	Cyprinidae	
8	Chirrhinus reba (Ham.)	Cypriniformis	Cyprini	Cyprinidae	
9	Garra mullya (Sykes)	Cypriniformis	Cyprini	Cyprinidae	
10	Labeo boggut (Sykes)	Cypriniformis	Cyprini	Cyprinidae	
11	Labeo calbasu (Ham.)	Cypriniformis	Cyprini	Cyprinidae	Kalond
12	Labeo fimbriatus (Bl.)	Cypriniformis	Cyprini	Cyprinidae	
13	Naomacheilus bota (Ham.)	Cypriniformis	Cyprini	Cobitidae	
14	Ompak bimaculatus (Bl.)	Cypriniformis	Siluri	Siluridae	
15	Wallago attu (Schn.)	Cypriniformis	Siluri	Siluridae	Padhin
16	Heteropneustes fossilis (Bl.)	Cypriniformis	Siluri	Saccobranchidae	
17	Clarias batrachus (L.)	Cypriniformis	Siluri	Calriidae	
18	Mystus bleekeri (Day)	Cypriniformis	Siluri	Bagridae	
19	Mysttus seenghala (Sykes)	Cypriniformis	Siluri	Bagridae	Cat fish
20	Mystus vittatus (Bl.)	Cypriniformis	Siluri	Bagridae	
21	Xenentodon cancila (Ham.)	Beloniformis	-	Belonidae	
22	Channa marulius (Ham.)	Ophiocephaliformis	-	Ophiocephalidae	
23	Channa Punctius (Bl.)	Ophiocephaliformis	-	Ophiocephalidae	
24	Mastocembelus armatus (Lac.)	Mastocembeliformis	-	Mastocembelidae	Baam

Source: Two Decades of Project Tiger, Melghat. Papers and Proceedings, 1992.

Other fishes generally occurring in SCA

S.No.	Local Name	Scientific name	Common name
1.	-	*Labeo bata*	Bata mas
2.	Singhal	*Cyprinum caprio*	Common carp
3.	Catla catla	*Catla*	
4.	-	*Chela bacela*	Chal
5.	Ambasus ranga	*Kanghi*	
6.	Badas ort or Mahseer		
7.	Naren	*Cirrhina mrigala*	Mrigal
8.	Sambal	*Ophiocephalus striatus*	Murrel (com)
9.	Gagra	*Ophiocephalus marulius*	Murrel large
10.	-	*Notopetarus notopetarus*	Patola
11.	Common carp	*Labeo rohita*	Rohu
12.	Fringe-lipped	*Labeo frimbriatus*	Rohu kut
13.	Marki rohu	*Tilapya mossibea*	Tilapya

APPENDIX VI

REPTILES

S.No.	Scientific name	Common name
1	*Crocodylus palustris*	Indian freshwater crocodile
2	*Calotes versicolor*	Chameleon
3	*Varanus bengalensis*	Monitor lizard
4	*Hemidactylus domesticus*	House lizard
5	*Mubya spp.*	Lizard
Non poisonous snakes		
6	*Typhlina bramina*	Common worm snake
7	*Python molursus*	Python
8	*Eryx conicus*	Common sand Bao
9	*Pytasmucosus*	Rat snake
10	*Boiga trigonata*	Cat snake
11	*Dryophis nausutus*	Common green whip snake
12	*Lycodon striatus*	Common wolf snake
13	*Oligodon arnensis*	Banded kurkri
14	*Amphiesma piscator piscator*	Checkered keelback water snake
15	*Chrysopelea ornate*	Flying snake
Poisonous snakes		
16	*Bungarus caeruleus*	Common Krait
17	*Naja naja kaouthia*	Cobra
18	*Naja nagan naja*	Cobra
19	*Vipera susselli*	Russell's viper
20	*Echis carinatus*	Saw-scaled viper
21	*Trimeresurus gramineus*	Bamboo pit viper

Source: Management Plan for the Melghat Tiger Reserve, 1988.

APPENDIX VII

MAMMALS

S.No.	Local Name	Scientific name	Common name
1.	Sher	*Panthera tigiris*	Tiger
2.	Chausinga	*Tetraceros quadricornis*	Four-horned antilope
3.	Jungli suar	*Sus scrofa*	Wild pig
4.	Nilgai	*Boselaphus tragocalamus*	Blue bull
5.	Bagar billa	*Felis chaus*	Jungle cat
6.	Bhedki	*Muntiacus muntjac*	Barking deer
7.	Chital	*Cervus axis*	Spotted deer
8.	Sonkutta	*Canis alpinus*	Wild dog
9.	Gaur	*Bos gaurus*	Indian bison
10.	Kharaha	*Lepus nigrocollis*	Wild hare
11.	Lakarbaggha	*Hyena hyaena*	Hyena
12.	Lomdi	*Vulpes bengalensis*	Indian fox
13.	Gidar	*Canis aureus*	Jackal
14.	Langur	*Presbytis entellus*	-
15.	Lal bandar	*Macaca mullata radiata*	Rhesus monk.
16.	Nevla	*Herpestris edwardsii*	Mongoose
17.	-	*Manis crassicaudata*	Pangolin
18.	Tendua/ Gulbag	*Panthera pardus*	Leopard
19.	Sahi	*Hystrix indica*	Porcupine
20.	Sambar	*Cervus unicolor*	Sambar
21.	Chunchunder	*Suncus murinus*	Shrew-grey musk
22.	Bhalu/Reech	*Melursus urcinus*	Sloth bear
23.	-	*Petaurista elegans*	Flying squirrel
24.	Badi gilahari		Giant squirrel
25.	Gilahar		Squirrel

LIST OF BIRDS

S. No.	Common Name	Scientific Name	Movement	Abundance
	PODICIPEDIDAE: Grebes			
1	Little Grebe or Dabchick	*Podiceps ruficollis*	M	U
	ARDEIDAE: Herons, Egrets, Bitterns			
2.	Grey Heron	*Ardea cinerea*		U
3	Pond Heron or Paddy Bird	*Ardeola grayii*	R	C
4	Cattle Egret	*Bubulcus ibis*	R	C
5	Large Egret	*Ardea alba*	M	U
6	Median Egret	*Egretta intermedia*	M	U
7	Little Egret	*Egretta garzetta*	R	C
8	Chestnut bittern	*Ixobrychus cinnamomeus*	M	U
9	Yellow bittern	*Ixobrychus sinensis*	M	U
	CICONIIDAE: Storks			
10.	White necked Stork	*Ciconia episcopus*	R	O
11.	Black Stork	*Ciconia nigra*	W	U
12.	Open billed stork	*Anastomus oscitans*		
	THRESKIORNITHIDAE: Ibises, Spoonbill			
13	White Ibis	*Threskiornis aethiopica*	M	U
14	Black ibis	*Pseudibis papillosa*	M	U
	ANATIDAE: Ducks, Geese			
15	Lesser whistling teal	*Dendrocygna javanica*	M	U
16	Pintail	*Anas acuta*	W	U
17	Common teal	*Anas crecca*	W	U
18	Spot billed duck	*Anas poecilorhyncha*	M	U
19	Gadwall	*Anas strepera*	W	U
20	Garganey or Bluewinged teal	*Anas querquedula*	W	U
21	Shoveller	*Anas clypeata*	W	U
22	Brahminy duck	*Tadorna ferruginea*	W	U
	ACCIPITRIDAE: Hawks, Vultures, Eagles			
23	Black winged kite	*Elanus caeruleus*	R	C
24	Crested honey Buzzard	*Pernis ptilorhyncus*	R	C
25	Pariah kite	*Milvus migrans govinda*	R	U
26	Brahminy kite	*Haliastur indus*	M	U
27	Shikra	*Accipiter badius*	R	C
28	Crested Goshawk	*Accipiter trivirgatus*	R	U
29	White-eyed Buzzard eagle	*Butastur teesa*	R	C
30	Crested Hawk eagle	*Splizhaetus cirrhatus*	R	C
31	Bonelli's eagle	*Hieraaetus fasciatus*	R	U
32	Tawny eagle	*Aquila rapax vindhiana*		U
33	Black eagle	*Ictinaetus malayensis*		O
34	Black or King Vulture	*Sarcogyps vcalvus*	R	U
35	Indian white backed Vulture	*Gyps bengalensis*	R	U
36	Indian longbilled Vulture	*Gyps indicus*	R	U
37	Indian Scavenger Vulture	*Neohron percnopterus*	R	C
38	Pale Harrier	*Circus marcrourus*	W	C
39	Short toed eagle	*Circaetus gallicus*	R	U
40	Crested serpent eagle	*Spilomis cheela*	R	C

41	Osprey	*Pandion haliaetus*	W	U
	FALCONIDAE: Falcons			
42	Laggar Falcon	*Falco biarmicus jugger*		U
43	Peregrine Falcon	*Falco peregrinus japonensis*	W	U
44	Shaheen Falcon	*Falco peregerinus peregrinator*		U
45	Hobby	*Falco subbuteo*	W	U
46	Redheaded Merlin	*Falco chicquera*		U
47	Lesser Kestrel	*Falco naumanni*		
48	European Kestrel	*Falco tinnunculus*	W	C
	PHASIANIDAE: Pheasants, Partridges, Qualis			
49	Painted Partridge	*Francolinus pictus*	R	C
50	Grey Partridge	*Francolinus pondicerianus*	R	U
51	Grey quail	*Coturnix coturnix*		U
52	Black breasted or rain quail	*Coturnix coromandelica*		C
53	Jungle bush quail	*Perdicula asiatica*	R	C
54	Rock bush quail	*Perdicula argoondah*	R	C
55	Painted bush quail	*Perdicular erythrorhyncha*	R	C
56	Red spur fowl	*Galloperdix spadicea*	R	C
57	Painted spur fowl	*Galloperdix lunulata*	R	U
58	Grey or Sonnerat's jungle fowl	*Gallus sonneratii*	R	A
59	Common Peafowl	*Pavo cristatus*	R	A
60	Red jungle fowl	*Gallus gallus*		
	TURNICIDAE: Bustard-quails			
61	Little bustard quail	*Turnix sylvatica*		C
62	Yellow legged button quail	*Turnix tanki*		C
63	Common bustard quail	*Turnix suscitator*		C
	GRUIDAE: Cranes			
64	Demoiselle crane	*Anthropoides virgo*	W	U
	RALLIDAE: Rails, Coots			
65	Whitebreasted waterhen	*Amanromis phoenicurus*	R	U
	CHARADRIIDAE: Plovers, Sandpipers, Snipe			
66	Red wattled lapwing	*Vanellus indicus*	R	C
67	Yellow wattled lapwing	*Vanellus malabaricus*	R	U
68	Spur winged lapwing	*Vanellus spinosus*		U
69	Little ringed plover	*Charadrius dubius*	R	C
70	Green shank	*Tringa nebularia*	W	U
71	Red shank	*Tringa totanus*	W	U
72	Wood or spotted sandpiper	*Tringa glareola*	W	C
73	Green sandpiper	*Tringa ochropus*	W	C
74	Common sandpiper	*Tringa hypoleucos*	W	C
75	Pintail snipe	*Gallinago stenura*	W	C
76	Fantail snipe	*Gallinago gallinago*	W	C
	RECURVIROSTRIDAE: Stilt Avocet			
77	Black winged stilt	*Himantopus himantopus*		U
	BURHINIDAE: Stone Curlew			
78	Stone Curlew	*Burthinus oedicnemus*	M	U
79	Great stone plover	*Esacus magnirostris*	M	U

	GLAREOLIDAE: Coursers, Pratinocles			
80	Small Indian Pratinicole	*Glareola lacteal*	M	C
	PTEROCLIDIDAE: Sandgrouse			
81	Indian sandgrouse	*Pterocles excustus*	M	U
82	Painted sandgrouse	*Pterocles indicus indicus*	M	U
	COLUMBIDAE: Pigeons, Doves			
83	Yellow legged green pigeon	*Tretron phoenicoptera*	R	A
84	Blue rock pigeon	*Columba livia*	R	C
85	Rufous turtle dove	*Streptopelia orientalis*	W	C
86	Indian ring dove	*Streptopelia decaocto*		C
87	Red turtle dove	*Streptopelia tranquebrica*		C
88	Spotted dove	*Streptopelia chinensis*	R	C
89	Little brown dove	*Streptopelia senegalensis*	R	C
	PSITTACIDAE: Parakets			
90	Alexandrine Paraket	*Psittacula eupatria*	R	C
91	Rose ringed parakeet	*Psittacula kramerii*	R	C
92	Blossom headed parakeet	*Psittacula cyanocephala*	R	C
	CUCULIDAE: Cuckoo			
93	Pied crested cuckoo	*Clamator jacobinus*	B	C
94	Common Hawk cuckoo or Brain Fever Bird	*Cuculus various*	R	C
95	Indian cuckoo	*Cuculus micropterus*		U
96	Cuckoo	*Cuculus canorus*		C
97	Small cuckoo	*Cuculus poliocephalus*		U
98	Indian bay-banded cuckoo	*Cacomantis sonneratii*		U
99	Indian Plaintive cuckoo	*Cacomantis passerinus*		U
100	Drongo cuckoo	*Surniculus lugubrius*		U
101	Koel	*Eudynamys scolopaces*		C
102	Small green billed malkoha	*Rhopodytes vividirostiris*		C
103	Sirkeer cuckoo	*Taccocua leschenaultii*	R	C
104	Crow-Pheasant Coucal	*Centropus sinensis*	R	C
	STRIGIDAE: Owls			
105	Barn owl	*Tyto alba*	R	C
106	Scops owl	*Otus scops*	R	C
107	Collared scops owl	*Otus bakkamoena*	R	C
108	Great horned owl or Eagle-owl	*Bubo bubo*	R	C
109	Dusky horned owl	*Bubo coromandus*	R	U
110	Brown fish owl	*Bubo zeylonensis*	R	U
111	Barred jungle owlet	*Glaucidium radiatum*	R	C
112	Brown hawk owl	*Ninox scutulata*	R	C
113	Spotted owlet	*Athene brama*	R	C
114	Mottled wood owl	*Strix ocellata*	R	C
115	Brown wood owl	*Strix leptogrmmica*	R	U
116	Short eared owl	*Asio flammeus*		
	CAPRIMULGIDAE: Nightjars			
117	Indian Jungle nightjar	*Caprimulgus indicus*		C
118	Common Indian nightjar	*Caprimulgus asiaticus*	R	C
119	Franklin's or Allied nightjar	*Caprimulgus affinis*	R	C
120	Long tailed nightjar			

	ARODIADAE: Swifts			
121	White rumped spinetail swift	*Chaetura sylvatica*	R	U
122	Alpine swift	*Apus melba*	R	C
123	House swift	*Apus afinis*	R	C
124	Crested tree swift	*Hemiprocne longipennis*	R	U
	ALCEDINIDAE: Kingfishers			
125	Pied kingfisher	*Ceryle rudis*	R	U
126	Small blue kingfisher	*Alcedo atthis*	R	C
127	White breasted kingfisher	*Halcyon smymensis*	R	C
128	Stork billed kingfisher	*Pelargopsis capensis*		
129	Black capped kingfisher	Halcyon pileata		
	MEROPIAE: Bee-eaters			
130	Blue tailed bee-eater	Merops philippinus	M	U
131	Green bee-eater	Merops orientalis	M	C
	CORACIIDAE: Rollers			
132	Indian roller	Coracias benghalenis	R	C
	UPUPIDAE: Hoopoe			
133	Hoopoe	Upupa epops	R	S
	BUCEROTIDAE: Hornbills			
134	Common grey hornbill	Tockus birostris	R	C
135	Malabar Pied hornbill	Anthracoceros coronatus		
	CAPITONIDAE: Barbets			
136	Large green barbet	Megalaima Zeylaica	R	C
137	Crimson breasted barbet	Megalaima haemacephala	R	C
	PICIDAE: Woodpeckers			
138	Little scaly bellied woodpecker	Picus myrmecophoneus	R	U
139	Lesser golden backed woodpecker	Dinopium benghalense	R	C
140	Yellow fronted pied or Maratha woodpecker	Picoides mahrattensis	R	C
141	Brown crowned pygmy woodpecker	Picoides nanus	R	C
142	Heartspotted woodpecker	Hemicircus canente	R	C
143	Black backed woodpecker	Chrysocolaptes festivus	R	U
144	Black woodpecker	Dryocopus javensis		O
	PITTIDAE: Pittas			
145	Indian pitta	Pitta brachyura	W	C
	ALAUDIDAE: Larks			
146	Red winged bush lark	Mirafra erythroptera	R	C
147	Ashy crowned finch lark	Eremopterix grisea	M	C
148	Rufoustailed finch lark	Ammomanes phoenicurus	M	C
149	Short toed lark	Colandrella cinerea	W	C
150	Deccan or Syke's crested lark	Galerida daya		U
151	Small or eastern skylark	Alauda gulgula	R	C
	HIRUNDINIDAE: Swallows			
152	Crag martin	Hirundo rupestris	W	C
153	Dusky crag martin	Hirundo concolor	R	C
154	Swallow	Hirundo rustica	W	C
155	Wiretailed swallow	Hirundo smithii	R	C

156	Cliff swallow	Hirundo fluvicola	R	C
157	Redrumped swallow	Hirundo daurica	W	C
	LINIIDAE: Shrikes			
158	Grey shrike	Lanius excubitor	R	C
159	Baybacked shrike	Lanius vittalus	R	C
160	Rufousbacked shrike	Lanius schach	W	U
161	Brown shrike	Lanius cristatus	W	U
	ORIOLIDAE: Orioles			
162	Golden oriole	Oriolus oriolus		C
163	Blackheaded oriole	Oriolus xanthomus	R	C
	DICRUDRIDAE: Drongos			
164	Black drongo or King Crow	Dicrurus adsimilis	R	A
165	Grey or Ashy drongo	Dicrurus leucophaeus	W	U
166	Whitebellied drongo	Dicrurus caerulescens	R	U
167	Large raquettailed drongo	Dicrurus paradiseus	R	U
	ARTAMIDAE: Swallow-Shrike			
168	Ashy swallow-shrike	*Artamus fuscus*	M	U
	STURNIDAE: Mynas			
169	Grey headed myna	*Sturnus Malabaricus*	M	C
170	Black headed or Brahminy myna	*Sturnus pagodarum*	M	C
171	Rosy starling or Rosy Pastor	*Sturnus roseus*	W	U
172	Pied myna	*Sturnus contra*	R	C
173	Common myna	*Acridotheres tristis*	R	A
174	Bank myna	*Acridotheres gingianus*	R	U
175	Jungle myna	*Acridotheres fuscus*	R	U
	CORVIDAE: Crows, Magpies			
176	Indian tree pie	*Dendrocitta vagabunda*	R	C
177	House crow	*Corvus splendens*	R	U
178	Jungle crow	*Covus macrorhynchos*	R	C
	CAMPEPHAGIDAE: Minivets, Cuckoo-Shrikes			
179	Pied flycatcher shrike	*Hemipus picaus*	R	C
180	Common wood shrike	*Tephrodornis pondicerianus*	R	C
181	Large cuckoo shrike	*Coracina novaehollandiae*	M	C
182	Black headed cuckoo shrike	*Coracina melanoptera*	R	C
183	Scarlet Minivet	*Pericrocotus flammeus*	R	C
184	Small Minivet	*Pericrocotus cinnamomeus*	R	A
185	White bellied Minivet	*Pericrocotus erythropygius*	R	U
	IRENIDAE: Lora, Chloropsis			
186	Lora	*Aegithina tiphia*	R	C
187	Jerdon's or Gold mantled chloropsis	*Chloropsis cochinchinensis*	R	C
	PYCNONOTIDAE: Bulbuls			
188	Red whiskered bulbul	*Pycnonotus jocosus*	R	C
190	Red vented bulbul	*Pycnonotus cafer*	R	A
191	White browed bulbul	*Pycnonotus lutsolus*	R	U
	MUSCICAPIDAE: Timalinae: Babblers			
192	Spotted babbler	*Pellorneum ruficeps*	R	C
193	Deccan scimitar babbler	*Pomator hinusschisticeps*	R	C

194	Rufousbellied babbler	*Dumetia hyperytthra*	R	C
195	Yellow eyed babbler	*Chrysomma sinense*	R	C
196	Common babbler	*Tandoides caudatus*	R	C
197	Large Grey babbler	*Turdoides malcolmi*	R	U
198	Jungle babbler	*Turdoides striatus*	R	C
199	Quaker babbler	*Alcpipe poiocephala*	R	C
	MUSCICAPINAE: Flycatcher			
200	Red breasted flycatcher	*Muscicapa pana*	W	C
201	White browed blue flycatcher	*Muscicapa superciliaris*	W	U
202	Tickell's blue flycatcher	*Muscicapa tickelliae*	R	C
203	Verditer flycatcher	*Muscicapa halassina*	W	C
204	Grey headed flycatcher	*Culicicapa Ceylonensis*	W	C
205	White browed fantail flycatcher	*Rhipidura aureola*	R	C
206	White spotted fantail flycatcher	*Rhipidura albicollis*	R	C
207	Paradise flycatcher	*Terpsiphone paradisi*	R	C
208	Black naped blue flycatcher	*Hypothpnis azurea*	R	C
209	Korean or black and yellow flycatcher	*Muscicapa ficedula*		O
	SYLVIINAE: Warblers			
210	Streaked fantail warbler	*Cisiticola juncidis*	R	C
211	Franklin's Wren Warbler	*Prinia hodgsonii*	R	C
212	Rufous fronted Wren Warbler	*Prinia buchanani*	R	C
213	Plain Wren Warbler	*Prinia subtlava*	R	C
214	Ashy Wren Warbler	*Prinia socialis*	R	C
215	Jungle Wren Warbler	*Prinia sylvatica*	R	C
216	Tailor bird	*Orthobemus sutorius*	R	C
217	Striated marsh warbler	*Megalurus palustris*	R	C
218	Orphean Warbler	*Sylvia hortensis*	W	U
219	Tickell's leaf warbler	*Phylloscopus affinis*	W	U
220	Black browed flycatcher warbler	*Seicercus burkii*	W	C
	TURDINAE: Thrushes, Chats			
221	Blue throat	*Erithacus svecicus*	W	U
222	Magpie robin	*Copsychus saularis*	R	C
223	Black redstart	*Pgoenicurus ochrurus rufiventris*	W	C
224	Collared bushchat	*Saxicola torquata*	W	C
225	Pied bushchat	*Saxicola caprata*	R	C
226	Indian robin	*Saxicoloides fulicata*	R	C
227	Blue rock thrush	*Monticola solitarius*	W	U
228	Malabar Whistling thrush	*Myiophonus horsfieldii*	R	C
229	Whitethroated Ground Thrush	*Zoothera citrina cyanotus*	R	C
230	Black capped blackbird	*Turdus merula nigopileus*	R	C
	PARIDAE: Tits			
231	Grey tit	*Parus major*	R	A
232	Yellow cheeked tit	*Parus xanthogenys*	R	C
	SITTIDAE: Nuthatches, Creepers			
233	Chestnut bellied nuthatch	*Sitta castanes*	R	C
234	Velvet fronted nuthatch	*Sitta frontalis*	R	C
235	Spotted grey creeper	*Salpornis splionotos*	R	U
	MOTACILLIDAE: Pipits, Wagtails			
236	Tree pipit	*Anthus hidgsoni*	W	U

237	Paddyfield pipit	*Anthus navaeseelandiae*	R	C
238	Yellowheaded wagtail	*Motacilla citreola*	W	C
239	Grey Wagtail	*Motacilla cinerea*	W	C
240	White or Pied wagtail	*Motacilla alba dukhunensis*	W	C
241	White or masked wagtail	*Motacilla alba personata*	W	C
242	Large pied wagtail	*Motacilla Maderaspantensis*	R	C
	DICAEIDAE: Flowerpeckers			
243	Thickbilled flowerpecker	*Dicaeum aglls*	R	U
244	Tickell's flowerpecker	*Dicaeum erythrorhynchos*	R	U
	NECTARINIDAE: Sunbirds, Spiderhunters			
245	Purple rumped sunbird	*Nectarinia zeylonica*	R	C
246	Purple sunbird	*Nectarinia asiatica*	R	C
	ZOSTEROPIDAE: White eye			
247	White-Eye	*Zopsterops palpebrosa*	R	A
	PLOCEIDAE: Sparrows, Munias, Weaver Birds			
248	House sparrow	*Passer domesticus*	R	A
249	Yellowthroated sparrow	*Petronia xanthocollis*	R	C
250	Baya	Ploceus philippinus	R	U
251	Streaked weaver bird	Ploceus Manyar	R	U
252	Red munia or Avadavat	Estrilda amandava	R	U
253	Green munia	Estrilda farmosa	R	C
254	White backed munia	Lonchura Striata	R	U
255	Spotted munia	Lonchura Punctulata	R	C
	FRINGILLIDAE: Finches			
256	Common rosefinch or Scarlett Grosbeak	Carpodacus erythrinus	W	C
	EMBERIZIDAE: Buntings			
257	Blackheaded bunting	Emberiza melanocephala	W	C
258	Redheaded bunting	Emberiza bruniceps	W	C
259	Greynbecked bunting	Emberiza buchanani	W	

Source: Two Decades of Project Tiger, Melghat, Papers and Proceedings, 1992.

Note: The list of birds pertain to entire SCA, however the movement and abundance mentioned in column 4 and 5 pertains to Melghat Tiger Reserve.

Key:
Movement
R – Resident
W – Winter migrant
M – Migrant
B – Breedign migrant

Abundance
A – Abundant
C – Common
O – Occasional
U – Un-common

AREA STATEMENTS FROM THE GIS SPATIAL DATABASE

APPENDIX IX

Area Statement Satpura Conservation Area

Class No.	Class Name	Area (sq Km)
1	Hoshangabad - MF	787.97
2	Satpura PA Complex	1478.40
4	North Betul MF	2397.31
5	West Betul MF	1693.74
6	South Betul MF	5566.67
7	Melghat Tiger Reserve	3193.12
8	Rampur Bhatodi WLS (Proposed)	380.08
	Total	**15497.29**

Reference- Plate 1

APPENDIX X

Area Statement Betul Managed Forest Division

	Class	Area Sq Km
1	RBWLS	392.68
2	North Betul	2397.45
3	West Betul	1693.67
4	South Betul	5566.99
	TOTAL	10050.79

Reference-Plate 4

APPENDIX XI

Hoshangabad - Area Estimates for Geomorphology

Name	Area (Sq Km)
Alluvial Plane	4397.185554
Buried Pediment	727.363840
Ballastic Upland	118.868673
Deccan Pleatue	1276.356769
Pediment Volcanics	648.345822
Pediment Sandstone	195.834660
Structural Hill(Gondwana Sediments)	2385.831194
Structural Hill(Metamorphic)	18.957508
Structural Hill(Vindhyan Sediments)	217.575159
Tawa Reservoir	94.224827
Tawa River	53.385024
Grand Total	**10133.92903**

Reference- Plate-19

APPENDIX XII

Area Estimates of Vegetation/ Landcover class Map of BSP PA Complex

	BSP-vegetation / Landcover class	Area in Sq. Mts	% age
1	Teak Mixed >60%	27065131.886	1.73
2	Teak Mixed 30 - 60 %	50140282.563	3.2
3	Teak Mixed <30%	9768795.972	0.62
4	Mixed Teak >60%	101374721.610	6.47
5	Mixed Teak 30 - 60 %	120734232.370	7.71
6	Mixed Teak <30%	23495486.454	1.5
7	Mixed Miscellaneous >60%	219774646.520	14.03
8	Mixed Miscellaneous 30 - 60%	86593983.020	5.53
9	Mixed Miscellaneous <30%	57582792.748	3.68
10	TM Int with Bamboo > 50%	1790437.889	0.11
11	TM Int with Bamboo < 50%	847088.894	0.05
12	MT Int with Bamboo > 50%	12597238.623	0.8
13	MT Int with Bamboo < 50%	2964811.128	0.18
14	MM Int with Bamboo >50%	90043303.326	5.75
15	MM Int with Bamboo <50%	24791789.154	1.58
16	Bamboo >50%	5050446.661	0.32
17	Bamboo <50%	3478198.336	0.22
18	Riparian	8684265.495	0.55
19	Dry Grassland	79047191.058	5.05
20	Moist Grassland	12061390.724	0.77
21	RO Int with Grasses	10317478.551	0.66
22	RO Int with Scrub	48847188.532	3.12
23	Bare Rocky Outcrop	19049874.097	1.22
24	Hab. Int with Agriculture	63469097.957	4.05
25	RS Int With Grasses	23938282.921	1.53
26	River course	16141214.695	1.03
27	Water Bodies	176847454.230	11.33
28	Plantation	9101392.602	0.58

29	Scrub/Savannah	155304443.500	9.92
30	Lantana	1134264.863	0.07
31	Sal >60%	5106598.387	0.33
32	Sal 30 - 60%	4501764.083	0.29
33	Sal < 30 %	5601026.201	0.36
34	Sal Mixed >60%	20211120.030	1.29
35	Sal Mixed 30-60 %	16091480.309	1.03
36	Sal Mixed <30%	2805981.960	0.18
37	Mixed Sal >60%	9898747.109	0.63
38	Mixed Sal 30-60%	17253018.868	1.1
39	Mixed Sal <30%	4663801.920	0.3
40	SM Int with Bamboo > 50%	8353772.480	0.53
41	MS Int with Bamboo > 50%	5250988.540	0.34
42	SM Int with Bamboo <50%	2140182.924	0.14
43	MS Int with Bamboo <50%	1819315.919	0.12
	TOTAL	**1565734725.109**	100

Reference Plate 26

Note : The area includes the submergence which falls outside the actual boundary of BSP the actual area of BSP

APPENDIX XIII

Area Estimates of the Clubbed Vegetation Map of BSP PA Complex

	Veg/ Landuse Cover Class	Area in Sq. Meters	%
1	Teak Forests	332578650.9	21.33
2	Miscellaneous Forests	363951422.3	23.437
3	Teak Forest with Bamboo	18199576.53	1.16
4	Miscellaneous with Bamboo	114835092.5	7.43
5	Bamboo	8528644.997	0.54
6	Riparian	8684265.495	0.55
7	Grasslands	91108581.78	5.81
8	Rocky Outcrops	78214541.18	4.99
9	Habitations	63469097.96	4.05
10	River Courses	40079497.62	2.56
11	Water Bodies	176847454.2	11.31
12	Scrub/ Savannah	155304443.5	9.92
13	Plantations	9101392.602	0.58
14	Lantana	1134264.863	0.073
15	Sal Forests	86133538.87	5.05
16	Sal Forest with Bamboo	17564259.86	1.21
	Grand Total	**1565734725**	**100**

Reference Plate 27
Note : The area includes the submergence which falls outside the actual boundary of BSP.

APPENDIX XIV

BSP Site Quality Map

SQCLASS	Name	Area Sq Km
1	Site Quality II Teak	10.34
2	Site Quality Vb Teak	63.86
3	Site Quality IVa Teak	55.76
4	Site Quality IVb Teak	49.54
5	Site Quality Va Mixed	1.62
6	Site Quality I Mixed	0.81
7	Site Quality II Mixed	2.87
8	Site Quality III Mixed	70.06
9	Site Quality IVa Mixed	311.96
10	Site Quality IVb Mixed	552.43
11	Site Quality Va Mixed	197.81
12	Site Quality Vb Mixed	47.82
13	Site Quality III Mixed	8.36
14	Site Quality IV a Sal	55.47
15	Site Quality Va Sal	0.79
16	Site Quality Vb Sal	1.66
17	Non Forest	46.47
	TOTAL	**1477.62**

Reference Plate-28

APPENDIX XV

MAP SHOWING AGE CLASS

Area in sq. m.

S. No.	Age	Class
1	Young aged	202820950.720
2	Middle aged	433129791.130
3	Old aged	150728163.000
4	Young Interspersed with Habitations	6367208.231
5	Young Interspersed with Habitation and Blanks	103053315.350
6	Young Interspersed with Blanks	28422014.291
7	Young Interspersed with Plantation	44796267.900
8	Middle Aged Inteerspersed with Habitations	75289880.964
9	Middle Aged Inteerspersed with Habitations and Blanks	6218004.989
10	Middle Aged Inteerspersed with Plantation	132805324.130
11	Old Aged with Habitations	23244020.070
12	Middle Aged Interspersed with Plantations\	18240096.297
13	Old Aged with Habitations	10090069.762
14	Old Aged with Habitations and Blanks	3630211.131
15	Old Aged with Plantations and Blanks	38979747.977
16	Old Aged with Blanks	47333124.093
17	Old Aged with Plantations	48440115.886
18	Area Clearfelled for submergence	55122576.127
19	Poorly stocked Interspersed with Patches of Young, Middle and Old aged	4653777.455
20	Plantation of various Ages	44300127.013
	Grand Total	1477664786.516

Reference Plate 29

APPENDIX XVI

BSP - Working Circle Map

S.N.	Name	Area (Sq Km)
1	Coppice with Reserve	372.61
2	Coppice with Reserve Core Area	110.13
3	Tawa Submergence Area	101.73
4	Submergence Area	46.64
5	Selection Cum Improvement	62.72
6	Unalloted Area	33.12
7	General Teak	139.35
8	Special Teak	124.29
9	Plateau Sal	5.05
10	Protection Cum Preservation	287.41
11	Unworkable Area	154.06
12	Non Forest	40.51
	TOTAL	**1477.62**

Reference-Plate 30

APPENDIX XVII

Area Estimates of Working Circles in Betul Managed Forests

S. No.	Working Circle Class	Area in Sq. Meters
1.	Blanks	59379200.000
2.	Coppice with Reserve	167523200.000
3.	Forest Villages	6758400.000
4.	Improvement	150899200.000
5.	Non- Forest	6122124800.000
6.	Protection	353270400.000
7.	Rampur Bhatori WLS	392670400.000
8.	Rehabilitation of Degraded Forests	216404800.000
9.	Selection cum Improvement	2100584000.000
10.	Teak Conversion	481134400.000
	Grand Total	**10050748800.000**

Reference – Plate 34

APPENDIX XVIII

BSP Bamboo Site Quality Class

Sr No	ClassName	Area in Sq mts
		-1475781917
1	Site Quality I	33217784
2	Site Quality II	155177154.8
3	Site Quality III	6131309.844
4	Unclassed Bamboo	118004561.8
5	Non Bamboo Areas	1163251165
	Total Area	**1475781975**

Reference- Plate 35

APPENDIX XIX

Betul 85 Veg Map

VEGCLASS	Class Name	Arae in Sq. Mts
Sr. No		-10050769920.000000
1	Dense Forest (>40%)	2820119912.468750
2	Open Forest (<40%)	600091331.101562
5	Scrub Savana	360012759.628235
6	Water Body	58111163.500000
7	Blank	6212435006.138610
		10050770172.837200

Reference Plate 38

APPENDIX XX

Percentage Area Statement of Vegetation /Landuse Map Betul District-GIS Estimates

S. No.	Class Name	Area in Sq Meteres	%
1.	Teak Mixed Open Forest (Density <50)	588621246.3	5.85
2.	Teak Mixed Closed Forest (Density >50%)	705122765.9	7.01
3.	Moist Teak Forest	35078866.34	0.35
4.	Mixed Open Forest (Density < 50%)	742128343.4	7.38
5.	Mixed Closed Forest (Density >50%)	602623962.8	5.99
6.	Moist Mixed Forest	48016013.1	0.48
7.	Salai Closed Forest	6468279.012	0.06
8.	Salai Open Forest	3743769.047	0.04
9.	Bamboo Closed Forest	93006000.5	0.92
10.	Bamboo Open Forest	16889109.51	0.02
11.	Riparian	44080085.93	0.44
12.	Degraded Forest	615809806	6.12
13.	Plantation	239606316.1	2.38
14.	Rocky Outcrop Interspersed With Scrub and Grasses	327736654.8	3.26
15.	Habitation Interspersed With Agriculture and Fallow	2933874872	29.26
16.	Agriculture	185158297.7	1.84
17.	Grassland	127986303.3	1.27
18.	Habitation	207705833.4	2.07
19.	Fallow with Agriculture	1369192031	13.65
20.	Fallow	163122151.7	1.62
21.	Water/River, Coarse	158756385.8	1.58
22.	River Sand Interspersed With Grasses	1748156.555	0.02
23.	Habitation Interspersed with Agriculture	306361013.5	3.05
24.	Revenue Tree Land	63181748.8	0.63
25.	Scrub Land	473655744.3	4.71
	Total	**10059673757**	**100**

Reference – Plate 40

APPENDIX XXI

Betul Complex Map

S.N.	Range	Area (Sq Km)
1	Gawasen	187.19
2	Bhaura	395.23
3	RB Proposed Sanctuary	392.68
4	Sarni	673.66
5	Barbatpur	519.93
6	Betul	621.45
7	Saoligarh	366.00
8	Amla	569.91
9	Multai	2403.25
10	Taodi	333.57
11	Bhainsdehi	677.24
12	Sawalmendha	515.95
13	Tapti	1045.63
14	Mohda	536.98
15	Chicholi	457.11
16	Athner	355.04
	TOTAL	**10050.83**

Reference Plate- 44

APPENDIX XXII

Area estimates for Reserve Forests and Protected Forest in Betul District

SN	Forest	Area (in Hectares)
1	Reserved Forest	27691.13
2	Protected Forest	744.94
3	Non Forest	6542.89

Reference Plate 45

Source Forest Department Madhya Pradesh

APPENDIX XXIII

Champion and Seth Classes in the Study Area

CHAMPION AND SETH CLASSES	ACA		GCA		SCA		TCA	
	MAP	WHR	MAP	WHR	MAP	WHR	MAP	WHR
Group 1 Tropical Evergreen Forests								
Subgroup 1A Southern Tropical Wet Evergreen Forests	✓	✓						
Subgroup 1B Northern Tropical Wet Evergreen Forests			✓	✓				
Group 2 Tropical semi-evergreen forests								
Subgroup 2A Southern Tropical Semi-evergreen forests		✓						
Subgroup 2B Northern Tropical Semi-evergreen Forests			✓	✓			✓	✓
Group 3 Tropical Moist Deciduous Forests								
Subgroup 3B South Indian Moist Deciduous Forests	✓	✓						
Type 3B/c1 Moist teak bearing forest					✓	✓		
Type 3B/c2 Southern moist mixed deciduous forests					✓	✓		
Subgroup 3C North Indian Moist Deciduous Forests			✓	✓				
Type 3C/c2b-2d Moist Bhabar and Plains Sal Forest							✓	✓
Type 3C/c2d1 Chander Sal							✓	
Type 3C/c2DS1 Moist Sal savannah							✓	✓
Type 3C/IS1 Low Alluvial Savanah woodlands							✓	✓
Type 3C/c3 West Gangetic Moist Mixed Deciduous Forests							✓	✓
Group 4 Littoral and Swamp Forests								
Subgroup 4D Tropical Seasonal Swamp Forests							✓	✓
Group 5 Tropical Dry Deciduous Forests								
Subgroup 5A Southern Tropical Dry Deciduous Forests								
Type 5A/c1 Dry Teak bearing Forest	✓	✓			✓	✓		
Type 5A/c3 Southern Dry Mixed Deciduous Forests	✓	✓			✓	✓		
Subgroup 5B Northern Tropical Dry Deciduous Forests								
Type 5B/c1c Dry peninsular sal forests					✓	✓		
Type 5 DS2 Dry Deciduous Scrub	✓	✓			✓	✓		
Type 5/Is2 Khair and Sissoo Forests							✓	✓
Type 5/Is3 Babul forests							✓	✓
Type 5E2 Boswellia Forests					✓	✓		
Type 5/E4 Hardwickia forest						✓		
Type 5/Is1Dry Tropical riverain forest							✓	✓
Group 6 Tropical Thorn Forests								
Subgroup 6A Southern Tropical Thorn Forests	✓	✓						
Group 7 Tropical Dry Evergreen Forests	✓ ?	✓						

CHAMPION AND SETH CLASSES	ACA		GCA		SCA		TCA	
	MAP	WHR	MAP	WHR	MAP	WHR	MAP	WHR
Group 8 Subtropical Broad-leaved Hill Forests								
Subgroup 8B Northern Tropical broad-leaved wet *Hill Forests*								
Type 8A/c3 Central Indian subtropical hill forests					✓		✓	
Group 11 Montane Wet Temperate Forests								
Subgroup 11A Southern Montane Wet Temperate Forests								
Type 11A/c1 Southern Montane Wet Temperate Forests	✓		✓					
Type 11CS2 Southern Montane Wet Grasslands	✓		✓					
Subgroup 4E Tropical Riparian Fringing Forests	✓ *	✓ *		✓	✓	✓		

NON-CHAMPION AND SETH CLASSES	ACA		GCA		SCA		TCA	
	MAP	*WHR*	*MAP*	*WHR*	*MAP*	*WHR*	*MAP*	*WHR*
Extensive Bamboo Areas	✓	✓	✓	✓	✓	✓		
Grasslands on Hill Plateaus			✓	✓	✓	✓		
Rivers	✓	✓	✓	✓	✓	✓	✓	✓
Reservoir	✓	✓			✓	✓		✓
Swamps (tals)							✓	✓
Teak Plantations	✓	**	✓	**				✓
	✓ **	✓ **						
Sal Plantations				✓				
Coffee and cardamum	✓	✓						
Tea	✓	✓						
Wattle and Pinus	✓	✓						
Young jhum (<10 years)				✓				
Middle jhum (10-20 years)				✓				
Old jhum (>20 years)				✓				
Riparian Forests								✓
Mesic Groves					✓	✓		
Eucalyptus Plantations	✓ **	✓ **					✓ **	✓ **

Note

* **"*Tropical Riparian Fringing Forests*" as a Champion and Seth Category and"*Riparian forest*"as a non Champion and Seth Class cannot be mapped separately and are shown as only Riparian forests.**

** "***Eucalyptus Plantations***" and "***Teak Plantations***" in the non Champion and Seth classes have been mapped separately in ACA but considered for WHR together; however in TCA they have been mapped together as plantations and have also been considered for WHR together.

BIBLIOGRAPHY

Abrahamson, W.G. 1984. Post-fire recovery of Florida Lake Wales Ridge Vegetation. Amer. Jour. Bot. 71 (1): 9-21.

Ali, Salim and Sidney Dillon Ripley. 1983. "Handbook of the Birds of India and Paksitan" together with those of Bangladesh, Nepal, Bhutan and Sri Lanka (Compact Edition). Oxford University Press, Delhi, Oxford, New York.

Ali, Salim. 1983. A Pictorial Guide to the Birds of the Indian Subcontinent/Salim Ali and S.Dillon Ripley, Bombay: Bombay. Natural History Society, 177p. 598.2[540] ALI.

Ali, Salim. 1983.Handbook of the Birds of India and Pakistan: Together with those of Bangladesh, Nepal Bhutan and Sri Lanka/Salim Ali and S. Dillon Ripley, Delhi: Oxford University Press, xlii,737p.: color.plates.598.2[54] ALI

Anderson, R.C. and L.E. Brown, 1986. Stability and instability in plant communities following fire. Amer. Jour. Bot. 73 (3): 364-368.

Anon. 1985. International Code of Zoological Nomeuclature.3rd, London: International Trust for Zoological Nomeuclature.

Ansan, A.A., 1987-88 to 2001-02. Working Plan Hoshangabad, Hoshangabad.

Auffenberg, Walter. 1994 The Bengal Monitor/ Walter Auffenberg. Gainesville: University Press of florida. xxi; 561p.598.112-1.5 AUF.

Bahuguna, V.K., V. Luthra and B.M.S. Rathor. 1994. Collective forest management in India. *Ambio*, 23, pp. 269-73.

Ballick, Michael J. 1996. Plants, people and culture: the science of ethonobotany/ Michael J. Balick and Paul Alan Cox. New York: Scientific American Library, 1996. 229pp.

Bhadur, Shalendra and B.S. Thengdi, 1993-94 to 2002-03. Working Plan West Melghat Forest Division, Amrawati.

Brechin, S.R., P.C. West, D. Harmon and K. Kutay. 1991. Resident Peoples and Protected Areas: A Framework for Enquiry. Pp. 5-28 in West and Brechin (Eds.).

Champion, H.G. and S.K. Seth, 1965 *Forest Types of India* (revised edition). F.R.I., Dehra Dun.

Daniel, J.C. 1983. The Book of Indian Reptiles / J.C. Daniel.— Bombay: Bombay Natural History Society, x,141p. 598.1[540] DAN.

Daniel, J.C., ed. 1983.A Century of Natural History.: Department of Science & Technology, Government of India— Bombay: Bombay Natural History Society, 759p.

Dhar, S.K. 1994. Rehabilitation of degraded tropical forest watersheds with people's participation. *Ambio,* 23, pp. 216-21.

Dhore, M.A. and P.A. Joshi, 1988. Flora of Melghat Tiger Reserve. Technical series No. 1, Directorate, Project Tiger Melghat, Paratwada.

Dhore, M.A. and R.K. Wankhade, 1992. Impact of Herbivory and Fire on the Floristic Composition of Melghat Reserve. In *Two Decades of Project Tiger, Melghat. Papers and Proceedings.* Directorate of Melghat Project Tiger, Paratwada. pp 115-120.

District Census Handbook, Betul 1996.

District Census Handbook, Hoshangabad 1996.

Durkheiem, E. 1976. *The Elementary Forms of Religious Life*. George Allen and Unwin, London, U.K.

Firth, R. 1956. *Human Types: An Introduction to Social Anthropology.* Thomas Nelson and Sons Ltd., London, U.K.

Forsyth J. 1871. The Highlans of Central India.

Gangopadhyay, P.B., 1985-86 to 1994-95. Working Plan Bori Sanctuary, Hoshangabad.

Gangopadhyay, P.B., 1985-86 to 1994-95. Working Plan Pachmarhri Sanctuary, Hoshangabad.

Gaussen, H., P. Legris, F. Blasco, V.M. Mehar-Homji and J.P. Troy, 1969. Notes on the sheet Satpura Mountains. Du département d'écologie, Institut Francais De Pondichery

Gogate, M.G., 1988-1998. Management Plan Melghat Tiger Reserve, Parthwara, Amrawati.

Gogate, M.G., P.J. Thosare and S.B. Banubakode, Two Decades of Project Tiger, Melghat. *Papers and Proceedings,* October 1st-3rd, 1992.

Grime, J.P. 1990. The Abridged Comparative Plant Ecology/ J.P. Grime, J.G. Hodgson and R. Hunt. London: Unwin Hyman, ix, 399pp.

Grimmett, Richard.1999. Pocket Guide to the Birds of the Indian Subcontinent / by Richard Grimmett, Carol Inskipp and Tim Inskipp.—New York: Oxford University Press, 384p. 598.2(540) GRI

Heinen, J.T. 1993. Park-people relations in Kkosi Tappu Wildlife Reserve, Nepal: a socio-economic analysis. *Environmental Conservation,* 20, pp. 25-34.

Hendrix, S.A. 1987. Herbivory and its impact on plant reproduction in Plant Reproductive Ecology ed. Doust pp. 246-266. Oxford.

Indurkar, R.N. 1992. Final Settlement of the Erstwhile Forest Villages in Melghat. In *Two Decades of Project Tiger, Melghat. Papers and Proceedings.* Directorate of Melghat Project Tiger, Paratwada. pp 13-17.

Janzen, D.H. 1971. Seed predation by animals. Annual Review of Ecology and Systematics. 2:465-492.

Koliyal, Anupama, 1997. "Extraction of Non Timber Forest Produce from selected tree species in Betul Forest Division and its impact on the Population Structure of these species"; Dissertation submitted to Saurashtra University, Rajkot in partial fulfillment of the Master's Degree in Wildlife Science, July 1997. Wildlife Innstitue of India, Dehradun.

Lehmkhul, J.F., R.K. Upreti, and U.R. Sharma. 1988. National Parks and local development: grasses and people in Royal Chitwan National park, Nepal. *Environmental Conservation,* 15, pp. 143-48.

Madhya Pradesh Forestry Project – A Profile. 1995. Madhya Pradesh Forest Department.

Malhotra, K.C. 1993. *Role of NTFPs in Village Economies*. ODI Network Paper.

Mehta, Prachi. 1998. The Effect of forestry practics on Bird species diversity in Satpura Hill Ranges.— Saurashtra University, Rajkot— Doctor of philosophy in Wildlife Science: 1998— Dehradun: Wildlife institute of India, 203p.Guide : A.J.T. Johnsingh. 042.4: 598.2: 502.7 (543)MEH.

Mel-Vyaghra, 2001. Newsletter of Melghat Tiger Reserve, Paratwada, Amravati.

Menon, Vivek.1998. Wildlife Crime: An enforcement guide / Vivek Menon and Ashok Kumar.— New Delhi: Natraj publishers,104p. 502.7:339:349.6 MEN.

Mishra, R. and N.K. Joshi. 1952. The forest complex fo Patharia Hill, Sagar. *J. Indian Bot. Soc.* 31: 154-170.

Moench, M. 1989. Rapid depletion of forests worries conservationists. *Hindustan Times*, March 8, pp. 24.

Murli, K.S., Uma Shankar, R. Uma Shankar, K.N. Ganeshaiah and K.S. Bawa. 1996. Extraction of Non-timber forest products in the forests of Biligiri Rangan Hills, India. 2. Impact of NTFP extraction on regeneration, population structure, and species composition. Economic Botany 50: (2) pp 252-269.

Musavi, Azra. 2000. A socio-economic study of tribes and non tribes in Melghat Tiger Reserve and adjoining areas, Wildlife Institute of India, Dehradun.

Newton, Paul N.1987. The Social organization of Forest Hanuman Langurs (Presbytis entellus).— International Journal of Primatology: 8: 3, P. 199-232.484

Pandeya, S.C. 1952. Grasslands of Sagar, Madhya Pradesh. Indian For. 78(12): 638-654.

Pandeya, S.C. 1952. Succession in grasslands of Sagar, *Saugar Univ. J.* 1: 111-127.

Pandeya, S.C. 1961. Ecology of grasslands of Sagar, Madhya Pradesh. I. Grassland map of the area on physiognomic basis, *J. Indian Bot. Soc.* 40: 592-600.

Pandeya, S.C. 1962a. Status of grasslands of Madhya Pradesh. India. *Trop. Ecol.* 3 (1-2): 101-105.

Pandeya, S.C. 1964. Ecology of grasslands of Sagar, Madhya Pradesh. II-A. Composition of the fenced grassland association. *J. Indian Bot. Soc.* 43 (4): 577-605.

Pandeya, S.C. 1964. Ecology of grasslands of Sagar, Madhya Pradesh. II-B. Composition of the associations open to grazing or occupying special habitat. *J. Indian Bot. Soc.* 43 (4): 606-639.

Panwar, H.S. 1992. *Ecodevelopment: An Integrated Approach to Sustainable Development for People an Protected Areas in India.* Paper presented in IV World Congress on National Parks and Protected Areas, 10-12 February, 1992. Caracas, Venezuela.

Panwar, H.S. and B.K. Mishra. 1994. Rajaji National park: Real issues problems and prospects. Indian peoples tribunal workshop, 30th April 1st May 1994.

Park, J.E. and K. Park. 1991. *Textbook of Preventive and Social Medicine,* 13th edition. Banarsidas Bharat Publishers, Jabalpur, India.

Patel R.I., 1968. Forest Flora of Melghat. Dehradun.

Patel, R.I. 1968. Forest Flora of Melghat, Dehradun.

Peters, Charles M., Gentry, Alwyn H and Mendelsohn, Robert O. 1989. Valuation of an Amazonian rainforest. Nature: 339: (29) 655-656 pp.

Pradeshi, Praveen. 1992. Economic Development Model. In *Two Decades of Project Tiger, Melghat. Papers and Proceedings.* Directorate of Melghat Project Tiger, Paratwada. pp 121-128.

Prater, S.H.1980. The Book of Indian Animals / S.H. Prater.— Bombay: Bombay Natural History Society, xxii, 324p. 59[540] PRA

Radcliffe-Brown, A.R. 1979. *Structure and Function in Primitive Society*. Rutlege and Kegan Paul, London and Henley. U.K.

Rangarajan, Mahesh.2001.From princely symbol to conservation icon: a politicalhistory of the lion in India.— In: The unfinished agenda: nationbuilding in south Asia. ed, P. 399-441.8395

Rangarajan, Mahesh.2001.India's Wildlife History: An Introduction / by Mahesh Rangarajan. — Delhi: Permanent black, 135p. 502.2(540) RAN

Safalsky, N., B.L. Dugelby and J.W. Terborgh. 1992. Can extractive reserves save the rain forest? An economic and socioeconomic compariso of nontimber forest product extraction systems in Peten, Guatemala and West Kalimantan, Indonesia. Conservation Bilogy. 7(1): 39-51.

Satyam, Y. 1995-96 to 2004-05. Working Plan West Betul Division, Betul.

Sawarkar, V.B.1998.Management of Forests in India for Biological Diversity and Forest Productivity - an Ecological Perspective.— Dehradun: Wildlife Institute of India, 518p. Project no. IN_FS-120.

Schelhas, J. 1991. A methodology for assessment of external issues facing national parks with an application in Costa Rica. *Environmental Conservation*, 18. pp. 323-30.

Shelton, N. 1983. Parks and sustainable development. 1982 World National Parks Congress, pp. 16-21. *National Parks*.

Singh, Ram Partap, 1993-94 to 2002-03. Working Plan South Betul Division, Betul.

Singh, V.P. and J.S. Singh. 1989. Man and forests: a case study of the dry tropics of India. *Environmental Conservation,* 16, pp. 129-36.

Sinha, Vinay Kumar and B.S. Thengdi, 1993-94 to 2002-03. Working Plan East Melghat Forest Division, Amrawati.

Srivastava Ravi, 1992-93 to 2001-2002. Working Plan North Betul.

Tamgadge D.B., S.T. Gaikawad, S.R. Nagabhushana, K.S. Gajbhiye, S.N. Deshmukh and J. Sehgal. 1996, Soils of Madhya Pradesh: Their Kinds, Distribution, Characterization and Interpretations for Optimising Land Use. b. Executive Summary, National Bureau of Soil Survey and Land Use Planning, Indian Council of Agricultural Research, Nagpur.

Thakur, M. L. 2000. Forest Entomology: Ecology and Management.— Dehradun:Sai Publishrers.

Troup, R.S. 1921. The Silviculture of Indian Trees, Vol. I & II; Clarendon Press. Oxford.

Troup, R.S. 1981. The Silviculture of Indian Trees, Vol. III; Revised and enlarged by the Editorial Board, Forest Research Institute and Colleges, Dehradun, Govt. of India Press. Nasik.

Troup, R.S. 1983. The Silviculture of Indian Trees, Vol. IV; Revised and enlarged by the Editorial Board, Forest Research Institute and Colleges, Dehradun, Govt. of India Press. Nasik.

Troup, R.S. 1984. The Silviculture of Indian Trees, Vol. V; Revised and enlarged by the Editorial Board, Forest Research Institute and Colleges, Dehradun, Govt. of India Press. Nasik.

Troup, R.S. 1985. The Silviculture of Indian Trees, Vol. VI; Revised and enlarged by the Editorial Board, Forest Research Institute and Colleges, Dehradun, Govt. of India Press. Nasik.

Troup, R.S. 1992. The Silviculture of Indian Trees, Vol. VII; Revised and enlarged by the Editorial Board, Forest Research Institute and Colleges, Dehradun, Govt. of India Press. Nasik.

Troup, R.S. 1932. Exotic Forest Trees in the British Empire; Clarendon Press. Oxford.

Uma Shankar, K.S. Murli, R. Uma Shankar, K.N. Ganeshaiah and K.S. Bawa. 1996. Extraction of Non-timber forest products in the forests of Biligiri Rangan Hills, India. 3. Productivity harvest of Amla *Phyllantus emblica* (Euphorbeaceae). Economic Botany 50(2) pp. 270-279.

Watt, G. 1889. A Dictionary ofEconomic Plants of India. Imperial Departmetn of Agriculture, Royal Governmetn of British India, New Delhi. (Reprint, 1989).

Witt, D.O. 1911. List of Fodder Grasses found in the Berar Forest Circle of the Central Provinces. Pioneer Press. Allahabad.

Witt, D.O. 1916. Descriptive list of Trees, Shrubs, Climbers and Economic Herbs of the Northern and Berar Forest Circles, Central Provinces. Allahabad