SETTING BIODIVERSITY CONSERVATION PRIORITIES FOR INDIA

Summary of the Findings and Conclusions of the Biodiversity Conservation Prioritisation Project

VOL. I

Edited by

Shekhar Singh, ARK Sastry, Raman Mehta & Vishaish Uppal

World Wide Fund for Nature - India

2000

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The World Wide Fund for Nature – India (WWF-India) has been working to promote harmony between humankind and nature for three decades. Today, it is recognised as a premier conservation NGO in the country dealing with conservation and development issues. At a time when the Web of Life has come under increasing threats, WWF-India attempts to find and implement solutions so that human beings can live in harmony with nature, and leave a world rich in natural resources and natural wonders for future generations.

Formerly known as the World Wildlife Fund, WWF-India was established as Charitable Trust in 1969. With its network of State/ Divisional and Field Offices spread across the country to implement its programmes, WWF-India is the largest and one of the most experienced conservation organisations in the country. WWF-India's Secretariat functions from New Delhi. The organisation is part of the WWF family with 27 independent National organisations. The co-ordinating body, the WWF International, is located at Gland in Switzerland.

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Preface

These two volumes bring together summaries of most of the reports produced as a part of the BCPP. They also include some of the special papers that were commissioned and contain information on the study itself and the methodology that was used.

Volume one contains the introductory sections and the sections describing the project and the project methodology. It also contains the first part of the project report, which spills over into volume two.

The project report is divided into five parts: *Prioritising Sites* (volume I); *Prioritising Species, Prioritising Macro Strategies, Prioritising Micro Strategies,* and *Special Papers* (volume II).

Prioritising Sites: All the papers in this section, except Johnsingh et al and Haridasan, which are reproduced in full, are summaries of the main report (with the same title) that were prepared for BCPP.

Prioritising Species: The first paper (Ajith Kumar et al) summarises seven reports that emanated out of CAMP workshops, one each on medicinal plants, soil and aquatic Invertebrates of south India, amphibians, reptiles, mangrove organisms, fresh water fish, and mammals. The other papers are summaries of the full reports with the same titles.

Prioritising Macro Strategies: Except for the paper on education and awareness (Erach Bharucha), which is a summary of a larger report with the same title, all the other papers have been reproduced in their entirety.

Prioritising Micro Strategies: Only the paper on Thailand (Wohra et al) has been reproduced in toto. All the other papers are summaries. The first paper (Srishti Jigyasa Pariwar) broadly summarises the findings and recommendations of 59 village cluster reports and seven state reports that emanated out of the micro strategies component of BCPP. The remaining papers are summaries of larger reports by the same name.

The summaries were prepared by the authors themselves and have mostly been edited only for language and clarity. While compiling these volumes, the editors have tried to retain the unique style of each paper and have not tried to make them uniform either in structure or in style.

Copies of the full reports can be accessed from WWF India or from the authors themselves.

New Delhi
September 2000

THE EDITORS

Acknowledgements

Many individuals and organisations have toiled hard to make BCPP possible. The foremost among them is the Biodiversity Support Programme*, Washington D.C., particularly Dr Janis Alcorn. Dr Alcorn was the motivating force behind the project and played a significant role in its conceptualisation and design. She then became, despite having to travel each time from Washington to Delhi, the only member of the BCPP Steering Group who did not miss a meeting. However, despite being always available for consultations and advice, she guided the process with a light hand, never intruding and never behaving like the sponsor.

An equal share of thanks must go to the World Wide Fund for Nature – India, particularly to Mr Samar Singh, who was the Secretary General during the project implementation phase. It was his vision and encouragement that emboldened many of us to embark upon this very ambitious project. And it was he who provided the space, both figuratively and literally, that allowed this project to be flexible and innovative. He was supported by a dedicated team at WWF India, particularly Dr NG Nair, Mr ARK Sastry, Mr SK Katyal, Mr Sudipto Chatterjee and Mr Krishan Kumar, who were a part of the BCPP team. The Indira Gandhi Conservation Monitoring Center of WWF India also gave valuable support to the process.

Thanks are also due to the present Secretary General of WWF India, Ms Meeta Vyas, who facilitated the process of the final publication of this report.

The BCPP steering group was the 'nerve center' of the project and its members spent endless hours travelling around the country and helping to keep the process going and going in the right direction. Many of them took up specific responsibilities and not only steered the process but participated in the studies themselves. Special thanks are due to Dr Madhav Gadgil and Dr Ajith Kumar who each volunteered to coordinate the micro strategies and the species component of the project respectively. The bulk of the administrative burden of the project was borne by the Member Secretary of the steering group, initially Dr NG Nair and then Mr ARK Sastry. It was primarily because of them that the project ran smoothly and was brought to a successful completion.

The project was implemented by a large number of project partners, both individuals and organisations. And almost without exception they all completed the studies taken up by them and completed them on time. For such a large exercise, involving over 40 studies and nearly a hundred organisations and individuals, this in itself is a remarkable achievement.

Finally, the team at the Indian Institute of Public Administration, which was charged with the overall coordination, performed heroically, as always. Special thanks are due to Dr. Vasumathi Sankaran, Mr Raman Mehta, Ms Tara Gandhi, Ms Vishaish Uppal, and Mr Arpan Sharma.

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Errata (Volume I)

Page 57, last para before **Introduction**. "**Tlhreats**" should be read as "**Threats**" in the first line.
Page 92, Table 4, row 2, column 9. "Katcall" should be read as "Katchal"
Page 92, Table 5, row 2, column 12. "Kamota" should be read as "Kamorta"
Page 157, right column, fifth para from the top. "LEVEL II" should be read as "LEVEL III"
Page 223. Disregard the heading "**Reference points for figures 1 and 2**"
Page 223, Table (*i*). Disregard column four titled *Reference points*
Page 224, Tables (*ii*) and (*iii*). Disregard column four in both tables titled *Reference points*
Page 262, left column, second para from top, line three. "Page 18" should be read as "Page 258"
Page 262, left column, third para from top, line two. "Page 21-22" should be read as "Page 260"
Page 262, left column, fourth para from top, line two. "Page 22" should be read as "Page 260"
Page 262, left column, fifth para from top, line two. "Page 22" should be read as "Page 260"
Page 262, left column, sixth para from top, line two. "Page 23" should be read as "Page 260"
Page 262, right column, second para from top, line two. "Page 23" should be read as "Page 261"
Page 262, right column, third para from top, line two. "Page 23" should be read as "Page 261"
Page 262, right column, fourth para from top, line one. "Page 24" should be read as "Page 261"

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The Biodiversity Conservation Prioritisation Project

India is a vast land, rich in opportunities and in biodiversity. It has evolved into a fabric of diverse cultures intertwined with a pervasive concern for all living things. For centuries, traditional attitudes and institutions have nurtured and conserved the natural wealth and diversity of this populous sub continent. Historically, animals and plants were revered, even worshipped, and forests, rivers and lakes were seen as abodes of the Gods. But, despite all this, in recent times much of our environment has come under severe threat. Conservation values and institutions that had evolved over millenniums have been replaced by those more conducive to destruction and profiteering. Species and ecosystems are being degraded and lost at an alarming rate. If total ecological disaster is to be prevented, there is clearly an urgent need to take stock of our predicament. Many of our people, especially the rural people, depend on the forests, rivers and lakes for their survival. Yet, our already scarce natural resources are more and more being diverted for elite consumption. The few that are left are often too sparse to allow for sustainable utilisation. New scientific understanding has made us aware of fresh dangers to the environment, yet our centralised institutional structures are not able to deal with even the old ones. The competition over natural resources is increasing and nature is more and more being seen as only a short-term economic resource. It is with this background that we have undertaken to make a beginning at trying to understand how we are to conserve our environment, and where and on what should we focus.

The Project

The BCPP was arguably the largest and most comprehensive exercise ever undertaken in India to prioritise **sites, species** and **strategies** for biodiversity conservation. Over two years the project involved hundreds of community groups and over forty NGOs, educational and scientific institutions, and government agencies in developing a participatory methodology for prioritisation and in applying this methodology to identify a set of conservation priorities. The project was executed through over a hundred sub-projects covering the whole country and working from national, regional and state-levels down to village clusters and individual villages.

The Project Structure

The project sought to prioritise sites among

- Deserts
- Rangelands
- Wetlands
- Coasts
- Oceans
- Forests
- Islands
- Mountains
- Biosphere Reserves
- Sacred groves
- National Parks and Sanctuaries

Further, it attempted to prioritise between species of:

- Medicinal plants and animals
- Wild relatives of cultivated and domesticated plants and animals.
- Other wild plants and animals

It also sought to prioritise strategies both at the macro and micro levels. At the macro level it tried to focus attention on certain priority issues like economic incentives, education and awareness, and gender biases, and identify laws, policies and schemes which could best contribute to biodiversity conservation. At the micro-level it identified, in consultation with village communities, village level biodiversity priorities and preferred strategies for conservation. For the purpose, local level NGOs worked for two years in fifty nine village clusters in seven states and a union territory: Orissa, Karnataka, Assam, Bihar, Rajasthan, Uttar Pradesh, Himachal Pradesh and Andaman & Nicobar Islands.

The Methodology

The project emphasised the need to involve all stake-holders in the process of prioritisation. It attempted to exchange information between different levels and sectors so that, for example, national level policies could be compared against village aspirations and preferred strategies could be matched to prioritised sites. The process of participation assumed that the involvement and agreement of all stake holders was critical for effective

conservation. It also recognised that a large part of the crucial information required to carry-out such a prioritisation was not available through published sources but needed to be abstracted from the work and experience of scientists, professionals, activists and other members of the community.

The project attempted to integrate biological concerns with socio-economic imperatives so that the resultant prioritisation was scientifically rigorous, socially just and operationally practicable

The Output

The BCPP addresses, through its reports and by disseminating the vast amount of data collected, various concerns and interests. For one, it has developed a methodology for data-deficient conditions. Such a methodology can be useful as a starting point in other data-deficient countries and for other exercises in India. It has also set in motion a process which would outlive the project and be integrated into the normal, even routine, functioning of conservation oriented groups and agencies in India.

The project and its output is expected to be of use to many, including:

- **Villagers and local level activists** – who have had the opportunity to review their own biodiversity priorities and formulate preferred conservation strategies. They have hopefully developed skills and capabilities for further conservation thought and action, and now have access to relevant data about their own situation and about the larger world, in a form that is assimilable and usable.
- **Conservation NGOs and community groups** – who are being alerted to the values and threats relating to specific sites and species within their areas of operation, and informed about preferred conservation strategies.
- **Local and state governments** – who now have specific reports covering their jurisdiction and highlighting the priority sites and species, and preferred conservation strategies.
- **The Government of India** – which is being provided with a comprehensive output of the whole exercise alongwith a national report outlining priority sites, species and macro and micro level strategies. They also have available the data sets and the methodologies that were developed and tested as a part of the project.
- **The national and international scientific community** - who is being presented with the outputs of a painstaking process of prioritisation using the best available scientific methods and data.
- **International agencies** – who can use the outputs of the exercise to recognise the priority areas and issues requiring attention and support, and now have access, perhaps for the first time, to a series of conservation strategies evolved with stakeholder participation and consensus.

The Aftermath

The BCPP closed with a workshop in the end of April, 1998. The outputs of the project were presented at this workshop to a select audience of administrators, scientists, conservationists, activists and community representatives. Efforts also started, as soon as the findings were available, to focus attention and resources towards the conservation of those sites and species that have been prioritised, and towards operationalising prioritised strategies. There is also a commitment among the project partners to continue this process of assessment, evaluation, discussion and wide ranging participation, so that conservation priorities keep evolving in response to changing times and varying circumstances. In fact many of them, in various capacities, are now participating in the formulation of the national Biodiversity Strategy and Action Plan (BSAP); that is being sponsored by the Global Environment Facility (GEF) and is being executed by the Government of India through a group of NGOs. They have taken with them their experiences and findings of the BCPP and are now putting them to good use in making the official strategy as effective as possible.

Detailed Project Design

Reproduced below are extracts from the original project design document

Objectives

The primary objectives of BCPP are:

- To develop a *participatory methodology* for setting *biodiversity* conservation priorities for India, across disciplines and levels.
- To prepare, in a participatory manner, a document describing *priority sites, species and strategies for biodiversity conservation in India.*
- To develop, in a participatory manner, *site specific biodiversity conservation plans*, for a few priority sites.
- To assist in strengthening the *capacity of multiple stakeholders* to do a science-based independent assessment of the processes of setting priorities, developing site specific conservation plans, and channelling funds for biodiversity conservation.

Some of the secondary objectives are:

- To make the developed methodology relevant to other countries.
- To design a biodiversity information collection and management system especially sensitive to the needs of NGOs and the local community and capable of handling disaggregated, local information.

Methodology

The project would be implemented in two phases. Phase I would be a participatory planning phase during which the partners (NGOs, government organisations at the national and state and local levels) would be identified and specific methods for data collection and analysis, and for priority setting would be chosen. Parameters for co-operation and interaction between the different stakeholders (including the government) would also be defined in phase I. Among other things, this would involve:

* A review of the methodologies used in other similar or related biodiversity prioritisation efforts, nationally and internationally. The methodology used, especially in terms of its scientific content and participatoriness, would be documented and assessed.
* A review of the methodologies used in other participatory planning and implementation efforts in India and elsewhere, in order to build upon past experiences. These could include the ecodevelopment indicative planning exercise for the GEF [IIPA 1995], the joint forest management experiences in West Bengal, the Ranthambhore Ecodevelopment Project of the WWF India, ICDP experiences in South East Asia and Africa, among others.
* A discussion of these methodological issues and options in a series of workshops designed to elicit a cross section of views from village communities, NGOs, government institutions, professionals and scientists. Appropriately designed workshops would be organised by NGOs at local community, state and national levels. Out of this process should emerge a broad consensus on the approach to be adopted.
* A field testing and fine tuning of the selected approach and methodology. This, again, would be done at all appropriate levels including local levels.

The second phase would involve the application of the methods and process, defined during the first phase, to produce the outputs. Among other things, this could involve:

* A critical assessment of the current priorities and strategies for biodiversity conservation, abstracted from ongoing activities and embodied in relevant laws, policies, plans and explicit priority statements.
* The consequent identification of the major gaps in the existing set of priorities and strategies for India, both in terms of the appropriateness of their content and in terms of the participatoriness of the methodology used.
* Application of the participatory methodology, developed and agreed upon in phase I, to these gaps (some of the more obvious gaps, as examples, are described in the Annexure I), to develop a prioritisation of sites and strategies for biodiversity conservation.
* Further application of this methodology to a selection of sites, representing various priority segments of biodiversity (see Annexure I for details), to develop participatory, site specific conservation plans. These sites, identified through the prioritisation process, would be assessed for actual and potential threats and, using a participatory methodology, a site specific plan would be developed for minimising these threats in a manner that involves the local communities and does not have a negative impact on their lives.

Management

WWF-India would be the secretariat for the project and it would be executed jointly by NGOs and individuals in association with the various other stakeholders. The project would be overseen by a Steering Group which would include representatives from a range of NGOs, research institutions and government bodies with the responsibility of developing the project details, identifying project partners and implementing agencies (NGOs, government institutions and individual professionals), monitoring the progress and putting together the final report. This Steering Group would also ensure that there is wide consultation among NGOs and citizen groups on all aspects of the project, through the various stages. The Steering Group could have an honorary chairperson and a full time member secretary, both to be identified later.

Outputs

At the end of the project (24 months) there would be:

- A written up participatory methodology for determining biodiversity priorities, relevant both for India and for other countries of the South.
- A document describing priority sites and strategies for biodiversity conservation in India, developed in a participatory manner and reflecting the national concerns;

- Detailed site specific plans for some priority locations, from among those identified, addressing biological and socio-economic needs, and prepared in partnership with the local communities;
- An expanded biodiversity database and an enhanced capacity to determine biodiversity conservation priorities and to accordingly influence the national planning process.

Significance

These outputs would have great value by themselves. In addition, they could link up to other ongoing and proposed conservation initiatives.

* The methodology could be used by state governments to plan for the biodiversity conservation activities envisaged under their plan budgets and various externally aided projects. The government's interest in adopting the methodology would be determined in phase I of the project. Where required, special training programmes would also be designed to develop, within the government, the capability to use the methodology.
* Considering the fact that many NGOs are already collaborating with the government in developing biodiversity conservation plans, the availability of such a methodology and related training opportunities would also assist these NGOs in their task.
* The Government of India can also use this methodology for developing biodiversity projects under the GEF, IDA and other national schemes. Specifically, the second GEF project on biodiversity conservation would be under preparation from 1996. The Government of India has already indicated its intention to strengthen management and eco-development activities around forty protected and forest areas as a part of this project. Preliminary discussions with officers of the Ministry of Environment and Forests suggests that this project could significantly feed into both the first and the second GEF project preparatory exercise by not only developing a suitable methodology but also by identifying priority sites and site specific conservation strategies.
* The listing of priority sites and strategies for biodiversity conservation in India, as an output of this project, would go a long way in focusing on the need to carry forward this work and to develop a comprehensive biodiversity conservation action plan for India. Considering that elements of such a plan are already under preparation in different places, mainly by NGOs and institutions, this project could become a catalytic force in bringing about some informal co-operation between these different institutions and NGOs, and by perhaps operationalising a commonly accepted and agreed methodology.
* The availability of site specific biodiversity conservation plans, as an output of this project, can facilitate future funding by providing a ready made portfolio of well designed projects.
* The networking and databases resulting from this study can significantly enhance NGO capabilities to effectively influence planning and investment at all levels.
* The objectives of the BCPP would go a long way in helping the people and the Government of India to meet the various obligations under the Convention on Biological Diversity. The specific clauses of the Convention that would be addressed by this project are listed in Annexure III.

Detailed Project Framework

The primary outputs of the project are expected to be:

- Description of the participatory methodology used for prioritisation
- Listing of priority sites and species
- Identification of optimal conservation strategies
- Some site specific, village level, conservation plans
- A user friendly and easily accessible biodiversity information system

It is likely that these outputs would be packaged into:

- A *summary report*, giving the status of biodiversity conservation and encapsulating a gist of the detailed reports prepared as a part of the project. The summary report would cover all the issues being dealt with under the project.
- A *report* on the participatory methodology used for the prioritisation exercise.
- *Individual papers* on various issues and aspects including prioritisation of values, policy, law, fiscal and economic aspects, institutional considerations, plans and programmes, community participation, international obligations, gender issues, internal trade, research, and education and awareness.
- *Individual reports* identifying priority sites, listed nationally, statewise and for different ecosystems, legal and institutional entities, and bio-geographic zones.
- A *report* on priority conservation strategies, nationally, statewise, and for different ecosystems, legal & institutional entities, and biogeographic zones.

- *Individual reports* identifying priority species of medicinal plants, and wild relatives, and other endangered species, and the sites and strategies important for their conservation.
- *Individual conservation plans* for some selected sites and villages.
- A *biodiversity database* developed in the process of carrying-out these various studies and formalised to function even after the termination of the project.

The three basic aspects which must be fundamental to all these activities and which, therefore, need to be decided upon at the very early stages of the project are:

- The values or sets of values that would be used to prioritise conservation sites and species.
- The methodology for prioritisation and the manner in which the prioritisation exercise would be participatory and would significantly involve different stake-holders.
- The basic principles that must be subscribed to, especially those of participatoriness, equity and sustainability, in any recommended conservation strategy.

Each individual report relating to ecosystems, biogeographic zones, legal and institutional entities, specific species, for the states and for the country, must address itself appropriately to all the various relevant issues, especially to the legal, economic, institutional and gender issues.

It would seem unlikely that detailed reports could be written on all the relevant topics. As such, there is a need to prioritise even among these topics and perhaps to focus on those which have been relatively ignored in the past. For the remaining, a survey of existing literature and data might be adequate for this prioritisation exercise. A proposed prioritisation of topics is at Annexure I.

As far as possible, an effort needs to be made to ensure that the prioritisation exercise is bottom up rather than top down. Unfortunately, in the time and resources available it would not be possible to do biodiversity conservation prioritisation exercises in all the blocks and districts of the country. However, it is proposed to do such an exercise in a sample of seventy village clusters spread over seven states and representing different biogeographic and socio-economic regions.

As prioritisation exercises would be simultaneously taken up across eco-systems, legal and institutional entities, and species, there is very likely to be a *prima facie* mismatch between the priorities emerging from each of these activities. For example, priority sites at local or state levels might not always match those selected at the national level. It would be an important part of the project to reconcile these differences and, in the process of doing this, to develop a methodology by which macro and micro prioritisation can be interfaced, along with priorities emerging from different stand points. It is hoped that such an exercise would produce a coherent set of priorities for the country and for each state.

Similarly, for the strategies exercise, optimal national and state level strategies and their components, including laws and policies, will be determined, and then these will be interfaced with local level requirements. For example, one part of the exercise would describe national and state laws relevant to biodiversity conservation. These would then be analysed at the village level to determine whether, if the preferred local level conservation strategies are to be operationalised, there need to be changes in these laws. Final recommendations will be adjusted for levels, taking into consideration preferred conservation strategies from village level to the national level.

It is recognised that, considering the diversity of perspectives and disciplines, there might not always be unanimity on the priority status of each site or species. This does not necessarily have to be a weakness of the exercise, for a prioritisation exercise of this sort should be expected to throw up alternate sets of priorities, each with a clearly stated basis and a description of the trade off involved in selecting one over the other.

The final summary document would present the output of the prioritisation exercise not just in one format but in different formats. For example, from the administrative point of view, priorities could be indicated nationally and statewise. Within these they could be indicated according to legal and institutional entities in terms of national parks, reserve forests, sacred sites, etc. On the other hand, from the biological point of view priorities could be indicated in terms of ecosystems, biogeographic regions and species.

ANNEXURE I

Biodiversity Conservation Prioritisation Project

PRIORITISING TOPICS

Given below is a list of priorities from among the topics to be covered as a part of BCPP. A distinction is sought to be made between studies, papers, reports and support systems. Studies are envisaged to involve some primary data collection and usually multiple partners. Papers are expected to be based on secondary data and would usually be written by a single expert. The report would be a compilation of the essence of all the studies and papers and would serve as the final project report. Support systems include mapping and information systems required by those undertaking the studies, writing papers and compiling the final report.

In establishing these priorities, the ecosystem has been taken as the primary unit for prioritisation as opposed to biogeographic zones or political states. This is because expertise is most likely for specific ecosystems rather than for specific biogeographic regions or for states. An exception is made for national parks and sanctuaries, biosphere reserves, and sacred sites for it is considered that these three require special focus and adequate interest and expertise exists to make such a focus feasible.

From among the various tasks, four are identified as warranting detailed study, namely fiscal, education and awareness, and participatory conservation strategies in village clusters and in other countries of the South. The first two have been prioritised as they are both critical without much work having been done on them so far. The third is essential to understand the potential of community based conservation strategies, and the fourth becomes important as one of the objectives of the project is to develop a strategy that is also relevant to other countries of the South.

Studies

For Determining Priority Sites

Ecosystems

- Forests
- Wetlands
- Deserts
- Coasts
- Oceans
- Mountains
- Islands
- Rangelands

Protected Areas

- National Parks and Sanctuaries
- Biosphere Reserves
- Sacred Sites

For Determining Priority Species

- Medicinal Plants and Animals
- Wild Relatives of Domesticated/ Cultivated Species
- Other Endangered Species

For Determining Priority Strategies

- Fiscal
- Education, Awareness and Training
- Participatory strategies of conservation in villages and village clusters
- Participatory strategies of conservation in other countries of the South

Papers

For Determining Priority Strategies

- Policy
- Law
- Institutional
- Plans and Programmes
- Community Participation
- International Obligations
- Traditional Methods of Biodiversity Conservation
- Gender Issues
- Internal Trade
- Research
- Prioritisation Values
- Biodiversity conservation and nutritional levels
- Prioritisation Methodology
- Conservation Methodology

Reports

- Consolidated Project Report

Support Systems

- Mapping
- Information System

ANNEXURE II

Potential Areas of Focus for Biodiversity Conservation Priorities Project to be Considered in Phase-I

Wildlife Protected Areas and Reserved Forests

The Wildlife Protected Areas (PAs), Reserved Forests, Marine, Coastal, Wetland and Riparian Areas as well as terrestrial habitats together cover about 25% of the country's natural habitats. With over 500 wildlife protected areas covering over 4% of the country's area and representing all the biogeographic types found in India, the PA network represents a unique opportunity for conserving wild biodiversity in India. However, the sheer numbers and the inherent diversity of ecosystems and threats makes it important to prioritise locations and strategies so that scarce resources can be optimally used. Given the density of human population and the general scarcity of land in India, these PAs often become centers of conflict over biomass, between the government and the local communities. If not sensitively managed, PAs can be the cause of great deprivation and injustice to the tribals and rural poor of India.

Given the crucial role that the PA network plays in biodiversity conservation, the development of conservation priorities and strategies for India's wildlife protected areas can be seen as a high priority. Initial progress has been made in this direction by the Government of India which, in 1984, came out with a Wildlife Action Plan [MOEF 1984], laying down the basic principles for wildlife management, including PA management. Detailed management plans have also been made for some of the PAs in India. However, much more needs to be done.

Of the various studies envisaged under the Wildlife Action Plan, only a few could be completed to date. Of those that were initiated, and completed, one was undertaken by the Wildlife Institute of India (WII) and the other by the Indian Institute of Public Administration (IIPA).

The WII carried out a gap analysis of the PA network [Rodgers and Panwar 1988] and identified the weaknesses in the network in terms of representativeness of biogeographic types. The report went on to make a series of recommendations for the expansion and upgrading (from sanctuaries to national parks) of various existing PAs, and for the creation of new ones.

The IIPA carried out a survey of the management status of PAs [Kothari et al 1989] in terms of their legal status, threats and pressures, and management capabilities. Various measures for improving the management of PAs in India were recommended.

However, at the end of the day there were two sets of recommendations from these two separate exercises, one recommending priorities on the basis of an assessment of biogeographic representativeness, *without any reference to threats, pressures and socio-economic feasibility*, and the other basing its recommendations on an assessment of threats, pressures and socio-economic factors, *without taking into consideration the biogeographic requirements.* Neither of these exercises involved the local communities in any significant way.

Recently, there have been efforts to develop and use an integrated and participatory approach for identifying priority locations and strategies for biodiversity conservation. Preparation of indicative ecodevelopment plans for ten PAs has been initiated for support by the IDA (two) and GEF (eight). However, the methodology is still developing and needs to be applied to many more PAs, especially as a large amount of money has already been committed for PA management through national budgets and bilateral and multilateral funding. For example, forestry projects of the World Bank and the ODA, in excess of one billion dollars are under execution or expected to be executed in the next five years. All of them have a biodiversity conservation component. The two GEF projects on biodiversity, one in the final stages of planning and the other in the offing, are also expected to amount to at least 300 million dollars.

There is, therefore, a clear and urgent need to develop an integrated participatory methodology, and for its application to a larger number of PAs (especially marine and wetland areas) across the country. This would result in the development of management and ecodevelopment plans for a number of PAs, based on local level information and developed with the participation of the local people. It would also lead to the identification of national and sub-national (regional) priorities and strategies for PA conservation.

There are approximately 42 million hectares of legally designated reserved forests in India, covering over 13% of the country's area and comprising of woodlands, grasslands, mountains, wetlands, desert and marine ecosystems. These reserved forests have strong legal protection, especially under the Indian Forest Act of 1927 and the Forest (Conservation) Act of 1980. Their management is the responsibility of professionals from the Indian Forest Service and State Forest Services. There is also a National Forest Policy of 1988 and an ongoing process for formulating a National Forestry Action Plan, sponsored by the FAO.

Unfortunately, the thrust of forest management strategies in the past has been to "work" the forests for extraction of timber and other forest produce. There has been inadequate concern on biodiversity conservation

despite the fact that among the reserved forests of India there are many which even today retain a large proportion of their pristine habitat.

The need seems to be to identify priority locations from among reserved forests and to carry out biodiversity and socio-economic assessments of these locations with the purpose of participatorily developing site specific strategies for conservation. The fact that a large amount of money is currently being invested in forest management, both out of national budgets and through a large number of externally aided projects, makes the need for such an exercise all the more critical.

Details for this segment could be built up in consultation with the Indian Institute of Public Administration, the Wildlife Institute of India, the Centre for Ecological Studies, Bangalore and the Society for the Promotion of Wasteland Development, all of whom have experience in this area.

In Situ Conservation of Wild Relatives of Cultivated Plants

Despite ongoing degradation of natural ecosystems, very little has been done to secure the *in situ* conservation of wild relatives of cultivated plants. In fact, information about their distribution and status is scarce. Given the fact that legally designated forests and wildlife protected areas together cover more than 25% of the country's surface area and jointly contain examples of all the various biogeographic types found in India, they could conceivably be high priority areas for identifying the occurrence of wild relatives. The network of forest and wildlife protected areas also contain most of the remaining relatively undisturbed natural ecosystems, have adequate legal protection and an exclusive management infrastructure. This makes them high priority locations for initiating efforts at *in situ* conservation of wild relatives. Essentially this could involve:

* Identifying and prioritising wild plant species for conservation action by looking at various factors including cultivation value; rare, endangered and threatened status; ecosystem value.
* Establishing the natural distribution of these priority species, especially through review of herbariums and published literature; field surveys in priority locations.
* Computerising the data collected and, where appropriate, developing GIS databases.
* Identifying priority sites and developing site specific conservation strategies.

Details for this segment would be developed in consultation with USAID/New Delhi as it is understood that this is a focus in their strategy statement.

In Situ Conservation of Medicinal Plants

Though there is a large and growing demand in India for medicinal plants, efforts at *conserving medicinal plants in situ* are almost non existent. With a large proportion of the Indian population preferring naturopathy and an increasing use of medicinal plants even for allopathic medicines, there is a growing commercial demand for these plants. Though some of them are now being cultivated, most are still being extracted from the wild, often unsustainably, leading to their disappearance.

For reasons mentioned above, forests and wildlife protected areas would be a good starting point for initiating surveys and *in situ* conservation efforts for medicinal plants. These could link up with the ongoing *ex situ* conservation initiatives aimed at providing employment to tribals and village communities. Specifically, such an effort would involve:

* Developing a priority listing of medicinal plants for conservation action by looking at various factors including regional endemism; rare, endangered and threatened status; domestic consumption and export value; ecosystem value.
* Establishing the natural distribution of these priority species, especially through review of herbariums, floras and published field studies; conducting CAMP exercises in different regions based on IUCN (version 2.2) guidelines for rapid assessment of RET species.
* Computerising the data collected and, where appropriate, developing GIS databases.
* Identifying priority sites and developing site specific conservation strategies.

Details for this segment could be developed in consultation with the ongoing national project on the cultivation of medicinal plants whose focus, however, is on cultivation and conservation outside PAs and forest areas.

Alternate Biodiversity Information System

It is critical for the Indian NGO sector to more effectively interact with national and state governments in planning for biodiversity conservation. The NGO sector also has the responsibility of influencing national thinking on biodiversity conservation issues and of ensuring that those most directly affected by the conservation strategies adopted, especially the rural poor, have a voice in this debate.

If thought and action has to move away from conventional paths, there is a need for new and different types of information, as a contrast to the data currently available which reinforce existing biases. There is especial need for local, qualitative information, which cuts across formal disciplines. There is a need to collect such information and to develop data bases which are accessible to every one.

Details for this segment could be developed in consultation with the Indira Gandhi Conservation Monitoring Centre of the WWF-India whose special focus is to develop a biodiversity information system for India. The output from this project could also help them in this endeavour as also feed into the second GEF project wherein the Government of India has identified the establishing of a biodiversity information system as a priority.

ANNEXURE III

List of Action Points Emanating from the Convention on Biological Diversity Addressed by the BCPP

ACTION POINT (Clause)

To develop national strategies for conservation and sustainable use of biodiversity or adapt already existing strategies, plans and programmes reflecting the relevant measures of the convention (Clause 6a)

To integrate the conservation and sustainable use of biodiversity into sectoral/cross sectoral plans, programmes and policies (6b)

To identify components of biodiversity important for their conservation and sustainable use with reference to Annexure I (7a)

To monitor identified biodiversity components, especially those requiring urgent conservation measures and with potential for sustainable use (7b)

To identify activities that have adverse impacts on conservation and sustainable use of biodiversity and to monitor their effects (7c)

To maintain and organise information derived from the above listed monitoring activities (7d)

To establish a system of protected areas or special areas to conserve biological diversity(8a)

To develop guidelines for selection, establishment and management of protected areas/special areas (8b)

To regulate or manage biological resources important for conservation of biological diversity, within or outside protected areas (8c)

To promote protection of ecosystems and natural habitats and the maintenance of viable populations of species in natural surroundings (8d)

To promote sustainable development in areas surrounding protected areas (8e)

To promote rehabilitation of degraded ecosystems and recovery of threatened species (8f)

To strike a balance between present uses of biological diversity and sustainable use and conservation of its components (8i)

To respect and preserve knowledge, innovation and practices of indigenous and local communities relevant for the conservation and sustainable use of biodiversity (8j)

To promote their wider application (8j)

To encourage the equitable sharing of benefits arising from this (8j)

To get (from the Global Community) financial and other support for in-situ conservation (8m)

To integrate conservation and sustainable use of biological resources in national decision making (10a) (See 6b)

To use biological resources so as to avoid impacts on diversity (10b)

To protect and encourage traditional and customary uses of biological resources which are sustainable (10c) (See 8j)

To support local populations in taking remedial action in degraded areas with reduced biodiversity (10d)

To adopt socio-economic incentives for conservation and sustainable use of the components of biodiversity (11)

To establish and maintain programmes for scientific and technical education and training in identification, conservation and sustainable use of biodiversity and its components (12a)

To get funds (from the Global Community) for such education and training (12a)

To encourage research into conservation and sustainable use of biodiversity (12b)

To promote, and cooperate in the use of, scientific advances for conservation and sustainable use of biological resources (12c)

To ensure that impact on biodiversity of programmes and policies are taken into account (14,1b) (See 6b)

To promote international technical and scientific co-operation in conservation and sustainable use of biodiversity (18,1)

To promote technical and scientific co-operation through the development and implementation of national policies (18,2)

To develop and strengthen national capabilities by means of human resource development and institution building. (18,2)

THE PROJECT METHODOLOGY

BCPP Process and Methods: Design, Application and Evaluation

Janis Alcorn and Vishaish Uppal

Introduction

The BCPP was born from the need for new, more systematic conservation priority setting methods appropriate to countries with rich but poorly known biodiversity where planning exercises have potential to build momentum for additional studies and conservation action. The BCPP offers a model for how NGOs, local scientists, and interested government officials can use an initial priority setting exercise to build a network and commitment to work together to establish priorities and get action at the politically relevant levels—local, state, biome-specific/ regional, and national. This chapter will describe and evaluate the BCPP process and the methods used by the collaborators.

In April of 1995, seventy-five global experts at a USAID-funded international workshop on prioritization methods in Washington DC, reached concensus that conservationists and donors needed to advance priority-setting methods beyond the current paradigm of quick, expert opinion workshops run by expatriates. The experts suggested that USAID and the Biodiversity Support Program (BSP) should fund the development of more participatory and scale-sensitive methods for priority-setting, and focus on prioritizing conservation actions as well as prioritizing locations and species needing conservation attention. They also recommended that a national exercise would be more useful than an Asian regional exercise, because it could serve as a model and offer lessons to other countries seeking to fulfill their obligations under the Convention on Biological Diversity.

BSP and USAID selected India as the leading candidate for this exercise due to a favorable constellation of reasons. India is among the megadiversity countries of the world, and the Government of India and the state governments are making significant investment in biodiversity conservation. India is a democracy, so there was maximum potential for civil society participation in the activity. A wide range of Indian NGOs are investing their funds in conservation related activities, and many bilateral donors are also interested in investing in biodiversity at specific sites in India. Because it was expected that overall investment in conservation in India would be increasing in the near future, there was high likelihood that the resulting priorities would be used to guide investment. A priority setting exercise in India could also serve to assist in selecting sites for future GEF and other multilateral donor investment. India is typical of many tropical countries in that it is a "data-deficient" country in terms of information about the distribution and status of species and habitats, particularly at the national level. Indian scientists are not dependent on foreign experts. There are significant numbers of biologists; yet the biologists (as is generally true of scientists worldwide) tend to be specialists who aren't accustomed to thinking at state or national levels. After a representative sample of Indian NGOs and research institutions expressed interest in a collaborative priority-setting project, BSP and USAID agreed to support the Indian initiative.

BCPP Design, Structure, and Methods

Initially, contact was established with one of the Indians who had attended the April 1995 meeting in Washington. Along with him, various other NGOs and individuals were also contacted and when they all expressed their interest in the project, the mechanisms and logistics of the project were discussed with them. WWF-India was selected by them as the nodal agency for coordinating the project, because it expressed interest in joining the multiparty project and collaborators welcomed WWF's offer to house the secretariat for grant oversight and financial management. The BCPP was formally launched via an agreement signed between BSP and WWF-India in November 1995. USAID set a two year time frame for implementing the project. A budget of US dollars 550,000.00 was provided to WWF-India for the project.

The project period was divided into two phases, over a total of two and a half years. The initial planning phase lasted from November, 1995 until April, 1996. The implementation phase began in April 1996, with the holding of a project design workshop in Delhi and the final workshop was held in April 1998. During the initial planning phase, the steering group was set up and the project was designed and priority issues identified. The design was finalised at the project design workshop that

was attended by 125 biologists, conservationists and other NGO and government representatives. The tasks of the second phase included the identification of project partners, the development of detailed terms of reference, the agreement on a methodology and time schedule with each project partner, the commissioning of the sub-components, release of funds to project partners; refinement of the methodologies and values to be used by subprojects; implementation of the fieldwork, desk studies, and workshops; and the preparation, review and finalisation of project reports.

Steering Group

The decision-making body for BCPP was a Steering Group (SG) that included: representatives from 15 Indian organizations (NGOs and research institutions); three government officials with special interests in conservation; and a BSP conservation specialist. A prominent national NGO, WWF-India, served as the convener of the SG. A member of the faculty of the Indian Institute of Public Administration, a major professional institution in India, was invited to chair the steering group and to co-ordinate the project in an honorary capacity. WWF-India appointed a respected botanist to serve as the member-secretary of the Steering Group (initially Dr. NG Nair and, subsequently, Dr ARK Sastry).

The BCPP Steering Group was responsible for creating a vision for BCPP and sanctioning grants to achieve that vision. They set out to:

- develop a participatory methodology for setting biodiversity conservation priorities for India, across disciplines and levels;
- identify priority sites, species and strategies for biodiversity conservation in India;
- develop site specific biodiversity conservation plans, for selected priority sites;
- develop capacities of multiple stakeholders to develop their own conservation priorities and strategies; and
- develop information systems for biodiversity conservation.

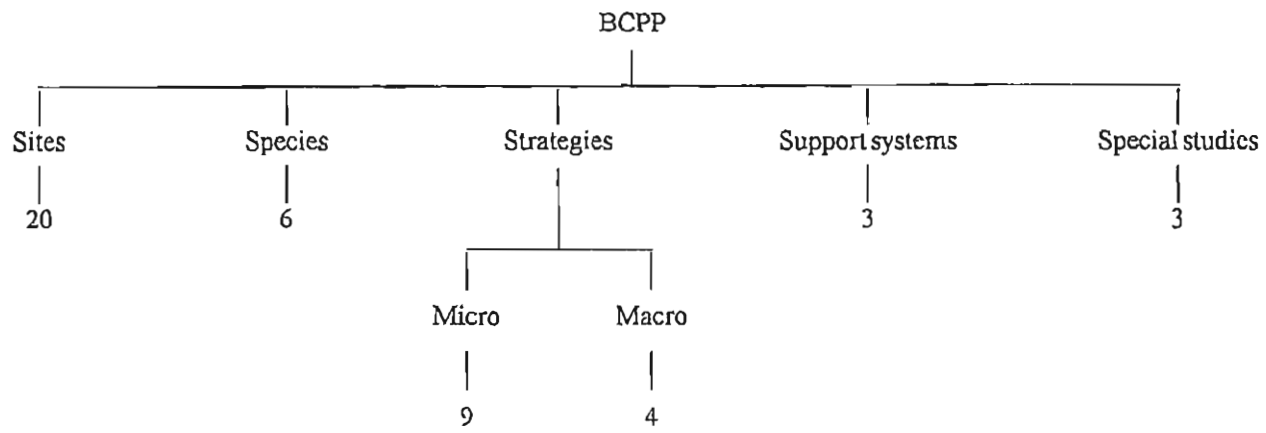
In order to bring multiple perspectives to address the task and produce recommendations that would be widely-accepted, and in order to manage the project in an open and participatory manner, the Steering Group comprised experts in various disciplines ranging from ecology and wildlife, to economics and sociology. The primary responsibilities of the Steering Group were to develop the project implementation strategy and provide guidance to the BCPP coordination unit located within WWF-India for the implementation of the BCPP. A Project Screening Committee was set up from among the Delhi based members of the Steering Group. The main functions of this Committee were: to invite and screen project proposals from groups identified by the SG on the basis of their track records, ongoing programs and interests; to secure modifications, if necessary; and then to recommend their approval to the SG.

Design Details

SG discussions led to the conclusion that the BCPP process would be designed to address two major goals:

- identify priority sites and species for conservation, and
- evolve strategies for local, state and national actions towards conservation.

The Steering Group sanctioned a total of forty seven projects. Of these, two subprojects were sanctioned for coordination (overall co-ordination to the Indian Institute of Public Administration-IIPA and the co-ordination of the micro strategies component to the Foundation for the Revitalisation of Local Health Traditions-FRLHT). The remaining subprojects were classified as:



To implement these subprojects, WWF-India administered subgrants that involved over 100 highly-respected organizations.

It was recognised at the outset that in order to carry out an exhaustive priority setting exercise for the whole country, many agencies and individuals would have to be involved in implementing the project. All the organisations in India that were consulted about their interest in participating in BCPP expressed great interest in getting involved in the process. It was also felt that, because of the available indigenous expertise, there was no need to contract foreign consultants. This latter decision also helped in ensuring that the funds for the priority setting exercise were stretched as far as possible.

The SG held detailed discussions on exercises to be undertaken for prioritisation of sites and species, and it was agreed that as far as the prioritisation of sites was concerned, ecosystems would serve as units because these units would be more intelligible to the public and government agencies.

The Steering group felt that, in addition to a national focus, conservation strategies needed to be developed at local levels (microstrategies). The SG assigned leadership for this microstrategies subcomponent to Dr. Madhav Gadgil. Seven states were chosen for the microstrategies' focus, based on their representativeness of the cultural and ecological diversity of India: Karnataka, Rajasthan, Himachal Pradesh, Bihar, Orissa, Assam, and Andaman & Nicobar Islands.

To discuss the methodology for developing local assessments and plans, a two day workshop was organised in Bangalore for the strategies subgroup in March 1996. The objective of holding the workshop was to "finalise a stratified sampling procedure" which would be used in the micro level sites in different states of India. This was where the microstrategies at the local level for biodiversity conservation were to be studied and prioritised, and it is the level at which they would evolve. It was suggested that the sites selected within each state should have biodiversity value and that there should be specific criteria for selection of sites and identification of nodal people and biodiversity elements. A work plan to implement this project was also drawn up and discussed with all the participants at the workshop.

The national "microstrategies" coordinators developed and distributed a methodology manual as well as field guides for identification of some common species to all the state-level agencies by May, 1996. Similarly, responsibilities and mandate of the state-level nodal agencies (lead NGOs or research institutions) were discussed. The time frame for field work by the state-level agencies was broadly scheduled for one year, from June, 1996 to May, 1997, and it was recognized that the contributions from the macrostrategies subgroup would be needed quickly if they were to be integrated into the microstrategies groups' fieldwork.

Workshops and group meetings were used as a central tool for prioritizing, sharing progress, debating, and coordinating. Three workshops brought over 100 participants from all subprojects together between April 1996 and April 1998. Those three workshops were: a Values & Methods Workshop to formally initiate the BCPP in April 1996; a Participants' Workshop in February 1998 to share draft reports; and a Final Workshop, in April 1998, to share the final results with the public. In addition, over 30,000 participants interacted in over 100 subproject workshops at local, state, regional and national levels during the project period.

Methods

The Steering Group decided that prioritisation values must include biological, economic/fiscal, social and cultural values. In April 1996, in order to achieve the integration of these values in all the subprojects, the BCPP was formally initiated with a project design workshop for grantees and other experts. This workshop focused on priority setting values and methods to orient the participants to the importance of using a transparent process. This workshop divided the 125 participants into three subgroups: species, sites and strategies.

At this workshop, biologists agreed that they did not want to compare different biomes to develop a priority suite of sites representing the country's biodiversity heritage. They felt it was necessary to start by comparing sites within particular biomes in order to identify the priority sites within each biome, and that task would take at least two years. They felt that scientists working on different subprojects should be free to develop methods and assign weights appropriate to their data. They agreed that all subprojects would encourage participation from a broad set of scientists and, where useful, non-scientists.

The SG determined the BCPP would include the following components:

National-scale priorities
- *species*
- *sites*
- *protected areas*

Local-scale priorities & strategies
- *species*
- *sites*

National strategies
- *Environmental education*
- *Biosphere Reserves*
- *Sacred Areas*

Special studies & Support
NE India
National database
Economic incentives
National legal & policy issues
Gender Issues
Some international experiences

But for purposes of looking at methods, these components can be generally grouped under five categories: Species, Sites, Strategies, Special Studies and Support.

Species

The species subgroup at the Project Design Workshop (April 1996) was split into three working groups:

- *Medicinal and other economically beneficial wild species*- The recommendation of this working group was that the primary value of any species would be human use. Other important values listed were social, cultural, biological etc. It was felt that the most important criteria for prioritisation would be local needs followed by scientific and industrial needs.
- *Wild relatives of domesticated/cultivated species*- The important indicators for prioritisation of species would include use as fuel and fodder, species that grow in marginal areas and during drought, species used by tribals, and species that have a high nutritive and/or medicinal value.
- *Other endangered species*- The working group decided that prioritisation should be based on two major objectives: a) identification of endangered species that require taxa specific conservation action, and b) contribution of useful information towards selection and prioritisation of sites for conservation. The working group also decided that three types of values would be used for the prioritisation of species. Of these, conservation status value would be given the highest priority, while the biological and socio-economic values would be given the next, equal, priority.

The species group participants, chaired by Dr Ajith Kumar of SACON, decided that the Conservation Assessment and Management Plan (CAMP) workshops would be the best method to evaluate species as it is based on maximum information that is available across a wide spectrum of people and the assessment is participatory and based on consensus. However, it was felt the CAMP workshop format would need to be modified in order to cover most taxa. This was an easily replicable method of evaluation and fitted in with the broad objectives of the BCPP. It was however recognised that this method is better suited for taxa, which are relatively well studied. Therefore, it was decided that a special workshop for developing an appropriate methodology should be conducted. This, however, was not done. In addition, during the course of the project, it was pointed out by some partners that the results of a CAMP workshop depended upon the group dynamics among the people sitting together on a given day, and could therefore vary at different points in time.

Three different methods were ultimately used to prioritize valuable and rare species for conservation action. The first method was the CAMP method, used by the biggest project which enabled 350 scientists to evaluate and classify 1,707 species of concern in the following categories: medicinal plants of North India; reptiles, amphibians, soil invertebrates, mammals, freshwater fish, and mangrove species. Madhav Gadgil and his colleagues at CES developed a second method to test a more objective method that did not rely on variable groups. They created a computerized method to rank mammals (402 spp) and birds (1230 spp). The results from their mammal exercise, however, closely matched the CAMP results for mammals. The third method was expert opinion built on a review of secondary literature with various degrees of consultation with other specialists. This latter process was used to prioritize wild crop relatives, wild livestock relatives, medicinal plants, endangered plants, and tree germplasm reserves.

Wild Relatives of Crop Plants and Domesticated Animals: A list of all wild relatives of crop plants and animals was prepared and categorised on the basis of distributional range, consumptive use and other criteria. The species that were data deficient as well as those species which are closest to their domesticated counterparts and were rare and endemic were prioritised. The prioritised list was further revised on the basis of discussions with specialists, social scientists and stakeholders. About 340 wild relatives of cultivated species were considered of which a total of 139 were prioritised. Of these 64 were fruits, 13 cereals and millets, and 21 spices. The remaining were legumes, vegetables, beverages and oilseeds. A total of 14 wild relatives of domesticated animals were also considered and all of them were prioritised.

Medicinal Plants of India: About 3500 species of plants are widely accepted to have medicinal properties, of which 1300 species were studied for prioritisation under the BCPP. Information on these 1300 species was obtained through literature available in the BSI & CSIR Publications, WWF-India sponsored projects, Proceedings of the Ethnobiological Congress held at National Botanical Research Institute, Lucknow, Taxon data sheets available from CAMP (Conservation Assessment Management Plan) workshops organised by Foundation for Revitalization of Local Health Traditions (FRLHT) and Zoo Outreach

Organisation (ZOO). The database of priorities was organised as follows:

Level 1: 1300 species considered for the prioritisation exercise

Level 2: The species reported in level 1 with a narrow distributional range, being traded and over-exploited were shortlisted to this level. In addition, some species which needed further scrutiny and assessment were also elevated to this level. Thus 1300 species of Level 1 were shortlisted to (approximately) 700 species at this level.

Level 3: The 700 species in level 2 were scored on the criteria of distribution, conservation status, trade, cultivation, use of plant/method of harvest, and data deficiency. Each criterion was given equal weight with score values ranging from 0-10 and was further sub-categorised. The scores obtained under each category were summed up for all the 700 species individually. Of these, 267 species were elevated to this level on the basis of their score

Level 4: Additional criteria were applied to the 267 species in level 3. The criteria which were used to exclude species from this level included species occurring in schedules I and II of CITES, Schedules I and II of the Wildlife (Protection) Act, 1972, and those species whose extraction or export is banned by the government. Those species which are known to be harvested destructively, whose regenerative capacities are not well known, or whose cultivation techniques are not well developed were included at this level. The number of these species was 58.

It was planned to further prioritise the 58 medicinal plants in level 4 through an interactive workshop which, however, was not done.

Endangered Species: This was one of the subprojects whose methodology was finalised during the BCPP project design workshop held in April, 1996, and no deviations were made during implementation. Conservation Assessment and Management Planning (CAMP) workshops were said to allow rapid application of the revised IUCN criteria, which were to be used for evaluating species, while ensuring the best use of the most recent published and unpublished information, and participation of the relevant experts. The number of species in the taxa, prior or ongoing attempts at similar assessments, information availability, and constraints of time were considered while selecting the taxa for assessment. Mammals, reptiles, amphibians and freshwater fishes were selected during the Project Design Workshop itself. Soil and aquatic invertebrates, and mangrove organisms were also selected later following discussion among the resource persons. Among plants, medicinal plants of central and north-east India, and north-west Himalaya were chosen, as this allowed a comparison of results from two methods, and also because it complemented the assessment of medicinal plants of south India by FRLHT. The species that were prioritised in each taxa were:

	Critically Endan-gered	*Endan-gered*	*Vulnerable*
Medicinal Plants	35	16	15
Soil Invertebrates	18	23	16
Amphibians	10	42	46
Reptiles	34	54	80
Mangrove Organisms	15	58	18
Mammals	22	33	60
Freshwater Fish	45	91	81

Some BCPP partners and other experts criticised the CAMP method because it was felt that the process of CAMP workshops through which species were prioritised is not very replicable as it depends on the expertise of whatever subset of individuals is available in a particular field on a given day. This may lead to differences in the results of CAMP workshops in different points in time. Also, once a CAMP workshop is over, while the results get recorded, it may not always be possible to review the process whereby a species was prioritised. It was also felt that species which have not been well studied can not be properly analysed through the CAMP process.

Endangered Plant species: The exercise of prioritising the endangered plant species was initiated through the screening of Red Data Books for Indian Plants and other publications on the threatened plants of the country, the bulk of these being publications of the Botanical Survey of India. This comprised screening of about 620 plant taxa. These species were prioritised on the basis of their conservation value, socio-economic value and biological value. These criteria were further classified into sub-criteria. Taking conservation value as the primary criterion for selection, about 80 plant taxa, evaluated as endangered, were short-listed. Of these 80 endangered species, 49 were further shortlisted after application of scores according to their conservation, socio-economic and biological value.

Mammals & Birds: Essentially, the prioritisation method in this subproject relied on a computer program to evaluate the following parameters to prioritize species from

data in computerized database:

1. Geographic distribution over entire world (divided in to six biogeographic zones)
2. Geographic distribution over oriental region (divided into six subregions)
3. Geographical distribution over Indian subregion (divided into ten provinces, according to Rodgers and Panwar 1988)
4. The kinds of habitats in which the species is generally observed.
5. The number of species in its family and genus.

On the basis of the above, each species was assigned a quantitative value ranging between 0 and 1 on the basis of 4 attributes which were: a) geographic range; b) conservation value by habitat preference; c) threat to the habitat; and d) taxonomic distinctiveness. A composite conservation value was arrived at and assigned to each species by summing the four values calculated above. In all, 1230 species of birds and 402 species of mammals were evaluated and ranked in a descending order. As already mentioned, for mammals, the results achieved by this process and through the CAMP process were similar.

Tree Germplasm: This study was conducted in order to compile in one place all the information published in various places about species diversity of Indian trees. Over 300 publications were scanned in a literature review to cull information about the characterististics of various species. These publications included books, monographs, reports, dissertations and papers.

Most of the species prioritisation exercises seemed to focus on well known taxa, for which information and expertise was readily available. The economic, social and cultural values of species did not seem to be covered adequately. To rectify this, the Steering Group had suggested that a group of experts should review the findings of the BCPP and identify gaps. The Steering group had also suggested that four regional meetings should be organised before the finalisation of reports so that experts who could not directly be associated with the BCPP prioritisation process could also provide their inputs. This, however, could not be done.

Sites

The Sites subgroup at the Project Design Workshop was attended by the largest number of participants (around 60), and a large number of people actively contributed their various perspectives to the debate. Some of them felt that primary prioritisation must be at the level of the biogeographic zone, not ecosystem, because, they argued, ecosystems change quite rapidly over relatively short distances as well as vary with altitude, among other things. However, the alternate view point was that, given the expertise available and the practicality from the point of view of conservation strategies, it would be better to prioritise sites within ecosystems. Besides, it was difficult to assess the relative value of two sites that were ecologically distinct. Consequently, most of the prioritisation exercises were taken up at the ecosystem level.

It was felt that the prioritisation of sites by the BCPP must draw upon the earlier prioritisation exercises held in the country and not start from scratch. It was also agreed that the values of sites must not just include biodiversity values, but must also draw upon socio-economic values before being prioritised. Socio-economic values were classified broadly as use values and non-use values. The group generally felt that, while non-use socio-economic values would add to the biodiversity value of a site, the use values would have a negative influence on biodiversity values.

It was stressed that there was a direct link between the prioritisation of species and sites. For conserving those species, which are a priority, one has to have sites in which to conserve them. Also, in general, a site with more species would be more valuable than a site with fewer species. This assumes that in general, in-situ conservation is preferable to ex-situ conservation. It was also pointed out that in the absence of detailed species data about sites, surrogate indicators e.g. the Champion and Seth communities for species richness, could also be used.

The two broad categories of values for which data was collected by the various sites subprojects of the BCPP can be divided into socio-economic values and biological values. Different subprojects used these values in different ways. Broadly, the subprojects used values for prioritisation in one of the following ways:

- *Use biological values as the primary values for prioritisation and socio-economic values as secondary values.* For example, in the study on prioritisation of national parks and sanctuaries, biological values were used to classify sites as very high or high biodiversity sites. Sites with very high biological values were accorded higher priority vis-à-vis high biological value sites. Within these categories, socio-economic values were further used to classify sites as being high pressure or low pressure sites. Very high value sites with high pressures were given a greater priority than very high value and low pressure sites.
- *Use both biological values as well as socio-economic values as primary values for prioritisation.* For example, in the study on grasslands of Assam a

combination of biological and socio-economic values was used to evaluate and prioritise the grasslands of the area. In case of wetlands also, both the values were aggregated to assess and prioritise the wetlands. In the study on wetlands, these values were further applied to biotic as well as abiotic attributes of a wetland and a matrix was used to arrive at the final prioritisation.

- *Use biological values from secondary sources to arrive at a primary level of prioritisation among a large number of species or sites. Within the primarily prioritised subset of species or sites, prioritise species or sites giving equal importance to both biological as well as socio-economic values.* For example, in the case of prioritisation of endangered plants, Red Data Books as well as other publications on threatened species were used to arrive at a list of 620 taxa. A subset of 80 taxa from among the 620 taxa was listed as high priority species on the basis of their conservation values. These 80 species were than further prioritised using conservation and biological values as well as socio-economic values. All these values were given an equal weightage.
- *Use biological values from secondary sources to arrive at a primary level of prioritisation among a large number of species or sites. Within the primarily prioritised subset of species or sites, prioritise species or sites using mostly biological values supplemented by socio-economic values.* In case of "coasts", a list of 38 nationally important coastal sites was prepared by the nodal agency to arrive at a primary level of prioritisation and then a working group of experts were given a set of biological as well as socio-economic criteria to assess each site. Socio-economic criteria, however, were not used to identify the first 38 sites.
- *Use mainly biological values for prioritisation of sites.* For example, for the prioritisation of the timberline zone in the Himalayas, the main criteria used for prioritisation were richness, naturalness, representativeness, uniqueness, endemicity and use value to identify sites.

Given below is a table that is based on a questionnaire filled in by all the nodal persons in the sites subgroup during the February, 1998, Project Partner's Workshop, which shows how much importance was given to different values in key subprojects.

Values Used for Prioritisation by some Sites Subgroups#

Sites Subgroup	*National Parks & Sanctuarie*	*Grasslands (Assam)*	*Wetlands*	*Grasslands*	*Desert*	*Meghalaya*	*Coasts*	*Mountain (Timberline zone of West Himalaya)*	*Islands*
Biological Values*									
Endemism	1	2	3	2	1	2	1	2	2
Uniqueness	1	1	3	3	2	1	1	6	2
Richness	2	1	1	4		4	1	3	2
Representa-tiveness	2	2	2	1	3	2		5	2
Naturalness		1		5		3	1	1	1
Connectivity	3	3		6		5			2
Others			Threat -1 Functions -3				Endangered species	Use Value - 4	Varieties of the same species and generation need greater value. (Generical relation-ship)
Other Values*									
Consumptive Use	1	3	2	2	1	1	2		1

Data from a format filled in during the Project Partner's Workshop held in February, 1998, by the nodal persons

Contd. . . .

* Value with the highest weight was given mark 1, the next highest weight given mark 2 and so on.

Sites Subgroup	*National Parks & Sanctuarie*	*Grasslands (Assam)*	*Wetlands*	*Grasslands*	*Desert*	*Meghalaya*	*Coasts*	*Mountain (Timberline zone of West Himalaya)*	*Islands*
Non-consumptive use		3	2	4	10				2
Ease of Conservation		1	1	3	2	2			2
Protection/ Management Status	1	2		1	6	1		1	
Others					Horticulture, Botanical interest	Threat Value-2, Cultural Impor- tance -2 Popula-tion-2			

A total of twenty projects were sanctioned under the sites subgroup. Of these 10 subprojects looked at ecosystems at the national level, 7 at the state level and the remaining 3 at the level of national conservation units.

National Ecosystems: The ecosystems selected for prioritization at the national level were Wetlands, Oceans, Islands, Coasts, Grasslands, Himalayan Alpine Zone and Forests.

The process and the methodology for wetlands was the most comprehensive and transparent. It can be replicated and used to assess any wetland. Though the prioritisation exercise mainly depended on secondary data available for wetlands, it converted the qualitative information available for each wetland into quantitative score. The quantitative score was derived from averaging 'total ecological criteria' score and the 'total socio-economic criteria' score. In all, an inventory of around 900 inland wetlands in the country was prepared, of which 150 were prioritised since data, which could be used for prioritisation in the methodology, were not available for the rest.

The study on grasslands excluded Alpine Pastures from the prioritisation exercise. These were looked at in the study on Himalayan Alpine Zone. Around 90 grasslands were identified in 13 states and were assigned statewise priorities. The study also identified the 10 most important grasslands in the country from out of the total of 90 sites. This study was also quite comprehensive and valued the identified sites biologically, socio-economically and in terms of the feasibility of conservation.

The study on coasts was also fairly comprehensive in terms of its methodology and the extent of participation in ranking sites that were prioritised. However, the initial identification of sites was limited, with the result that 10 areas out of only 38 coastal sites were prioritised for the whole country.

There were three separate studies on islands. Two looked at priority sites in the Andaman and Nicobar Islands, while the third identified sites in Lakshadweep. The two studies on Andaman and Nicobar differed fundamentally in that while one looked at only the floristic values to prioritise sites, the other looked at the faunal values for identification of biologically important sites. The first study, which looked at only the floristic values in Andaman and Nicobar Islands, identified 10 priority sites. However, since the first study considered only plants, the other study looked at the faunal values in Andaman and Nicobar Islands and identified an additional 8 sites as priorities. The study on Lakshadweep Islands identified 5 priority sites. All the three studies primarily relied on secondary data and some consultation with experts and were less comprehensive than the studies on wetlands, grasslands and coasts.

The studies on Alpine Grasslands and Forests identified priority sites but were quick exercises using rapid methods of prioritisation and limited data. Despite their importance, forests were not adequately prioritized because of lack of cooperation by the Forest Department and related agencies —and lack of public access to forest management plans and maps. In part because of this situation, the BCPP teams were actively involved in advocating for the passage of the Freedom of Information Act. The two studies on oceans highlighted the limited data available as well as identified the vast gaps in information. However, a few sites were prioritised on the basis of existing information.

National Conservation Units: The national conservation units that were reviewed under the BCPP were National Parks and Sanctuaries, Biosphere Reserves and Sacred Elements of Nature (such as sacred groves). However, the projects on Sacred Elements of Nature and Biosphere Reserves did not prioritise any sites. Instead, they assessed the overall status and management of these sites and recommended steps for improvement in current management practises.

Much work had already been done evaluating the condition of India's protected areas system. Rogers & Panwar published a gap analysis and recommended new PAs in the late 80s. IIPA had an existing database on human use of PAs. In BCPP, there was sufficient information on 250 of the 500 PAs to classify them according to biodiversity levels and threat levels. This was done by experts with consultation of the literature, the WII database, and other experts. The project on national parks and sanctuaries defined a methodology for prioritisation based on the criteria for prioritisation of sites delineated in the project design workshop and the availability of data. The methodology was finalised in consultation with several experts both within and outside the country. The methodology prioritised sites by using both biological and socio-economic parameters. While the biological values were used as primary values for prioritisation of sites, the socio-economic values were used to further prioritise those sites that had been already prioritised on the basis of their biological values.

***State level Studies*:** Seven state level studies were done. Three studies looked at biodiversity rich sites in a state and the other four studies either looked at a particular ecosystem within a state, or at a part of a state.

The three studies which prioritised biodiversity rich sites within a state were focussed on Tripura, Meghalaya and Arunachal Pradesh. The Tripura study was primarily based on a participatory method of eliciting official as well as local people's knowledge about biodiversity rich areas. A series of meetings were held with forest officials, local level politicians and leaders, NGOs and local people and areas of high biodiversity were identified in consultation with them. A total of 36 sites were thus identified. Of these, 30 sites were further assessed and prioritised on the basis of their biological, socio-economic and feasibility of conservation values.

The Meghalaya study used secondary information to locate biodiversity rich sites. These sites were then ranked according to the number of species harboured within them as well as their biological or socio-economic importance, data on which was also based on secondary sources. A total of 16 priority sites were identified in the state. The investigator of this study was also supposed to do a similar exercise for Mizoram and Nagaland, but this was not done.

The Arunachal study was also based on secondary data. The Botanical Survey of India records were studied and location specific information on species was plotted on a map. Out of all the locations that were identified, four sites were selected as priorities. These sites were field visited. However, there was no attempt at ranking these sites in terms of their biological or socio-economic importance.

Out of the studies that looked at specific ecosystems in or a part of a state, the study on grasslands of southern and central Assam identified grasslands having an area of 10 sq. km. or more. This was the first cut for prioritisation. Subsequently, secondary data was collected along with primary field surveys to collect fresh data on both biological and socio-economic aspects. On the basis of certain objective criteria, the 20 grasslands which had been identified on the basis of their size, were ranked according to their biological as well as socio-economic importance.

The study on the Timberline Zone of West Himalaya relied entirely on secondary data to collect location specific information that was fed into a grid system. Twenty grid clusters were prioritised for biodiversity conservation. The feature of this study was that a sophisticated methodology was developed and tested, but the collection of data for the application of the methodology was a little weak. Further, the study only covered the Timberline zone in Uttar Pradesh and ignored Himachal Pradesh and Jammu and Kashmir.

The study on Deserts basically identified certain ecosystems like *magras* and *orans*, which contain biodiversity rich sites in the Thar Desert. There were, however, very few specific sites like *Khichan* which were pinpointed. There was no clear methodology or systematic collection of data even although a questionnaire was developed for collection of socio-economic information. The author relied basically on his extensive knowledge and experience of the region to identify priority ecosystems and sites.

The study of river islands of the Brahmaputra in Assam was not an exercise of prioritisation but was rather an initial step to learn more about the conservation status of these islands.

Strategies

Strategies were undertaken at the Micro and Macro levels in recognition of the need for scale appropriate methods. The Macrostrategies subproject focused on national level conservation strategies—a step that is commonly undertaken in biodiversity assessment studies. The Microstrategies study set about trying to identify locally threatened species, facilitate local communities to derive a set of local strategies for biodiversity conservation, and identify threats associated with larger scale policies. This was a process without any other precedent. It was expected

that the Micro and Macro groups would interact with each other to share needed information, and to identify national strategies that could support local strategies.

Microstrategies. The microstrategies subgroup in the Values & Methods workshop was led by Prof. Madhav Gadgil who proposed the "Shrustigyan" methodology manual. The group suggested modifications that were needed to improve it. After this, the subgroup identified constraints for effective conservation of biodiversity. In plenary session, all workshop participants agreed it would be important to develop Macro level background studies on policy, relevant laws, gender, and education, in order to support the work of the microstrategies group. And, in turn, the microstrategies implementors were supposed to gather information for the macrostrategy studies subprojects. The main objectives of this subproject were:

- To document knowledge and perception of local people about Biodiversity and Conservation at the village/panchayat level using CBR.
- To record perceptions of Government functionaries NGO, NGIs, Industries and other cross sections of the society from the Village/Panchayat level to District, State, National level on the basis of aforesaid primary and village panchayat level experience.

Madhav Gadgil and his colleagues led the development and implementation of this component. The microstudies project was built around the Biodiversity Register concept developed by Prof. Gadgil. Under BCPP, the Microstudies component was essentially a pilot state-level effort linking Biodiversity Registers with BCPP in seven seven states that were representative of the ecological and cultural diversity in India. The seven states were Himachal Pradesh, Assam, Orissa, Bihar, Andaman & Nicobar Islands, Karnataka, and Rajasthan. This subproject involved 350 researchers and local people from 55 village clusters (2 to 10 villages per cluster). The Researchers were trained in the modified "shrustigyan" method which involves these basic steps:

1. map ecozones and identify user groups,
2. list species, uses, and other knowledge,
3. facilitate local prioritization of threatened species and actions within user groups,
4. discuss issues and plans of all user groups in town meetings (gram sabha) to develop conservation plans.

Each state was represented by a nodal agency. The nodal agency was trained in how to use the methodology manual, *Shrustigyan*, to carry out the study. The nodal agency in turn selected village clusters in their state so as to represent the different ecological regions. For selection of village clusters, each state nodal agency had to identify eco-geographic zones and try and distribute 8-10 sites among these zones to obtain adequate representation of the following ecosystems: forests, lakes, rivers and seas.

According to *Shrustigyan*, the ecosystems had to be sampled in both Protected and Unprotected areas. While protected areas would include national parks and sanctuaries, unprotected areas could include minor forests, grazing land etc., represent intensively exploited areas; new urban centres; economically backward, remote, tribal areas; areas having an ecodevelopment thrust; areas showing environment regeneration due to the efforts by people alone etc. The nodal agency was to conduct surveys according to the method laid out in the manual in about 10 village clusters in each of these seven states.

Sites had different principle investigators (team leaders), and those team leaders came from different backgrounds -- making the pilots typical of what might occur if a nationwide effort were to be undertaken in the future. Fourteen team leaders were college teachers, 2 wereuniversity teachers, 2 were schoolteachers, 4 were government officials, 13 were NGO workers and 6 were individuals engaged in development or conservation activities at the site. In all, 350 researchers were engaged in the BCPP investigations together with 200 local village-level assistants who were also trained in the method.

The sites included forests, pastures, wetlands, cultivated areas (agroecosystems), hot and cold deserts, islands, urban areas, plains, hills, mountains, and coastal mangroves. Some of the above were situated within, or around the periphery of, national parks and sanctuaries.

The strategies, which emerged from this Shrustigyan process, can broadly be classified into two categories: location specific (Micro) and broad based (Macro). For example, one of the location specific strategies dealt with the diversion of effluents emanating from an oil refinery. Some of the broad based strategies for addressing this issue included suggestions for linking annual development funds with conservation, the introduction of positive incentives for nature conservation, recommendations for changing laws and policies at the national level, creation or use of recognised local level institutions for management of resources at the local level.

Besides the main subproject on Micro-strategies using the Shrustigyan method, two other subprojects were sanctioned for prioritising Micro-strategies in the hills of Uttar Pradesh. One of these projects, "A People's Plan for Biodiversity Conservation in the Dehradun Himalayas" was done at a site that was located near Dehradun in the Garhwal Himalayas. The other project, "Biodiversity Conservation in the U.P. Hills" looked at two sites each in the Kumaon and Garhwal regions respectively.

The first of the above mentioned projects studied conservation strategies in a place where the people have been involved in conservation efforts earlier, notably the

effort to stop limestone mining in the Dehradun Hills and the movement to try and conserve indigenous seeds under the *Beej Bachao Andolan*. The methodology which itself was developed interactively with local people at the site consisted of the use of interviews, group discussions, public meetings, field visit to the study area with knowledgeable individuals. In this study, the local people prioritised species entirely on their own while sites were prioritised by the local people and the investigators.

The values that were used for prioritisation that were selected by the community and are given below:

For prioritisation of species, threat and utility value were considered to be more important than the others. In case of sites, more importance was given to richness and abundance of species and ecosystem functions.

Values used for prioritisation of species	*Values used for prioritisation of sites*
Utility	Richness and abundance of species
Ecological	Species dynamics and threats
Extent of decline and threat	Ecosystem functions
Abundance/rarity	Utility values

Strategies of conservation in the study area were assessed and chosen for all the sites irrespective of their priority status. The foremost strategies for conservation were identified to be overall conservation of all ecosystems and species and the prevention of forest fires. The local people also felt that migratory graziers should not be allowed to graze in the area. Strategies for weed eradication and limiting crop damage by wild animals were also prioritised.

In the second case, forest fires were identified as a major problem for biodiversity conservation. In addition, corruption by the forest department was identified as a major impediment to biodiversity conservation. Other threats to biodiversity conservation included, unplanned and unbalanced development programs, tourism, grazing, horticulture, extraction of medicinal herbs, encroachments and other illegal activities -- all of which needed attention at the Macro scale because these problems could not be addressed by local strategies alone.

Macrostrategies. The macro strategies subcomponent was meant to prioritize issues relevant for conservation action. Four studies were sanctioned under the broad head of Macro strategies to cover the following:

- Education and Awareness
- Fiscal and Economic Issues
- Law and Policy
- Gender Issues

The analysts were to link the macro issues with the strategies at the Micro level. For example, the study on Law and Policy was to look at the laws relevant for formulating strategies for conservation in the seven states where the Micro-strategies subgroup would be working. Legal handbooks for each of the seven states were also to be prepared. The Centre for Environmental Law in New Delhi, was sanctioned to carry on this study, but they did not complete it.

In the remaining time available, a study entitled 'Biodiversity Conservation in India: The Legal Framework' was subsequently done. In this study the existing laws, policies and government schemes (central as well as state schemes) were examined in relation to the identified Micro strategies for Biodiversity Conservation in India across ecosystems ranging across forests, wetlands, rangelands and other ecosystems. Gaps as well as weaknesses were identified in the existing policy and legal framework and recommendations were given for:

- operationalising the Micro strategies for conservation identified under the BCPP, and
- overall strengthening of biodiversity conservation in India.

The study on Fiscal and Economic issues looked at Macro fiscal and economic policy interventions to facilitate local or Micro level conservation efforts. Initially the data for this project was to be collected by the various nodal agencies and the field investigators of the Micro level studies in the seven states taken up by the BCPP. For this, the Principle Investigator developed a detailed questionnaire. However, the questionnaire was too detailed and complex to be administered by the Micro-level team. Subsequently, an investigator was specially sent to four states (Rajasthan, Bihar, Himachal and Karnataka) to collect data in collaboration with state level investigators.

Similarly for the study on education and awareness, the Micro level investigators were asked to send information to the state nodal agency doing the study. This also did not happen except in the case of Andaman and Nicobar Islands. The nodal person handling the study on education and awareness then sent out his own team of researchers to all the states except Andaman and Nicobar Islands. The state level microstrategies nodal agencies helped this team to administer their questionnaires to different groups as well as collect other information. The education and awareness study was very comprehensive and looked at several issues

including the level of biodiversity information and awareness among teachers, students, rural/urban communities, school and college curricula, mass media, parliament, and NGOs. Wide-ranging recommendations were given at the national, state and grassroots level.

Gender concerns were a part of the original design. However, the study on gender issues could only be started in February 1997. A brief questionnaire/table was circulated to all the micro level nodal agencies after their work was underway and the agencies did collect some gender disaggregated data. Unfortunately, the commissioned study was never completed. The field investigators in most cases were not very gender sensitised and by the time they were asked to start collecting gender disaggregated data, they were already in the midst of their micro level strategies data collection and aggregation. Subsequently, two general papers were done for the BCPP on gender issues. Both basically discussed the importance and relevance of disaggregating gender sensitive data for planning effective and sustainable strategies for the conservation of biodiversity.

The macro strategies subprojects (fiscal, gender, education) originally intended for the microstrategies teams to collect data from the local communities for use in the macrostrategies studies. However, this was not achieved to the extent expected, due to time constraints and inadequate coordination between the macrostrategies and microstrategies subprojects. Consequently, like in the case of the study on education, a separate data collection exercise had to be launched.

Special Studies

The Steering Group also commissioned a series of special studies to elicit information and knowledge of conservation experiences outside India in order to incorporate lessons into the macrostrategies' recommendations for India. The studies covered:

- Local communities' role in biodiversity conservation in Mexico
- Participatory management of coastal resources in Southern Thailand

Experts identified by the BCPP Steering Group looked at the institutional structures and conservation strategies being followed in specific sites in three countries. The experts visited the sites and collected information through interactions with the people involved as well as documents related to the specific conservation efforts. The studies on Thailand and Mexico were comprehensive. They highlighted important principles for participatory biodiversity conservation.

In addition, two special papers were prepared by two North American biologists for presentation at the final workshop. One used broad principles in conservation biology to argue for the creation of comparatively large, actively managed protected areas as opposed to the hands-off approach followed in India. The other discussed ethical considerations concerning biodiversity conservation and their relevance for the formulation of an appropriate policy or strategy. Because these studies were presented only in the final workshop, no other BCPP subcomponents used inputs from these studies. But their advice will be considered by Indian conservationists as they plan future projects.

Support Systems

One of the aims of the BCPP was also to develop a biodiversity information system. In pursuance of this objective, the Steering Group sanctioned two studies in April 1996. The first of these was for preparing a basic digital database in support of biodiversity conservation prioritisation, gap analysis, and other related applications in India. The second was for promoting participatory prioritisation and conservation of biodiversity through the development and use of "manual Geographic Information Systems" at the local level. Both these studies were commissioned to the Indira Gandhi Conservation Monitoring Centre (IGCMC), WWF-India.

The first project used the forest cover maps of the Forest Survey of India to produce digitised forest cover maps of all the states of India. Subsequently these maps incorporated the boundaries of national parks and sanctuaries. The database preparation lagged behind the expected schedule. Completion of these maps required an unexpectedly long time, such that it was not possible for most subprojects of the BCPP to use them.

The second study tested a methodology developed by Dr.(Mrs.) Vasumathi Sankaran, whereby local people could use sketch maps and knowledge of known coordinates to create a "manual GIS" for generating accurate maps at the local level -- in effect giving villagers access to the means for creating their own accurate maps. The method includes mapping of local agroecosystems and identification of local species. Although this study and methodology was created on schedule, it was also not used by any of the BCPP subprojects for carrying out their own tasks because they focussed on collecting non-spatial information that fed into the biodiversity registers rather than spatial information regarding the distribution of biodiversity resources.

Similarly, for the Micro strategies subgroup, a study was commissioned to Dr. K.C. Jayaram of the Madras Science Foundation to prepare manuals of common fresh

water fishes found in the seven states. The duration of this study was for six months. Though the study was completed in time and the manuals for each state were given to the nodal persons of each state, their use was not incorporated into the microstrategies fieldwork.

Results from the Application of the BCPP Process and Methods

One measure for evaluating any priority-setting process or methodology is its results. Did BCPP meet its broad goals?

At the national level, the Government of India has used the BCPP results toward meeting its obligations under the Convention on Biological Diversity. And UNDP GEF has incorporated the BCPP's participatory processes into the follow-on Biodiversity Assessment now underway. BCPP organizers recognized that the two year BCPP process should be viewed as starting point for an ongoing process and recommended that it should be repeated at five year intervals. A large number of priority sites and species were identified under various subprojects of the BCPP, and actions are now being taken to address some of these. The priority listing of Protected Areas developed as a part of the BCPP process was used to select sites for Phase – II of the World Bank's GEF Ecodevelopment Project in India. The CAMP process led to the listing of additional threatened and endangered species in the Red Book for India. Public outreach and education programs, designed under BCPP, are now being funded to build public awareness and commitment to conservation goals. Around the country, scientists have been energized to join their colleagues to think at national levels, and there have been discussions of establishing a formal Biodiversity Conservation Network of scientists and NGOs. They saw the impact of joining their voices with other parts of civil society in supporting the passage of the Freedom of Information Act.

Two new priority-setting methods were tested and elaborated into manuals: the Wetland Prioritisation Manual and the *Srushtigyaan* methodology manual used by the Micro-strategies subgroup. The Wetlands Prioritisation Manual provides a replicable method for evaluation of wetlands. The Wetlands Manual is being used for a State Level review of wetlands in Maharashtra. Interest has been expressed in the prioritisation methods tested for PAs and Forests under the BCPP process by the Government of India, which may want to use these methods for their own decision making in future.

Srushtigyaan was adapted, modified and changed by the investigators who tested it in almost all ecological and social regimes across the country, thus proving the method to be flexible enough to be applicable and suitable for a wide range of conditions and different types of teams.

The major spin-off of the microstrategies subgroup was the spread of the methodology to more organizations and areas. It is currently being used in a pilot project in 96 panchayats in Ernakulam district of Kerala State, under the decentralised planning programme of the state government. It is also being used by NGOs in Karnataka (Save Western Ghats Movement) and Maharashtra, and some villagers in Uttarakhand have expressed an interest in using it. Interest has also been expressed from the international community, with organizations and individuals from Sri Lanka, Malaysia, South Africa and Peru taking a keen interest in its development and requesting the updated *Srustigyan* manual, which was completed in May 98.

In addtion, the microstrategies fieldwork has had impacts on local conservation. For example, in the Andaman and Nicobar Islands, the data collected under the BCPP process led to the setting up of a task force to examine issues like encroachment, extraction of timber, poaching, forest fires and other threats in the Islands. The Task Force is also studying the depeletion of resources on which the indigenous Onge people depend. Further, a corrupt police official involved in illegal logging was removed from his position, and additonal forest guards were posted on Little Andamans to enforce existing laws. The Microplan formulated for the Micro-site in Dehradun District in the Himalayas has been funded by WWF-India for implementation. The local people who were involved in them microstrategies work in Assam become more aware of the importance of grasslands as an ecosystem and are now taking action to conserve the sites that they use for their livelihood. In a microstrategies site in Himachal Pradesh where a sanctuary has been denotified to make way for a cement plant, the local people have decided to set up an environmental monitoring network to document the impact of the factory. In yet another site in Himachal Pradesh, the local people have formulated and are now implementing a strategy for oak regeneration and conservation.

The BCPP Micro strategies process also resulted in several *jan sunvais* or public hearings regarding the ongoing ecodevelopment project in Great Himalayan National Park, because one of the BCPP Micro strategies sites was located in the periphery of the Protected Area. Local people were interested to know what kind of an impact, positive as well as negative, the ecodevelopment project could have on them. Significantly, the microstrategies subgroup also led to the development of a group of local individuals capable of being able to recognise and plan for the mitigation of problems of their villages/ communities with participation of other local people.

There were some implications of the microstrategies for the four macro level studies. This aspect was reviewed as a special exercise, which was carried out at the initiative of the Steering Group. For example a majority of communities

involved in the microstrategies subgroup stated that they wanted some form of local control over their natural resource base and specified changes in the State Panchayati Raj Acts. The local communities also expressed their opposition against certain central conservation legislations like the Wildlife (Protection) Act, 1972, and suggested modifications in them. These points are being taken up by NGOs.

Finally, the microstrategies process raised the awareness of many community-oriented NGOs that biodiversity conservation is a very real concern for communities' livelihoods as well as being a national issue needing urgent attention. This resulted in a significant increase in the number of NGOs raising public concerns about biodiversity-related issues.

At the end of the day, the overall impact of the BCPP is difficult to quantify as the process of the dissemination of the findings and results has only just begun. Some of its outputs are already beginning to make a difference. Efforts are on to channelise resources for the operationalisation of some of the strategies identified by the BCPP for conservation. In additon, the BCPP project partners have made an informal commitment to carry on the process of prioritization as situations continue to evolve over time.

Conclusions and Recommendations

Design

The design of BCPP process was unique. It brought several new elements to the global effort to develop appropriate and effective ways to set conservation priorities:

- attention to scale by developing local and national level priorities;
- attention to sites, species and strategies within one exercise;
- creation of a larger broad-based network building on the ongoing efforts of existing isolated NGOs and scientists working on their own; and
- active testing of multiple methods, including new methods.

The most innovative method in BCPP was that for identifying local-level priorities and strategies. It is useful for two purposes:

- it is a process that can be used to facilitate the discussion of threatened species and ecosystems in villages in order to develop local solutions; and
- it is a process that surveys the local scale to identify national and state-level issues that must be resolved at state and national levels.

The innovative microstrategies approach provides new data for consideration at national levels, instead of using the same old desk studies repeatedly reviewed for quick national biodiversity assessments. Application of the microstrategies method produced 55 local implementation plans, state-level policy discussions and a commitment to begin the process in other states. At the same time, however, the Micro team produced a valuable and legitimate survey that reflects the problems faced by biodiversity at local levels in a variety of situations across India. It provided independent verification of national level issues that emerge again and again at local sites across India.

The methods tested for forests and protected areas -- using surveys with groundlevel personnel to identify problems—offer promise for likewise bringing their local perspectives on these same problems covered by the microstrategies approach. However, those methods were not adequately tested to allow us to draw conclusions here.

Methods for Encouraging Participation and Democratic Policy Reform

The nature of participation could be broadly classified into three types:

- Participation among the research team
- Participation of the research team with other outside experts/scientists
- Participation of the local community with the research team
- Participation of BCPP partners with policy makers, bureaucrats, and the public at large

Most of the project teams of the Species subgroup seem to have interacted mostly among themselves. A few had informal one to one interactions with some outside experts in their subjects. The endangered species project is the only one that had formal interactions with experts through the CAMP process. An average of thirty scientists (experts in the particular subject of the workshop) participated in each CAMP workshop. Many of them had not interacted before and welcomed the opportunity to meet one another to share information and build networks.

The different Sites subprojects had different approaches, and therefore the level and kind of participation in each project was variable. For example, the Timberline study of the western Himalayas had maximum interaction within the research team with two consultation workshops with other experts. There was no interaction with the local community. At the other end of the spectrum, in the case of the Desert "manual GIS" field studies, the research team had maximum interaction with the local community in all the study areas. The team involved the local community in data collection as well. Most of the Sites subprojects involved experts/scientists and the research

team with minimum interaction with the local community. The local community was involved to obtain information on socio-economic values for the subproject. The Sites subprojects that were doing state wise prioritisation only relied on secondary data to carry out the prioritisation exercise. These projects had almost no interaction with other experts, other institutions or the local communities, with the exception of the prioritisation exercise in Tripura.

The microstrategies projects involved the greatest participation of different stakeholders. They followed a prescribed methodology to involve the local community, and created innovative ways to enhance participation. The differences in their approach were due to the composition of the research team. For example, in Orissa the same team studied all the sites and therefore it was more difficult for them to have had the same level of rapport, with the local people. In contrast, the investigators on teams in Andamans, Himachal Pradesh and Rajasthan were assigned a site and were stationed at a single site throughout the duration of the project. Many had already been working at the site. The investigating teams in Rajasthan and Himachal Pradesh consisted of investigators who were themselves members of the local communities, while in Andamans the investigators were not local persons. Each person working in the microstrategies subgroup, however, used a method had earlier been evolved in consultation with experts and the nodal persons of the agencies that were involved in the exercise at the state level.

As far as dissemination of information for greater public participation is concerned, at the village level, the findings of the Micro-strategies subgroup were made available to the village community mainly through the gram sabha meetings in all the states except Andaman and Nicobar. In Himachal Pradesh and Karnataka, village reports were written or translated into the vernacular language and distributed to select persons in villages. In some cases, the findings were shared with the larger community and the local officials and politicians through the forum of public meetings. In Himachal Pradesh, BCPP partners presented their findings to the State Council on Technology and Science Task Force that is developing a biodiversity action plan for the state. In Karnataka and Kerala, state governments are using BCPP methods and priorities to initiate Panchayat Raj (local decentralized government) conservation programs. State-level reports on sites and species priorities were planned in order to make the information available to state-level decision makers, but those plans have yet to be executed (at the time of this writing). In addition, to producing scientific journal and newsletter articles, BCPP collaborators used radio programs and local newspaper articles to promote the process and opportunities for public involvement throughout the two year effort. A national magazine article was used to raise public awareness of the national issues uncovered from the Microstudies survey.

Linkages and Coordination

Under the best of circumstances, coordination is always a challenge that cannot be underestimated. In the case of BCPP, due to a two-year time constraint set by USAID, it was not possible to stage activities so that results from one phase could be integrated into a following phase, nor did the time allow for iterative interaction between Macro and Micro strategies which could have strengthened the cross-scale linkages supporting conservation from national to grassroots levels.

In addition, the linkages among various subcomponents, for example between sites and species, or sites and strategies were not established properly in the project. To some degree this occured because almost all the subprojects required more time than what was initially planned to finish their own tasks. Also, there was little concerted effort, with a few exceptions like the nodal person doing the study on education and awareness, on part of any of the partners to exchange data and information with other subprojects. In some cases, the projects were not designed to facilitate linkages. For example in the endangered species project (CAMP), while priority species were identified, the details of the sites in which they occur were not specified. Similarly, the findings of the various subprojects in the sites subgroup were not passed on to the Micro strategies subgroup for discussion with the local communities, wherever relevant or possible. The results of the CAMP workshops were circulated to the microstrategies subgroup for discussions with local communities, but little discussion took place because the microstrategies coordination agency felt that until they knew which species actually were likely to occur in the sites at which they were working, no meaningful discussions could take place. Therefore, the species subgroup was sent a list of the sites and the districts within which they were located so that a list of the priority species occurring in these areas could be compiled. However, this could not done.

Integration of Non-biological Values into Conservation Priorities

It is difficult to integrate biological values with information about social and economic factors in order to identify and prioritize the most feasible actions and strategies across scales. Various attempts wer made to incorporate socio-economic values, but different groups weighted those values differently in relation to biological values and in relation to each other. It is a subject about which many biologists are passionate; they feel biological values alone

should determine the priority species, sites and strategies. Some biologists, social scientists, and most NGOs are equally passionate that biological values are insufficient for making choices that affect the livelihoods of hundreds of millions of people.

Conservation is a social and political process, not a biological process. Biologists can identify the biological goals for conservation; they can provide essential information about the physical requirements for conservation management; they can provide the technical information upon which successful strategies can be founded; and they can evaluate the success or failure of conservation efforts. They can also stimulate political interest in biodiversity. But successful conservation requires an active civil society and politicians who use the information from scientists while balancing their constituents' interests and values in order to move conservation to a more prominent place on the national agenda.

The BCPP collaborators made a valiant effort to blaze a trail toward a concensus that conserving biodiversity was a valuable endeavor appreciated by villagers as well as urban-based researchers, and that collaboration across these sectors and scales was possible.

Addressing Conservation Concerns in the Context of Demands from other Sectors

While the BCPP teams recognized the need for including economic analyses in order for government to weigh these priorities against priorities in other sectors, this goal was not achieved. No acceptable method for attempting the goal was devised. Economic value was, however, incorporated -- either as a threat in the species and site exercises, or, as a criteria increasing the species importance for prioritization where teams were specifically trying to conserve economically valuable species or sites, as in medicinal plants and wild crop relatives. While medicinal plants were not used to evaluate protected areas, the medicinal plant group did list which protected areas were known to contain concentrations of medicinal plants, so there is a basis for prioritizing protected areas on the basis of their economic values (in terms of medicinal plant values) in the future.

Conclusions and Recommendations

BCPP process offers a valuable design for setting conservation priorities through a participatory process that builds public support for the final recommendations. It could be improved by incorporating the following changes:

- adequate and flexible time (4 years, instead of 2 years) for the phased, initial assessment;
- proper phasing, so that products of one phase could be completed before second phase (activities that depend on products from phase I) is begun;
- public access to government's data and maps;
- sufficient funding and time to fill gaps in information so that a reliable final map of national priorities and widespread enthusiasm for implementing local and national-level plans are generated within ten years; and
- a mechanism to improved coordination between subprojects.

The key principles of the BCPP process extend the principles articulated by Nels Johnson's Guiding Principles for Priority-setting (1995), based on a review of earlier priority setting methods. The general recommendations that should be considered by others in designing priority-setting efforts include:

- build on the activities and interests of independent groups so they contribute their ongoing projects and energies, and continue to carry on activities after the prioritization project is completed;
- debate, scrutinize and improve the methods as they are used;
- build an encyclopedia of ignorance to guide future studies to modify the priorities as new information becomes available;
- involve local communities, states, and federal levels of government;
- use transparent processes and do public outreach during implementation; and
- nurture networks between and among national scientists and NGOs that will continue beyond the life of the project.

References

Agenda of the BSP's geographic priorities setting workshop, April 17-19, 1995.

Agenda and Reports of the BCPP Project Design Workshop, April 1996.

Minutes of the Steering Group meetings of BCPP.

Reports of the Midterm Review of the BCPP.

Quarterly Reports of the BCPP.

Agenda and Reports of the BCPP Project Partners Workshop, February 1998.

Agenda and Report of the BCPP Final Workshop. April 1998.

Reports of the BCPP Micro strategies meeting (overall as well as in different states).

Executive Summaries of all BCPP subprojects.

Final reports of all BCPP Subprojects. (These reports form the chapters of this book.)

Towards a Biodiversity Conservation Prioritisation Methodology

Shekhar Singh and Arpan Sharma

The Biodiversity Conservation Prioritisation Project (BCPP) is primarily a 'process' project rather than a 'product' project. Its basic objectives have been to develop a set of methodologies for prioritising sites, species and strategies for biodiversity conservation, to develop and test these methodologies in collaboration with as many segments of the society as possible, especially the local communities. Another basic objective has been to help develop, in the process, capacities and interest among community groups, NGOs, scientists, other professionals and various government agencies in prioritising for conservation.

Of course, some preliminary 'products', in terms of lists of prioritised sites and species, and descriptions of prioritised strategies, also emerge, but they are tentative. For one, no one expects an even minimally decent prioritisation of a vast and varied country like India in a brief period of two years – that being the duration of BCPP. Besides, the financial resources available did not allow for the sorts of research that would be required to come up with a more definitive list of priorities. Though what has emerged as priorities certainly need to be prioritised, lack of data has resulted in many sites and species, in some cases a majority of them, not being assessed. Even those that have been assessed have often been assessed on insufficient data. In many cases data sets were not comparable across sites and species. In all this it is difficult to avoid a bias in favour of better known and researched species and sites, even though the lesser-known ones might deserve greater attention.

What emerges very strongly is the beginning of an understanding of why there is a need to prioritise, and what is involved in prioritising properly. And, perhaps most important, what sorts of data, expertise and processes we need in order to be able to determine conservation priorities with any sense of confidence. Though this exercise has provided the beginnings of knowledge, it has more valuably provided a deeper understanding and knowledge of all that we know not. It has also thrown up transitional methodologies especially suited for data-deficient conditions, like those that prevail in most countries of the South and, indeed, in much of the world.

Given below are some of the methodologies that were developed, tried, tested and used in the BCPP. There is no one methodology. Each project has developed its own way of best reaching the objectives given the many constraints. And perhaps that in itself is a strength, for it reflects an intellectual diversity that matches the biological diversity that is sought to be addressed.

The Project Methodology

As this has been described in detail elsewhere (see Alcorn and Uppal in this volume), only the broad principles are being enunciated here and some of the dilemmas described.

The major question confronting the BCPP Steering Group (SG) was - what methodology should be used to finalise the project methodology? This was a critical question because there was no one accepted methodology for such an exercise. Besides, the methodologies developed in other countries assumed a level of data availability that was unrealistic for India.

The SG decided that the only acceptable way of finalising the project methodology was to do it in consultation with the potential project partners and other experts. For this purpose, the SG commissioned a study of other prioritisation exercises so that the participants of the design workshop would have some background information (see Singh and Taneja in this volume for a summary). The design workshop was held in mid April, 1996, and initial methodologies for prioritising sites, species and strategies were discussed among over 120 participants and some consensus reached.

However, it became clear during the workshop that no one methodology was clearly the best. There were differences of opinion on the various approaches and each of the possible approaches had different strengths and weaknesses. Also, different methodologies worked differently for different ecosystem types, or for different taxa. Therefore, a conscious decision was made to encourage the use of

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different methodologies, depending on the preference of the project partners and the suitability to the area of study. This did mean that the final results would not all be comparable as they were arrived at through varied methods, however as this was seen primarily as a process project, such an outcome was considered acceptable. The only general principle that was laid down was that the methodology must be as participatory as possible and appropriate.

The methodologies finally used have been described in each of the reports whose summaries are given in this publication. However, for easy comparison they are being summarised below.

Sites

The methodology for prioritising sites was perhaps the most difficult to get agreement on. As the major thrust of wild biodiversity conservation in India is through *in situ* conservation, the prioritisation and conservation of sites was seen as perhaps the most critical of tasks. Therefore, it was all the more important that proper methodologies for prioritising sites become available and operational.

The sites sub-group at the design workshop raised many difficult questions (for a more detailed account see WA Rodgers in this volume). Some of these are discussed below.

- At what level should sites be prioritised? Ecosystems, biogeographic zones, states, or some other?

Though the sites sub-group felt strongly that this should be done at the level of biogeographic zones, there were practical difficulties with this. Expertise was not available at a biogeographic zone level, for people and institutions rarely specialised on a specific biogeographic zone. The expertise available was on ecosytems, like on wetlands, grasslands, deserts, etc. Therefore, while recognising the force of the sub-group's arguments, the SG reluctantly adopted the ecosystem approach. Of course, there was general agreement that sites must be compared for prioritisation within ecosystems (or biomes, if within biogeographic zones). You cannot prioritise between a grassland site and a desert site, and so on.

In retrospect, perhaps it would have been better if the prioritisation exercise was carried out separately for each state, and within each state for each ecosystem. If a uniform methodology could have been followed for each ecosystem across states, then from the state level priorities, national level priorities could be deduced. This is because it became difficult to find experts who had the same level of expertise and information for all parts of the country. Besides, even those who had that expertise found it difficult to ensure that, in the time available, the same level of attention was paid to all parts of the country. As a test case, priorities were drawn up for three of the north-eastern states: Meghalaya, Arunachal Pradesh and Tripura. Also, an exercise was done to prioritise from among the grasslands of Assam, another north-eastern state.

- What values to use while assessing a site?

Though the values summarised in Singh and Taneja were generally accepted, there was a debate on how to apply these values. How does one prioritise between these values?

For biodiversity values, the best method seemed to be the iterative method. Essentially, within an ecosystem (or biome) the site that had the most species was judged as the most valuable site. The site that added the most new species to the first site was then judged the second most valuable site, and so on. It was argued that the list of priority sites that emerged through such a process would meet all the prescribed conditions.

However, there was also general consensus that comparable site-specific data on species were not available. Therefore, whatever be the merits of such an approach, it was not feasible in the Indian conditions. Consequently, each expert had to develop, given the types of information available, the most appropriate methodology that gave them the best results.

- How does one prioritise sites in a participatory manner?

Broadly speaking, sites were to be prioritised on the basis of three types of values – biological, socio-economic and conservation feasibility values. Whereas it was easy to design a process by which the second and third set of values were determined through extensive consultations with all stake holders, especially local communities, it was not obvious how the same could be done for biological values.

Though local communities could contribute significantly in identifying the biological species, communities and processes that a specific site has, the time frame and resource availability under BCPP did not permit a primary survey of the thousands of sites across the country. Consequently, prioritisation had to be done on the basis of available secondary information and using values (like endemism or rarity) that were difficult for local communities to comment on, at least at the national and global context. Besides, this would also involve having to take data on prioritised sites to each of the areas across the country—a huge exercise for which there was neither time nor money.

Of course, if it had been possible to stagger the micro-strategies exercise to after the sites prioritisation exercise was completed, then it would have been possible to develop micro-strategies around the prioritised sites. This would have provided an opportunity to discuss the basis and rationale of prioritising a particular site with the affected and interested people, including the local communities. Unfortunately, the project schedule did not allow this.

s a result, this remained a major weakness of the project and though there was extensive discussion between experts and professionals, there was very little participation by local communities in the process of prioritising sites*.

Given below is a tabulated statement of the methodologies used by the various exercises for prioritising sites.

Species

The prioritisation of species also needed a methodology that was appropriate for Indian Conditions. Like for sites, here also there were significant data gaps, but of a different kind. For many species there were no data at all. For others, the data on distribution, status and trends were missing. But, most critical, the data available for species was not easily comparable across species. Some were much better studied and understood while for others very scanty information was available.

*Fortunately, in the ongoing exercise for formulating a Biodiversity Strategy and Action Plan for India, being conducted by the Government of India through a group of NGOs and with the support of the GEF, the BCPP priority sites are being taken up for detailed community discussions

Study	*Was there a pre-selection of sites and, if so, what were the criteria used?*	*What were the Indicators/values/ criteria used for prioritising?*	*What were the sources of information?*
1	*2*	*3*	*4*
Andaman and Nicobar Islands: JL Ellis, et al	Yes. Criteria not clear	From Singh and Taneja (1996)	Literature review, discussions with experts, forest officials, field visits
Andaman and Nicobar Islands: Tara Gandhi	Yes. On the basis of richness and endemism	Endemism, richness, naturalness, presence of endangered species, inadequately studied, indigenous/ ethnic interest, sites of traditional conservation practices.	Literature review, discussions with experts, forest officials, NGO representatives, field visits
Lakshadweep: DN Mathew and Tara Gandhi	Areas/sites with some or all of the following characteristics were pre selected : - high diversity of flora and fauna - location of important ecosystems such as sea grass beds, mangroves etc., - relatively undisturbed natural areas - vulnerable spots - areas facing threat from pollution, - areas where species important for local livelihoods occur	Sites conforming to 3 or more of the parameters listed below were prioritised: • Sites recommended for inclusion in the PA network by other studies such as Rodgers & Panwar, James & Pillai, • Sites harbour ing rare flora and fauna • Having endangered species • Sites important for fisheries • Threatened sites threatened • Undisturbed sites • Sites with rare plants • Breeding sites for pelagic birds • Coral reef sites with high species diversity, both undisturbe and threatened.	Literature survey of published, unpublished, scientific, semi scientific literature, govt records, maps, popular articles, status reports on species and habitats in the study area. Authors previous experience and studies. Discussions with other scientists. Discussions with local community members, NGOs.
Marine: AG Untawale et al	37 sites /stations were identified on the basis of: Marine/coastal flora and fauna, presence of mangroves & corals, reproductive phenology of mangroves, marine algae, benthic fauna, density of corals and sea anemones, abundance of wild life.	After assessing the merits of each of the 37 sites, 10 were selected for further detailed observation. In the last phase, 5 out of 10 were recommended as Marine PAs. Though no specific criteria has been assigned for shortlisting 10 sites out of 37 (and then again 5 out of 10), based on the characteristics of the 5 sites recommended as Marine PAs, one can assume that the following might have been some of the values looked at: • Diversity of marine floral and faunal species, avifauna • Algal richness • Presence of islets and coves • Cultural value of the site. • Nesting site, migratory route • Presence of corals and mangroves • Naturalness despite large human population in close vicinity (eg.Colaba) 5 other sites of importance have been mentioned at the all India level on the basis of- • Biogeography- presence of fringing corals, estuaries, deltas	

Contd....

1	*2*	*3*	*4*
		• Ecological status, naturalness and uniqueness- presence of marine and coastal flora and fauna, endangered species, nesting/mating site, economically important species, presence of sea grass beds, ornamental fishes, • Socio economic aspects- fisheries resources, eco tourism, aquaculture, commercial exploitation of murex and shells • Scientific aspect- scientific research in progress or completed • National/international significance. - biosphere reserve, national park	
Coasts: Hemal Kanvinde	38 nationally important coastal sites were selected by the project partners. Out of these, experts, in a workshop, selected 13 for detailed assessment. Finally, for various reasons, four of these 13 sites were dropped and only nine sites taken up for assessment. The sites pre selected on the basis of following criteria: representativeness, presence of significant number of rare, vulnerable, endangered species, important habitat for plants and animals, substantial socio economic and cultural value. Pre selection done during the workshop mentioned in column 4.	• Ecological importance • Species diversity • Habitat variety • Habitat of rare and endangered species • Nursery/ breeding /rest area • Feeding sites • Naturalness • Economic importance for recreation, subsistence of traditional users • Social importance- heritage, cultural recreational, historical, educational value. • Scientific importance- valuable for research and monitoring. • National/international significance- subject to international treaty or convention, potential as world heritage site, biosphere reserve, Ramsar site. • Conservation feasibility. Scientists, wildlife biologists, forest managers and NGO representatives modified the criteria of Kelleher et al (1995) to came up with this set of criteria which was considered to be most suitable for Indian coasts.	• Mangroves in India—A Status Report. MoEF,1987 • Wetlands of India-A Directory. MoEF,1990 • Directory of Indian Wetlands. WWF-India,1993 • A Global Representative System of Marine Protected Areas. Vol II. IUCN,1995 • ITTO-CRSARD Project 1994 This selection was done during a workshop of scientists, wildlife biologists, forest managers and NGOs. This selection was done during a workshop of scientists, wildlife biologists, forest managers and NGOs.
Marine: Prabhash C.Sinha	Yes. Based on their biological value.	Based on the description of the prioritised sites, it can be concluded that the following indicators may have been used to prioritise sites: A legally recognised form of protection-national park or biosphere reserve, presence of commercially important species of flora and fauna, presence of rare and endangered fauna such as common dolphins, sperm & blue whales, dugongs, saltwater crocodiles, marine turtles.	Secondary sources. Discussions with other experts.

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1	2	3	4
Wetlands: Jay S Samant	900 inland wetland sites were initially identified for which some information was available. From these, 150 wetlands were pre selected. 700 were excluded because the required data were not available and hence they could not be prioritised . All of them may not be insignificant from the ecological/ socio economic viewpoint. In fact many of them may turn out to be high priority wetlands if and when data is available for them. This constitutes a significant gap in knowledge.	• Ecological indicators - richness, distinctiveness, rarity, representativeness, keystone function, threat. • Socio economic indicators- consumptive utility (food, incomes), non consumptive utility (religious, recreation, scientific),. • Conservation feasibility: economic, legislative, administrative, institutional, community support.	Published and unpublished data pertaining to inland wetlands-reports, books, theses, articles, maps, wetland directories etc. Consultations with research institutions & scientists. "A Directory of Asian Wetlands" "Rodgers and Panwar" Various prioritisation methods used in the past were analysed and an integrated approach, suitable to India, was developed. This was circulated among experts for comments.
Indian Grasslands: A.R Rahmani and M. Zafar-Ul Islam	Various types of rangelands found in India (arid, semi arid, wet, alpine and shola) are mentioned in the report though the prioritisation exercise is restricted to the rangelands of the Indian plains i.e. arid and semi arid and the shola rangelands of the western ghats. Only these 2 categories have been analysed presumably because of easy availability of data pertaining to these. All such areas where climatic and edaphic factors prohibit the growth of trees and vegetation is restricted to shrubs, bushes and grass have been considered rangeland sites. 93 sites spread over 13 states were identified and assessed. Basis for selection of these sites not specified. No pre selection as all 93 sites were assessed.	• Biological values • socio economic values • administrative importance • geographical representation • habitat representation • cultural and social values	Secondary literature including past studies on rangelands and the authors considerable research experience with rangeland fuana, particularly avifauna. A wide spectrum of people were consulted to gather information on these parameters. These included grassland users, local communities, social scientists, scientists, forest officers, and NGO representatives.
Grasslands of Assam: Anwaruddin Choudhury	Though pre selection has not been specifically mentioned in the methodology, the fact that only those grasslands which were 10 sq.km. or more in area were evaluated, can be considered to be a form of pre selection.	• Size of grassland • Presence of rare and endangered species of wildlife • Presence of sizable population of rare and endangered species of wildlife • Disturbance/threat (poaching, encroachment, grazing grass collection, fishing, wood cutting, insurgent related activities and general attitude of the villagers). Less disturbance given higher score in terms of effectiveness of conservation measures. • Contiguity with other grasslands - Conservation status (both legal status and enforcement in the field	• Literature search- Chaudhary, 1985a, 1985b, 1987c, 1990b, 1997c, Lahon and Sonowal, 1973, brochures of forest and tourism depts of Assam govt., unpublished reports, district gazateers, census reports. • Consultations with forest officers, NGOs, local villagers. • Field visits and primary observation. • Previous experience of the author.

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1	*2*	*3*	*4*
Desert: SM Mohonot	Yes. Site selection based primarily on the authors own knowledge of the area. Local NGOs, teachers and biology students were also consulted. Seven sites selected for prioritisation primarily on the basis of uniqueness of these sites and the lack of information about other areas within the desert ecosystem.	• Biological indicators – interaction between keystone tree species and animals, occurrence of indicator species, endemism, uniqueness of a site. • Socio economic indicators – use of medicinal plants.	Field surveys, secondary material, consultations with local people, NGOs, forest officials and other experts.
Timberline Zone: Uppeandra Dhar	The entire study area was divided into uniform grids, each of 74.45 sq.km. The boundaries of each grid defined a site. Hence the entire timberline area of the western Himalayas was covered in the study.	• Richness- no. of species • Representativeness- plant communities • Naturalness- no. of native species • Endemicity- no. of endemics, • Uniqueness- rarity status • Use value- edible, medicinal, fuel, fodder, etc.	Primary and secondary surveys. Sample field visits. Extensive discussions with other experts.
Alpine Himalayas: AJT Johnsingh et al	Alpine zone sites in Trans and Greater Himalayas have been defined as follows— Areas which constitute the treeless zone between the treeline and the snowline comprising meadows, pastures, scrub and rocks.	Large mammal and floral diversity, status of threat, endemism, representativeness, catchment functions.	Secondary sources, expert consultations. Rodgers and Panwar (1996)
Forests: R Mehta	All forest areas whose crown cover densities was 40% or above were selected for prioritisation. Thus the boundaries of each site were those fringe areas beyond which the crown cover density fell below 40%. Wildlife PAs were excluded from this exercise.	All forest areas with crown cover density of 40% or above which fulfilled the following criteria were listed as priority forest areas: • isolated forest patches. • Forest patches adjoining PAs. • Forest patches that connect 2 or more PAs. • Relatively undisturbed forest patches located within relatively large, unprotected forest tracts.	The initial identification of sites was done using the Survey of India forest cover maps for the country at the scale of 1:250,000. Information regarding the biodiversity value of each forest range was collected from knowledgeable people within the govt and outside it. Analysis of working plans, discussions with officers and others, and sample field visits were conducted.
National Parks and Sanctuaries: R Mehta	Out of 525 PAs in the country, 253 were taken up for prioritisation. About a hundred were disqualified because they were too small to meaningfully assess. Of the remaining 425, 253 were selected primarily because relevant data were available only for these.	• .Biological values • .Pressures or threats • .Management or legal status	IIPA and WII databses, published material and sample field visits. Discussions with experts.

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1	*2*	*3*	*4*
Tripura: AK Gupta	36 sites from all over the state were selected for prioritisation. Identification of these sites was done during a workshop of forest officers, local MLAs, NGOs, local community representatives of the joint forest management committees, academics from colleges and Tripura University.	Each site was evaluated on the basis of the following values— • Biodiversity values consisting of- representativeness, vulnerability, ecosystem diversity, landscape complexity, conservation threat and conservation opportunity. • Taxa based values consisting of- species richness, endemism, threat, complimentarity, irreplacability, redundency, critical habitat, national/international importance. • Socio economic values consisting of- direct and indirect values, consumptive and non-consumptive values, option values, tourism value, research value, landscape and recreation values. • Conservation feasability values consisting of- protection status, level of threats, management capabilities, size, attitude of the local communities.	Secondary information, extensive field visits, discussions with local communities, with forest officers and other experts and with local NGOs.
Meghalaya: Debjani Roy and Sangita Choudhury	Sites initially selected because of known biodiversity values.	• Bio diversity values- richness, uniqueness/taxa based values, naturalness, endemism, representativeness. • Socio economic values- ornamental value, research and horticultural value, economic and socio cultural value, medicinal plants. • Number of rare species based on IUCN categories (rare, vulnerable, endangered).	Secondary data collection from various libraries, discussions with village elders and knowledgeable persons.
Arunachal Pradesh: K Haridasan	Preliminary identification of sites on the basis of floral values.	Though the criteria for arriving at the four prioritised sites has not been specified, site descriptions give some idea of the indicators that may have been used: • Large, undisturbed natural areas. • Presence of endemic, endangered and threatened plants. • Presence of economically valuable flora, particularly timber and cane, bamboo, medicinal plants • Sources of disturbance in the vicinity such as saw mills, human settlement, trading centres, markets, towns • Presence of floral species of subsistence use to local communities. • Presence of wild crop relatives • Vulnerability due to better communication facilities, hunting, and collection of non timber forest produce, conversion to cropland. • Presence of rare, endangered and endemic species of wild animals.	Previous botanical surveys. Field trips and interviews with local people.

In the design workshop three different types of methodologies were proposed. The first was the CAMP methodology for prioritisation (for details see Ajith Kumar et al in volume II), that involved a process of prioritisation based on expert consultations around a structured proforma. The second methodology involved ascribing certain quantitative values to each species in a manner such that the basis for the rank given to each species would be transparent to every one (see Padmanabhan and Gadgil in vol II for further details). In the third methodology, experts surveyed the published and unpublished literature and, on the basis of these, made a preliminary list of priorities that was then discussed with other experts (see Rana and Chatterjee, Sastry and Chatterjee, Ahmedullah, and Sahai in volume II).

Each had strengths and weaknesses. For example, the CAMP method was very participatory among experts and had the great advantage of capturing the knowledge of the experts that might not be available in any published source. However, the basis for prioritisation was not subsequently obvious to the reader and the list of species assessed depended very heavily on which expert was able to attend the CAMP workshop. On the other hand the method followed by Padmanabhan and Gadgil did not involve much discussion during the prioritising stage but was transparent and encouraged informed discussion after publication. The third was a tried and tested method and produced results that were based on documents that were widely available and therefore could be used by every one. However, all these methods had a common handicap of insufficient and sometimes incomparable information.

Interestingly, in the prioritisation of mammals, that being the only set of species that was prioritised through the use of more than one methodology, the list produced by Ajith Kumar et al was not dissimilar to the list produced by Padmanabhan and Gadgil!

At the design workshop there was general consensus that the focus should be on prioritising medicinal plants and animals, wild relatives of cultivated plants and domesticated animals, and other wild species. As it turned out, the other wild species that were prioritised comprised soil and aquatic invertebrates of south India (CAMP), amphibians (CAMP), reptiles (CAMP), mangrove organisms (CAMP), mammals (CAMP, and Padmanabhan and Gadgil), and Indian trees (Sahai).

Strategies

Perhaps the most adventurous and innovative aspect of BCPP was the attempt to prioritise not just sites and species, as usually done, but also strategies. In one of the first meetings of the BCPP Steering Group, a member stressed that though there was a need to know *what* to conserve and *where* to conserve, by far the greater need was to determine *how* to conserve. Out of this thought grew the very strong BCPP component of prioritising macro and micro strategies.

The idea was to assess, on the one hand, the policies, laws and programmes of the government and determine how effective they were in promoting biodiversity conservation. On the other hand, the effort was to be to interact with local, rural communities and find out what biodiversity meant to them, how and why they valued it and in what way did they want to conserve it. The expectation was that, ultimately, the existing macro strategies, manifested in policies, laws and programmes of the government, and the preferred micro strategies, enunciated by local communities, would be inter-faced. An effort would be made to determine the changes that would be required at the macro level if the preferred micro strategies were to be operationalised.

The task of prioritising from among micro strategies was taken up, under the leadership of Madhav Gadgil, by the Shrishti Jigyasa Pariwar (SJP), which is an informal consortium of naturalists with a social outlook, scattered all over India (see volume II for details). The methodology for the micro studies component was worked out in great detail and published in two manuals. Two parallel but independent studies on micro strategies were taken up by Ajay Mahajan and Ajay Rawat, both in the UP Himalayas (Mahajan et al and Rawat, volume II).

The thrust of the SJP exercise, that was carried out in over 50 village clusters spread over seven Indian states, was to develop people's biodiversity registers (PBR). This was done rigorously and in the process a large amount of information was gathered on community perceptions of biodiversity and its conservation. An interesting analysis of these data has been done by Monica Ogra (volume II). She has also tried to investigate the interface between the macro and micro studies.

Though it was initially hoped that many of the macro aspects could be studied, for various reasons only laws and policies (Rao and Prasad, vol II), gender issues (Kapoor, vol II and Pandey, vol II), education and awareness (Bharucha, vol II) and economics (Chopra vol II) could be studied. Of these, only education and awareness aspects could be studied on the basis of primary research. The remaining issues were looked at primarily on the basis of secondary literature. The project design envisaged micro-strategy teams also collecting field level information about gender issues, economic issues and aspects related to education, awareness and laws and policies. However, very little of this actually took place for a variety of reasons.

Prioritisation for Biodiversity Conservation: Values and Criteria

Shekhar Singh and Bansuri Taneja

Introduction

This need to prioritise conservation sites arises because of the various limitations and constraints that operate in the real world. Ideally, perhaps all biodiversity everywhere would be conserved. However, there are financial, institutional and human resource constraints which limit conservation efforts. There are also multiple demands on land and ecosystems. To meet all these demands and yet also adequately conserve biodiversity is not easy and, if it is to be achieved at all, it becomes critical to focus efforts on priority sites and species.

Prioritisation of strategies is again important to ensure that efforts at conservation yield the best possible results and that undesirable side-effects, especially the alienation and impoverishment of local communities, is avoided.

Values for Prioritising Sites

Prioritisation of sites, for conservation, needs to be done with reference to certain well defined values. These include biodiversity and socio-economic value of the site, and the value determining the feasability of conserving a site.

Biodiversity Values

The importance of a site in terms of its biodiversity value can be assessed on the basis of its:

Biological *representativeness*
Biological *unigueness*
Naturalness
Biodiversity *richness*
Support functions for other sites and for species
Potential value of a site where it might potentially be of high biodiversity value (for one or more of the earlier mentioned reasons) but its biodiversity value has not been studied or established.

Though these different basis for determining biodiversity value are not ranked, in determining the final priority a judgement would have to be made about their relative importance. For example, there might have to be a choice made between unique ecosystems and representative ecosystems, or between ecosystems where the biodiversity value has already been established and those where it is suspected but not yet studied.

Described below is each of these proposed values in detail.

Representativeness

Strictly speaking, a site is representative only of itself. However, as there are limits on how disaggregated conservation efforts can be, eco-system and habitat types have to be demarcated and representative sites identified.

The level of biological similarity of a particular site with other similar sites, or with an ecosystem type, in terms of the number and percentage of defining characteristics of that eco-system (or of similar sites) the site has, would determine its representativeness. Since it is impossible to find a site identical to an entire eco-system, sites can be prioritised on the basis of levels of similarity.

The level of disaggregation at which eco-systems can and should be represented is dependent on the scale at which the exercise of selecting representative sites is being carried out. Small scale studies will distinguish between eco-systems in greater detail. Albeit, a representative site must be large enough to reflect the integrity of ecosystem processes and not just ecosystem species.

An additional criteria for prioritising representative sites, especially when deciding between ecosystem types, is the coverage in terms of protected representative sites that each ecosystem type already has. An ecosystem with no or relatively few protected sites would have a higher priority than one with many such sites.

Uniqueness

Strictly speaking, each site is unique. However, in terms of practical conservation, areas that are markedly different in their habitat, ecosystem processes, or species combination from all other areas, are classified, through admittedly somewhat arbitrarity, as unique ecosystems.

This criterion has the twin components of distinctiveness and rarity. Distinctiveness with regards to a community would mean how far separated the unit is from its nearest neighbour in terms of combinations and processes. With regards to species, this translates into the relatedness of the specie with other levels of the taxonomic heirarchy, e.g. a specie that is the only members of its genus or family would be a greater loss to diversity than one which is part of a large genus. 'Rarity' signifies the occurence of species or combinations of species, or of process, which are rare in nature. Rarity may be a natural occurrence or due to human intervention.

Naturalness

This captures the extent to which a system has been free from human intervention and therefore has been allowed to exist and evolve in its natural state. Such sites are likely to be examples of relatively unmodified ecological processes.

There are two difficult questions related to this criterion. First, is all human intervention negative in terms of naturalness values? Second, is any ecosystem on Earth "natural"? Concivably human activities leading to pollution and climate change, among other, might have modified even those wilderness patches never actually visited by humans.

Richness/diversity

This refers to the number (and density) of species contained in an area. Measurement of species per unit area is perhaps the most objective measure of this criterion. In the context of ecological communities, it could mean diversity of habitats.

However, this criterion should be used to prioritise between sites belonging to the same ecosystem type only. Species richness cannot be used to prioritise between ecosystem types.

Diversity is an additional value insofar as the less the genetic relatedness of constituent species, the greater the value of diversity.

Endemism

An endemic species is one whose occurrence is restricted or particular to a locality or area. The measure most often used is the number/percentage of species endemic to a site. The problem of scale arises here as well, since the question of local endmism is dependent on the size of the area under consideration. Also, if limits on geographical extent are set for characterization of a species as endemic, species with larger ranges but endemic within those may be overlooked, e.g. birds endemic to the Mediterranean rim are not considered restricted range species because of the 50,000 sq. Kms., limit on endemic bird areas [ICBP, 1992].

Significance for other Areas of Biodiversity Value

This involves valuation of an area based on its importance for the health of other ecosystems, even though it may not be biologically rich itself. These inputs could be constant, cyclic (repeatedly in a known cycle) or periodic (at unknown intervals).

(a) *Constant inputs* could be functions such as water catchment for wetlands, or genetic corridors. With regards to species, constant services would mean their role in maintaining processes such as pollination or their status as keystone species.
(b) *Cyclic significance* to an area of biodiversity value is a function of an area occuring at regular intervals e.g. nesting/wintering grounds, stopovers on migratory routes.
(c) *Periodic inputs* could include refugia provided to species in times of crisis (e.g. floods) in their natural habitat. This would often be at unknown intervals.

Containing Valuable or Important Species

The value of the constituent species could be ecological, economic, as conservation symbols or because of their threatened status. Apart from conserving ecosystems, biodiversity conservation would also involve the conservation of specific species. Prioritisation between species could be made on the basis of endemism, of how rare they are, how fragile they are, threatened they are and their importance to other species (the keystone function).

Potential for High Biodiversity Value

Unexplored areas whose potential biodiversity value is high, e.g. unexplored island in the Andaman and Nicober group.

Socio-economic Values

In deciding priority sites for conservation it is important to assess and take into consideration the socio-economic value of the site. In one sense, all biodiversity values are

also socio-economic values as, directly or indirectly, individually or collectively, biodiversity resources are also socio-economic resources. However, more specific socio economic values also need to be taken into consideration in the prioritisation process.

There are indirect socio-economic values where biodiversity rich sites perform catchment, seed bank, climate regulation and other such functions which contribute to the social and economic welfare of humanity. There are, in addition, direct socio economic benefits where local communities, especially the tribal and forest dwelling communities, use plants and animals for food, medicine and to meet other basic needs. Consequently, a river, or a bay, or a part of the sea which, apart from having rich biodiversity, also functions as a seed bank in support of the fisheries of the region, has added priority for conservation. If the area also directly supports fisher fold or other local people (even from tourism based activities) then its priority goes up further.

Social and economic values can be classified as follows:

Direct economic value
Indirect economic value
Option value
Socio-cultural value
Scientific value

Direct Economic Value

The direct economic value of a site (or species) is the economic value of those goods and services it directly provides (or can provide) that are generally acknowledged to have a market price, and perhaps a replacement cost or an exchange value. Such goods could include timber, fuelwood, and medicinal and edible plants (consumptive value). Such services could include tourism (non-consumptive value).

Indirect Economic Value

The indirect economic value of a site (or species) is the (notional) economic value of those goods and services provided (or providable) that are not ordinarily bought or sold (or even exchanged) and, consequently, do not have acknowledged economic value. Such goods and services are, however, critical for human well being and for the continued availability of other goods and services which have direct economic value. Examples would include carbon sink, climate and hydraulic regulation, seed bank, and soil and oxygen replenishment functions.

Option Value

Option value is the (notional) value, economic, cultural or scientific, that a site or a species might have in the future, but which is not yet recognised.

Socio-cultural Value

Socio cultural value is the non-economic value that human beings attach to sites and species, as a part of sentiment, culture, aesthetics, history or religion. This is especially true of rural and forest bases communities.

Scientific Value

Scientific value is indicated by the potential of a site or species to contribute to our knowledge of the world. This could include sites of long standing research value and others where new studies could prove fruitful, e.g. the Antarctica.

Conservation Feasibility Values

Given the need to prioritise because of the constraints already mentioned, it is important to assess the conservation feasibility of an area, in terms of how easy or difficult it is to conserve. Essentially this involves on the one hand an assessment of the threats and pressures on the area and, on the other hand, the capabilities and institutional structures available to conserve the area. If a choice has to be made between two areas which are otherwise of equal biodiversity and socio economic value, clearly that which is easier to conserve must be chosen.

An exception to this rule might, however, need to be made in the case of an area which, if something is not urgently done, would loose all its unique biodiversity value. In such cases, priority may be given to such an area even when it is difficult to conserve, over other areas which are easier to conserve but can well wait for a while.

Some of the important concerns could be:

Protection status
Level of threats
Management Capability
Size and ecological vulnerability

Protection Status

The legal or social protection a site enjoys is an important factor for determining the conservation feasability value. For example, a duly notified national park would have greater feasability value than a sanctuary. Similarly, a sanctuary would have higher conservation feasability than

a reserved forest, and all three would have a higher value than a site which has no special conservation status. Conservation feasability value can also be enhanced by the non-legal social status of a site, like that of a sacred site.

Level of Threat

The level and type of human pressures that an area is subjected to is also an important criterion for determining the feasability value. For example, constant pressures might be far more damaging than infrequent, cyclic, ones. Similarly, pressures emanating form the legitimate needs of the local population might be far more difficult to control than those from elite tourist activities.

Management Capability

The ability and willingness of the government and other institutions, including local community institutions, to conserve the site is an important basis for determining feasability value. Mere legal status does not guarantee proper protection.

This involves not only having the capability of managing the site but also in influencing larger policy and action which ahs a bearing on the conservation of the site. It also involves being able to get the participation and support of local communities in conserving the site.

Size and Ecological Vulnerability

The damage that specific pressures can causes to a site often depends on size and ecological vulnerability of the area. Smaller sites are often less able to absorb pressures and threats. The layout and extent of a site, its shape and relationship with other sites, also has a bearing on its viability as a conservation unit.

Values for Prioritising Species

Apart from conserving ecosystems, biodiversity conservation would also involve the conservation of specific species. Prioritisation between species could be made on the basis of endemism, of how rare they are, how fragile they are, threatened they are and their importance to other species (the keystone function). In addition, their socio-economic value would also need to be considerd.

Values for Prioritising Strategies

In prioritising strategies various aspects have to be kept in mind. Some of these are described below:

1. As a first priority, the strategy must achieve the objective of conserving biodiversity. The more effectively and expeditiously it does so the better.
2. However, the efficacy and expeditiousness of a strategy must be balanced against its side effects. For example, it might be argued that the most effective strategy for the conservation of biodiversity in any site is to remove all human interference from that site by shifting out populations and banning all human interactions. However, such a strategy might cause extensive suffering to the local communities. This, then, would have to be balanced against the biodiversity conservation benefits, in order to determine the priority strategy.
3. The strategy must be cost effective so that in the available resources (financial and human) as large a number of sites as possible are conserved.
4. The strategy should be sustainable in the sense that it is not forever dependent on external inputs. For example, it should avoid financial resources which are either unlikely to continue or whose continuance in a particular site would mean that they are denied to other sites.
5. The strategy must have an in-built ability to monitor its efficacy and to change appropriately whith changing times and circumstances.
6. The fact that any strategy which has the remotest chances of success must involve local people and must ensure that justice is done by them, is well established. What needs to be stressed here is that not only should the strategy that is prioritised be such that it is participatory but also that the actual process of prioritisation and formulation of the strategy should also be participatory.

Survey of Prioritisation Values

An attempt was made to study various biodiversity conservation prioritisation exercises undertaken in different parts of the world with the purpose of extracting the prioritisation values used in these exercises. For the purpose, 47 prioritisation exercises were studied, 33 through primary sources and 14 through a secondary source.

The summary of findings, in terms of the different types of prioritisation values preferred, are given below.

Summary of Findings

NOTE : One point was given to a value for each exercise that it was fully used in. Half a point was given for partial use.

VALUES		*SCORE*			*RANKING*	
		Primary Studies	*Secondary Studies*	*Total*	*Within Section*	*Overall*
BIODIVERSITY VALUES						
1a	Representative	16	4	20	5	7
1b	Gaps in PAs	12	2	14	6	10
2	Uniqueness	21	5	26	3	4
3	Naturalness	11 1/2	2 1/2	14	6	10
4	Richness/diversity	27 1/2	10 1/2	38	1	1
5	Endemism	26	10	36	2	2
6a	Significance for other areas	10 1/2	1	11 1/2	7	12
6b	Cyclic significance	10 1/2	1	11 1/2	7	12
7	Important Species	14	6 1/2	20 1/2	4	6
8	Potential Value	3	-	3	8	14
SOCIO ECONOMIC VALUE						
9	Direct	18 1/2	5	23 1/2	1	5
10	Indirect	14	5	19	2	8
11	Option	8	-	8	4	13
12	Socio cultural	11 1/2	3	14 1/2	3	9
13	Scientific	7	1	8	4	13
CONSERVATION FEASABILITY VALUES						
14	Protection Status	17	9	26	2	4
15	Level of Threat	27	3	30	1	3
16	Management capacity	11	2	13	3	11
17	Size	5 1/2	2 1/2	8	4	13

NOTES:

* Value in relation to other areas of biodiversity significance is sometimes indistinguishable from indirect economic value (i.e. functions such as catchment areas).
* Cyclic significance is the most obvious of the roles that a site could perform with reference to an area/species. It is therefore usually more explicity stated.
* Popular/prominent species are again a highly visible criterion for conservation. It is perhaps widely used also because it helps in obtaining institutional support.
* Potential for high biodiversity value is not much looked into, though perhaps it should be because it can include the criterion of naturalness as well.
* Direct economic values are often not explicitly mentioned, perhaps because there is a demand that biodiversity should be conserved for its own sake and not just because it is of value to humans. Sometimes, direct economic values are implicit in the decision to conserve.
* Option value also seems to be implied in many studies, but not directly considered perhaps because of the difficulty of quantification.
* Scientific value usually seems to refer only to existing research and usefulness of biodiversity to science.
* Valuation based on the feasibility of conservation often assumes that adequate conservation action will be taken subsequent to the site being prioritised.

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The Process of Participatory Mapping for Planning for Biodiversity Conservation

Vasumathi Sankaran, Hilaluddin and Papiya Bandhyopadhyay

Many of the rural poor are largely dependent on the biomass produced by the ecosystem in which they live. It fulfils their need for fuel, fodder, food fibre and medicine. The tribals and other rural poor are the real ecosystem people since they are closely linked to their environment. Currently there is a lack of information about the interactions between the people and their use of natural resources from the ecosystem in which they live.

Those who are interested in biodiversity conservation have to realise that there can be no successful conservation attempt without incorporating the needs and wishes of local people in conservation plans. There is therefore a need for a participatory process in conservation planning. One such process is that of the participatory sketch mapping, which was developed as a part of the Participatory Rural Appraisal (PRA) methodology. Subsequently, many innovations were tried to perfect the process of gathering data through such mapping.

Objective

The main objective of this exercise is to help a community manage and conserve its resources and to enable the community to develop in a participatory manner, a spatial representation of an area (a village or an ecologically valuable site etc.), as the community itself sees it and knows it.

Specific Objectives

1. To help the participants gain a macro view of their environment.
2. To help the participants in recalling the past land-use history and compare it with the present land-use, thereby initiating the process of discussing conservation strategies.
3. To capture local names and significance of the physical features of the area, which will help in understanding the local ecological knowledge,
4. To depict land-use and use and interactions with other natural resources in the area.
5. To facilitate participatory mapping of social and gender issues of the village.
6. To facilitate mapping of resource (fodder, fuel wood, NTFP {Non Timber Forest Products} etc.) extraction areas of the village and its surrounds.
7. To facilitate transferring of information from a sketch map to a map drawn to scale (Survey of India toposheet), so that it can be integrated into larger plans.

Methodology

1. Participatory mapping with people, using Survey of India (SOI) toposheets as the base map; it is possible to enlarge the area to be focused to twice or thrice the size (explained in Annexure I). This forms the new base map.
2. Discussion with the key informants on past history and present problems faced by villagers regarding resource collection.
3. Villagers should be encouraged to draw sketch maps to show:
   - The specific areas from where various resources like fodder and fuel are collected.
   - The residential locations of various communities who live in the village.
   - The specific areas from where resources are collected by separate groups of men, women and children.
   - Control points like branching streams and roads that could be easily identified on the base map. With reference to these control points all information must be transferred from the sketch map to the base map. (The planning team must hold separate discussions with various groups and with each group similar maps should be drawn. This helps in triangulation of information).

4. Draw a block diagram or a two-dimensional transact diagram of a typical landform feature found in the site. (A scrutiny of the toposheet will reveal features like escarpments and flat topped hills, gentle slopes, saddle and river valleys; these can be drawn as block diagrams or transacts diagrams and taken to the field). Ask the villagers to name each feature in the local language, describe the soil, important plants found in each area, and the animals found, any past history of land-use like shifting cultivation, and the present status. Record them in a tabular form. When data from a number of adjoining villages are collected and analysed, the habitat zones for various species can be identified. Finally ask the villagers which of the species they would like to extract for commercial purposes and which they would like to extract only for personal use. Ask the reason for it.
5. Display all the maps and pictorial representations at the village assembly meetings. The visual framework would facilitate a focused discussion on resource use and conservation.

The Micro-strategies Subgroup of the Biodiversity Conservation Prioritisation Project has selected sample sites in seven states to prioritise people's strategies for conservation. The mapping exercise was attempted in four of these states. Two groups of villages were selected in the desert ecosystem from the state of Rajasthan. Other ecosystem chosen were; the wetlands around Chilika Lake in the state of Orissa, Palamau Tiger Reserve in Bihar to represent the Gangetic plain ecosystem, and South Andaman and Little Andaman to represent the island ecosystem.

Historical mapping was done with a group of villagers to understand the reasons behind existing conflicts. Attempt was made to understand local ecological knowledge through mapping. Resource mapping and mapping of threats and pressures were some of the other attributes elicited in the mapping exercise. However, the main aim was to transfer people's information to maps having proper co-ordinates and scale, so that it can be used in GIS applications. Each ecosystem was taken up mapping had some specific issue relevant to it.

Barmer and Jaisalmer Districts, Rajasthan:
Desert Ecosystem

The sample villages in the **desert ecosystem** did not experience any deprivations due to sudden closure of resource extraction areas, as there were no new declarations of protected areas or other restrictions on resource use. Since people continued to use natural resources, as in the earlier days, there was no need to highlight historic resource use. On the other hand, sacred groves, that existed as conservation areas were now getting eroded; they needed to be studied and plans were needed for their preservation and perpetuation. It was decided to do resource mapping and pressure mapping with the people, which were to be used as primary data input and use remote sensing map and ground water map as secondary source data input for village meetings. The exercise of transferring people's information to the base map, prepared from SOI toposheet and to another set of maps prepared by the Revenue Department of the sample villages was done. This could add people's information as one of the layers in future GIS database applications. An explanation of the mapping exercise follows.

In the village meetings the maps that are of the same scale were overlaid so that the people could understand the interrelationship between resources. For example, ground water map overlaid on land-use map shows the relationship between vegetation and water. This could persuade people to restrain themselves from over exploiting ground water.

Sample villages were chosen in Barmer district of the state of Rajasthan, where the Bishnois, a community known for its conservation ethics, live. They had patches of sacred groves called '*orans*', inside the village boundary. Another group of selected villages is located around 'Ramdeora Oran' in Jaisalmer district. Ramdeora Oran is one of the biggest patches of a sacred grove in Jaisalmer and some parts of it are still well preserved.

Mapping: The site chosen for the mapping exercise is climatically very dry. Grazing and fuel wood extraction exerts high pressure on the endemic vegetation. The Bishnoi community though known for their conservation practices, no longer strictly adheres to their old customs. Other professional pastoral communities are increasing their herd sizes. Marginal lands are being brought under cultivation. Areas that were totally dependent on stored rainwater for domestic use have an additional source now; the tube wells, which tap ground water. The ground water reservoir in the desert does not permit exploitation of this water to any large extent, other than for domestic use and for watering the cattle. However, some villages, which have a good store of ground water, are pumping out water for irrigating agricultural fields. In the event of successive failures of monsoon, there could be total ground water depletion, which would leave no water even for domestic needs. All the villages have sacred groves (*orans*) that protect the catchments of the ponds (*nadis*), which store rainwater for use throughout the year. Conserving these sacred groves would be in the interest of the people.

Land use and resource mapping was done with the villagers. Satellite imagery interpretation of the natural vegetation of the sample sites, and hydro geological map showing the ground water potential, was collected as

secondary sources. Biological assessment of the vegetation of *orans* to assess parameters, like species richness, endemism and diversity were conducted and a valuation exercise for each of the *orans* was carried out to assess priority area for conservation (a sample exercise is given in Annexure II).

Even though it was beyond the scope of this study, the maps drawn by the villagers and those procured from outside could be displayed in the village assembly (*gram sabha*) meeting, where strategies for conservation would be discussed.

The investigating team found out after discussing with the *sarpanch* (elected representative who heads the village council) and other villagers that the village of Doli Kalan had three numerically important caste groups. They were the Bishnois, Rajputs and the business community. Resource and land use mapping was done with each group to help triangulate information. They were similar in all aspects. However, when monetary transactions were discussed, the assessments of the groups varied! The villages of Doli Kalan, Doli Khurd and Doli Rajguron had their respective revenue maps with them. People's information was transferred to the revenue maps with the help of control points like roads and ponds. The revenue maps though drawn to scale had no co-ordinates (latitudes and longitudes). These maps need to have co-ordinates to use them in a GIS format. Therefore, the information was once again transferred to an enlarged toposheet with the help of control points, like ponds and roads. The remote sensing map and hydrogeology maps have been enlarged to the same scale so that they can be overlaid and analysed.

Discussion with the people: The exercise commenced with mapping and transact walk, followed by discussion with the villagers. Land use and resource use was the two main topics discussed with the villagers.

Doli Kalan, Doli Khurd and Doli Rajguron were three villages, which are surrounded by agricultural lands belonging to other villages. The fallow lands were stony, sandy wastes with no vegetation. These three villages totally depended on their *orans* for NTFP collection and for grazing of their livestock. Though agriculture was the main occupation of many of the households, all had a few livestock, as is common in rural India. The *orans* themselves were catchments for the *nadis* (ponds). In the past the upstream area of the catchments had a good tree cover. This had the effect of filtering the water flowing into the *nadi*. Presently the pressure on the biodiversity is so great, that this cover is being slowly stripped.

Field assessment of biodiversity revealed another fact; that the agricultural fields had more bio-diversity than the *orans*, which are heavily grazed. Examples of some of the important grasses, herbs and shrubs found only in the agricultural fields and cultivable fallow are: Bur (*Sida cordifolia*), Goldhali (*Dacstelandra valvichii*) Baicker (*Indigofera cordifolia*) Samco (*Corchorus trilocularis*) Sewan (*Lasiurus sindicus*) Lochimula (*Cistanche tuberona*) etc.

The agricultural fields are closed for grazing for four months, during the cropping season. It is also the growing season in the desert. This could be the reason for finding more species in agricultural fields. This indicates that closure for any short duration will help in regeneration.

The other issue was the registration of land. *Orans* were sacred groves and protection of the Oran was the responsibility of the temple that is situated in it. Later, the idea seems to have changed. In these arid lands, *orans* were open for grazing even in the past. However, the government has declared it the *orans* to be *gaochar* (grazing land) and brought them under the Revenue Administration. In villages, when land is required for community use, the first target is panchayat fallow (land belonging to village council), or *gaochar* lands. Parts of *Orans* were thus parcelled and redistributed. The sense of sanctity and the fear of the unknown, which helped conservation, are thus getting eroded.

While doing the seasonality chart with the women, they came out with a suggestion that they should be gainfully employed for the eight non-agricultural months. Their preferences need to be ascertained and gainful employment opportunities should be made available to them.

In the villages of Biramdeora Aika and Panji ki Dhani, a similar situation existed regarding biodiversity and resource use. Because of the vast area under *Oran* and the seasonal migration of the cattle, parts of the Oran were in a much better condition. The closed areas that were administered by the Forest Department and the Soil Conservation Department had a good ground cover and are an example for the people to see and follow. These villages have *khadin* lands (land having a natural slope followed by a shallow depression) for agriculture; *khadin* lands allow winter cropping; yet they conserve much of the ground water. A depleted ground water table will have its adverse effect even on wild biodiversity. Villagers of Panji ki Dhani were initially very reluctant to participate in mapping or discussing the resources and land use. They thought mapping would help the government to identify land for road construction, which may require that portions of privately owned land be handed over to the authorities. They were very reluctant to share any information regarding their income from livestock rearing. They had to be persuaded for some time before the mapping exercise could be completed.

The overlaying of the village map with hydrogeology and remote sensing data mapping was useful in cross

checking much of the information given by the people and information got from ground verification. All such information needs to be shared with people and it is hoped that the visual format will generate useful discussions for arriving at strategies for conservation.

Chilika: ***Wetland Ecosystem***

Chilika lagoon is estimated to have been formed about 5000 years ago. The lagoon and its surroundings are enriched with varieties of aquatic and terrestrial fauna and flora. It has been declared as a wetland of international importance under Ramsar Convention. About 65,000 fishermen living in and around Chilika depend on it for their livelihood. Migratory birds reside in Chilika in the winter.

Chilika has become a zone of conflict between traditional fishermen and the non-fishermen communities. The communities living in the neighbourhood of Chilika belong to higher caste groups, who did not take up fishing as an occupation. They mostly fished for self-consumption. With the introduction of prawn culture and the high income generated by it, many non-fishermen have entered the fishing profession, thereby increasing competition. Various fishing communities like the *Nolia Kandra* and *Keuta* had their own fishing techniques and special fishing grounds. The non-fishermen could fish only in demarcated areas under special licenses. The non-fishermen requested the government for recognition of their customary rights in the foreshore waters of Chilika, but this request was rejected. They, being in larger numbers, were able to get the help of merchants and middlemen, and have now forcibly entered the waters of Chilika for fishing. In some cases conflicts have arisen because of lack of fair and equitable distribution of fishery sources among the Primary Fishermen Co-operative Societies (PFCS). Under the Chilika Reorganisation Scheme of 1959 it was expected that the distribution of lease for fisheries among PFCS would be undertaken on the basis of traditional rights (*Sairats*), but erratic distribution of the Sairats led to dissatisfaction among the fishermen. The fishing grounds have not been demarcated properly. Many unsurveyed patches exist which has led to conflicts between fishermen and non-fishermen. The mapping was done in three villages among different fishermen communities. They have drawn maps to show the resource extraction area in the past and also the present area of use. They have shown the patches where the biodiversity is rich and therefore valuable. The local names by which the various fishing grounds are known have been marked. They have also shown the pressure exerted on their resource extraction area. People's mapping has been transferred to the SOI toposheet using control points. Remote sensing map shows the condition of the vegetation in the sample site.

The problems faced by the fishermen and suggestion given by them for better management are given below:

Issues

1. For spawning, the fish prefer three to four feet height of water. At present, for making pens for prawn culture, the spawning areas are being bunded.
2. Water-spread area of Chilika is getting reduced because of bunding for prawn culture.
3. Other communities with more money have now taken to fishing. The rich new entrants can pay the present high lease amount. The older fishermen cannot afford the high lease value of the *sairats*
4. Siltation has increased. Rombha mouth (one of the Chilika lagoon mouths) should be dredged.

Suggestions (based upon information provided by Madan Charan Jali and Chintamani Jali)

Action to be taken in Chilika lake

1. Practices such as; prawn culture, trawler fishing, fine net used in capture fishery and fishing in breeding season should be banned.

Action to be taken by Government

1. Subsidy for buying fishing material should be given.
2. Traditional demarcation on lease should continue, so that other villages do not create problems.
3. Leases should be given to traditional fishermen first.
4. Bidding amounts in auctions should be affordable to the traditional fishermen.
5. The federations or co-operatives in Chilika should belong to the people and not be political. The community interest should be taken care of.
6. The should federations or co-operatives should be three tired - zonal, district and state level.

Action to be taken by Co-operatives

I. Currently the co-operative society does not undertake selling of the fish. It allows sales to be conducted by middlemen who make the profit.

II. The co-operative society should sell fish, and the profit from the sale of fish should be loaned to the fishermen to solve their present financial problem. The fishermen should return the loan to the village co-operatives in instalments.

III. The co-operative society should play the role of mediator between the govt. and the villagers.
IV. It should look after the development of Chilika.
V. Every group of 4-5 villages should have one ice-factory for preserving the fish catch.
VI. The members should be able to voice their opinion freely.

Part of the catchment of Chilika Lake consists of the Danai and Patia Reserve Forests. Degradation of forestlands affects the tribals who live in them. People's movements for forest preservation have started involving the tribals and other rural poor, in protecting their neighbourhood forests under Joint Forest Management.

There is a group of five villages protecting a patch of Danai Reserve Forest. Some of these are tribal villages and others are non-tribal. A similar group of villages protect Patia Reserve Forest. Mapping exercise was done with the women and men separately and with tribals and caste groups separately. It was clear that the different groups use different areas of the forest for extracting different resources. They have also shown areas rich in biodiversity, which are of value to them. The Remote Sensing map shows the area to be under good crown cover. Biodiversity assessments of two resource extraction areas were done. One was Brahampur Reserve Forest and other was Danai Reserve Forest. Threats and socio-economic values were calculated. The valuation is recorded in tabular form. Danai Reserve Forest has low threats and high socio-economic interests as compared to Brahampur Reserve Forest.

Palamau Tiger Reserve (PTR): ***Gangetic plain ecosystem***

Chhotanagpur plateau in South Bihar is one of the major watersheds of the Sone River catchment. The plateau is covered by thick sal (*Shorea robusta*) forests and is the home of some well known tribal communities. Palamau Tiger Reserve, which is located on a part of the plateau, has been declared a protected area. However, tribal populations live in and around the PA. The mapping exercise was conducted in three villages; namely, Kujrum located inside the core zone of PTR, Surkumi in the buffer zone of PTR and Ramseli adjacent to the boundary of PTR. Since the people live in and around the PA, their conservation strategies have to take into account the provisions of the Wildlife (Protection) Act 1972 and other land tenure systems existing in the region.

The Forests of PTR comprise of Reserved and Protected Forests. Besides the Reserved Forests gazetted under the Indian Forest Act 1878, PTR comprises of the Protected Forests declared under the same Act and the *Khalsa* or *Khasmahal* Forests, which were earlier under the administration of the Civil Department. The process of notifying those Protected Forests, i.e., Old Protected Forests, and the Khalsa Forests as the Reserved Forests under the Indian Forest Act, 1927 was completed in 1978. Owing to their peculiar history, these Old Protected Forests and Khalsa Forests as well as the Reserved Forests declared after 1923 are burdened with general rights, privileges and concessions prevalent in the Protected Forests of Chhotanagpur.

The tenants of the villages near the Reserve Forests are allowed to graze their cattle (except sheep and goats) free of charge, subject to such restrictions, which may be thought fit by the Forest Officer in charge. The tenants are also allowed to remove free of cost; brush wood, grasses, bamboo and edible flower and fruits including that of Mahua from these forests.

In case of Old Protected Forests and Khalsa Forests, the villagers concerned are allowed to take: (I) timber, poles and bamboo for their domestic use, (ii) timber and poles for their agricultural implements, (iii) fencing materials, (iv) Mahua flowers, edible fruits and roots, (v) fire wood, and (vi) rearing of lac and tassar on payment of royalty.

So far as the new Protected Forests are concerned the nature and number of rights allowed to the villagers vary from village to village and these are enumerated in *Khatian* Part- II, the record of rights. In general, the rights are in respect of timber, poles and bamboos for domestic and agricultural uses; the collection of fire wood, dead and dried fallen trees; grazing with the exception of goats and sheep; collection of fruits and flowers including that of Mahua; and rearing of lac. These rights are allowed to be exercised with certain restrictions in order to safeguard the health of the forest and regeneration in annual coupes. Besides these rights as mentioned in the records of rights, there are certain customary rights which have also been allowed and which are enjoyed by the villagers subject to the control of the Forest Officer who is in charge. Such rights are in respect of collection of brushwood for fencing, way to places of worship and cremation ground etc.

The men and women of Kujrum mapped the resource extraction area. A single tribe known as the *Oraons* inhabited it. The map shows the path followed by men and women while doing their daily chores. Women collect certain NTFP products and men take the cattle out for grazing. The women marked the areas rich in biodiversity. They indicated the pressures exerted on their land especially due to crop raiding by elephants. All information was transferred to SOI toposheets. The villagers have also done a seasonality chart and matrix of useful plants.

Kujrum is a core zone village. The villagers expressed their desire to shift to a more accessible location. The reasons being; there was no source of income and no more employment on daily wages by the Forest Department is

available, as used to be the case earlier. None of the development schemes of the government are implemented in the core zone. The villagers have no *patta* (registration) for their lands and they have no social amenities like roads and hospitals.

Surkumi, the buffer zone village had two main tribal communities: the Birjias and the Korwas. Mapping was done with both the communities. The information was transferred to the toposheet. Both the communities use different areas of the forest and extract different resources for their sustenance. The Remote Sensing map when overlaid showed that most of the forest- cover was intact. Maps drawn by the Birjias and Korwas along with the map showing the same information depicted on the toposheet is given in Annexure IIIa to IIIh. The maps show the kind of details that the research team a toi tried to extract in each of the sites visited by it.

Mapping exercise was also done at Ramseli, which lies outside the boundary of PTR. The villagers extract their resources from the Reserve Forest, which seems to have become degraded now as shown by the Remote Sensing map. This village has a village ecodevelopment committee and its members are engaged in some conservation work. They have formed a small working group to take up forest protection. With the help of the Forest Department, they plan to do more conservation work for securing a continuous supply of NTFP.

Andaman and Nicobar Islands

The Andaman and Nicobar Island ecosystems are ecologically very valuable as they harbour three important and endangered ecosystems; the tropical evergreen forests, the mangroves and coral reefs.

Two sample exercises were done in Andamans. Resource mapping was done with a group of fishermen settled in the Andamans from the Indian mainland around Marine National Park in Wandur. Another exercise was done with a herbal medicine man in Husmatabad near Wandur. Resource mapping exercise was also carried out with the *Onges* in Dugong Creek in the Little Andaman Island.

In spite of empirical evidence to show how the tribals are affected by contact with outsiders, the Andaman Administration allowed the Forest Development Corporation to operate in the Little Andaman Island. The introduction of Red Oil Palm plantation on the Island to supply oil to the Lever Company has brought in a host of ecological problems. It has brought about a change in the faunal composition and the introduction of pesticides has polluted the coastal waters, besides the accumulation of industrial residues. A small portion of land in the north and a smaller patch in the south are set aside for the *Onges*. But much of it is covered by marshes. The actual area used by *Onges* for their resource collection is marked on the map. It is based on Pandya's estimate that each Onge covers an area of 2.47 sq. km. for resource collection; also the maps drawn by the Onges show the area they go to for extraction of resources.

The *Onges* discussed their problems during the mapping process. Currently, the *Onge* Reserve may appear adequate in relation to their numbers. But the government has settled many outsiders (mainlanders) on this island. The immigration is continuing. The migrants are encroaching on the tribal territory. There are other problems as well. Government is encouraging the *Onge* population to increase their numbers. Soon the *Onges* would need to use a larger area for resource collection because of their increased numbers. However, it will be difficult for them to find the additional forest land to fulfil their needs.

There were other problems the *Onges* face at present because of the condition of the forest. One of the main food items of the *Onges* is the Andaman wild pig, which is decreasing in numbers in the forest. The settlers are encroaching into the forest area and hunt the wild animals for meat. This leads to great competition for resources in the small tribal reserve. The initiation ceremony, *tanageru*, of an *Onge* boy depends on the successful hunting of a number of male wild pigs. Till the initiation ceremony is not over, the *Onge* male cannot start a family of his own. They need to have exclusive access to the resources in their reserve both for biological and cultural reasons.

Another animal, which the *Onges* hunt (*harpoon*) for food is the Dugong. They complained that they are hardly able to hunt a dugong and reported that a dead dugong was washed ashore in January 1996. They do not consume the meat of what they have not killed therefore they had to abandon it. The status of the sea grass bed seemed to be good around Dugong Creek, but the problem lies in the trapping of dugongs in the shore (*seine*) net laid by the fishermen. Therefore, there are no dugongs available for hunting. Many of the species of fish travel up the creek to fawn and the fishermen spread the net at the mouth of the creek to get a better catch, though we were informed that fishing regulations forbid this practice. Dugongs and turtles get trapped in the net at times and the fishermen just discard them, since they would be penalised if these animals were taken ashore. As it is, the numbers of dugongs are depleting and these hazards make their populations shrink further. That the dugongs are over hunted by the *Onges* may not be true since their own population has declined sharply. The dugong faces hazards created by human activities other than hunting by the *Onges* and it is now an endangered species.

The tribal territory at Dugong Creek has a dense tropical evergreen forest. There may be many medicinal herbs, which are as yet unexplored. There is a great pressure from external forces to explore the tropical forests at Dugong creek. In spite of the Tribal Welfare Department of the Government keeping the area out of bounds for others, people still hire country boats and land at the creek with the help of the unsuspecting *Onges* to go into the forest. With the application of patent laws becoming controversial in the case of living organisms, such exploitation of biodiversity is bound to create problems.

The Forest Development Corporation is likely to take up forest working. The working has not started yet as they have to fulfil certain conditions set by the Supreme Court. Once the working starts, elephants will most likely be used for hauling logs. The area to be worked is likely to be near the Onge territory. This may cause disturbance to the Onges. Besides, forest working near the Onge territory may lead to new settlements of non-tribals coming up in the area. This is an added hazard as contact with outsiders has not proved to be beneficial to the tribals in the past.

The ecosystem and the ecosystem people both are under stress in the Andaman Islands. Increasing immigrant population and economic development planned in isolation by the various government agencies has contributed greatly to this state of affairs.

The next set of mapping was done at Mahatma Gandhi Marine National Park at Wandur with the fishermen settlers. The fishermen have to cross the Marine national Park to reach their fishing grounds. At present they are being allowed to do so. Fishermen talked of harassment by the forest guards at the boundaries of the protected area. The forest department officials opined that the fishermen very often fished within the boundaries of the PA. The fishermen also reported that they were attacked by the Jarawas when they had to land on the Jarawa Reserve at times due to the boats becoming unstable or due to rough weather.

The fishermen face competition in their fishing grounds from poachers coming mostly from Burma and Thailand. Poachers come to extract sea cucumbers and other fish. The fishermen said that armed men from the mechanised trawlers belonging to the foreigners attacked them. A family of fishermen who cautiously acknowledged that they collect banned species like sea cucumbers and seashells also did mapping of routes and biodiversity rich areas.

Mapping of the resource extraction by the herbal medicine man Deb Dulal Das was done. With the help of the original Bengali books he has identified similar species of herbs in the forests and fields around his house. He reported that sometimes he identifies other species belonging to the same family of plants and checks up their medicinal properties. If satisfied, he uses them in his medicines. Very reluctantly he showed the area where the medicinal herbs are available and also the areas where he is not allowed legally to collect them.

Annexure I

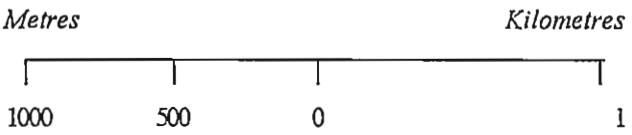
Toposheet is a map of a region drawn to the scale of 1:50,000. Scale is the ratio of distance between any two points on a map to the actual distance between the corresponding two points on the ground. It can be expressed as a statement e.g. two centimetres is equal to one kilometre; or as a representative fraction e.g. 1:50,000; or as a graphical section. On maps in addition to the statement or the representative fraction, it is generally convenient to give a graphical section, or a linear scale. The linear scale is a line conveniently divided and subdivided so that the distance on the map can be directly measured and read off from the map in terms of distances on the ground. This scale has a great advantage of remaining true, even after reduction, or enlargement of map by photographic process. [Working With Maps, 1992]

Topographical Maps

These maps show natural as well as man-made features of an area. They are usually drawn on large scales, and so it is possible to show considerable details of natural and man-made features, such as hills, rivers, forests, towns, villages, roads, railways, canals, bridges and telegraph lines, etc. On these maps, contours bring out the relief features. Individual features shown on the map can be identified on the ground by their shape and position. They are on a smaller scale than the cadastral maps and do not show the boundaries of individual properties and buildings. [Working with maps, 1992]

Linear scale is drawn as shown in Fig. 1.

Figure I



The process of enlargement is shown in the following figures. AB in figure 1 measures 1 cm. The same figure has been enlarged such that A1 B1 is three times the length of AB as shown in Figure III.

FIGURE II

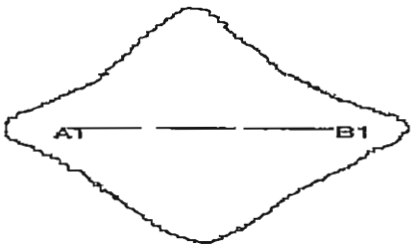
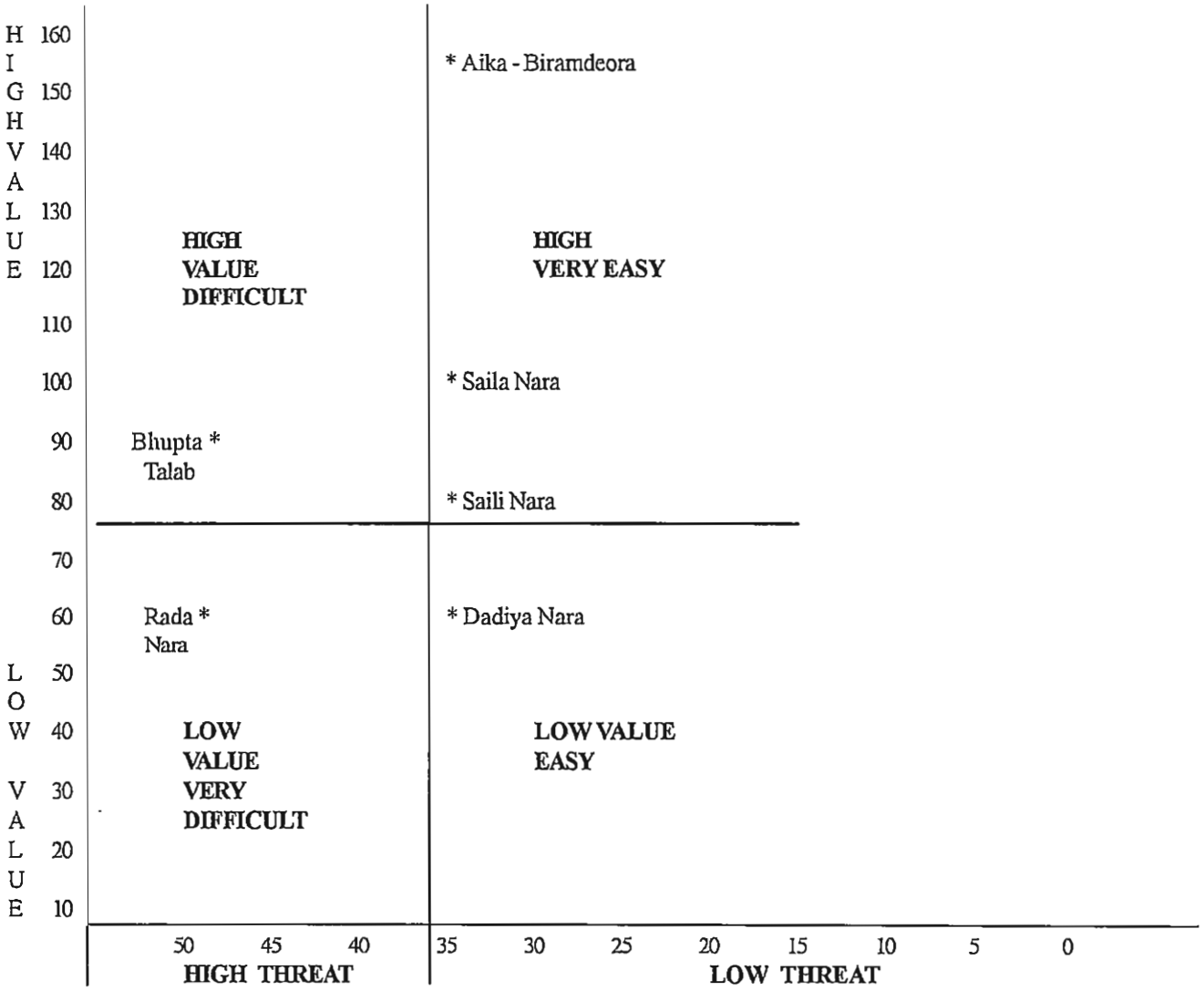


FIGURE III

Annexure II

Section A

PRIORITIZATION OF *ORANS* FOR CONSERVATION



Note: The summation of threat values is shown on the X-axis of the graph. Summation of economic values forms the Y-axis. The results of the graph show prioritisation of the six sites.
Matrix of values for threats and benefits is given in the Section B

Section B

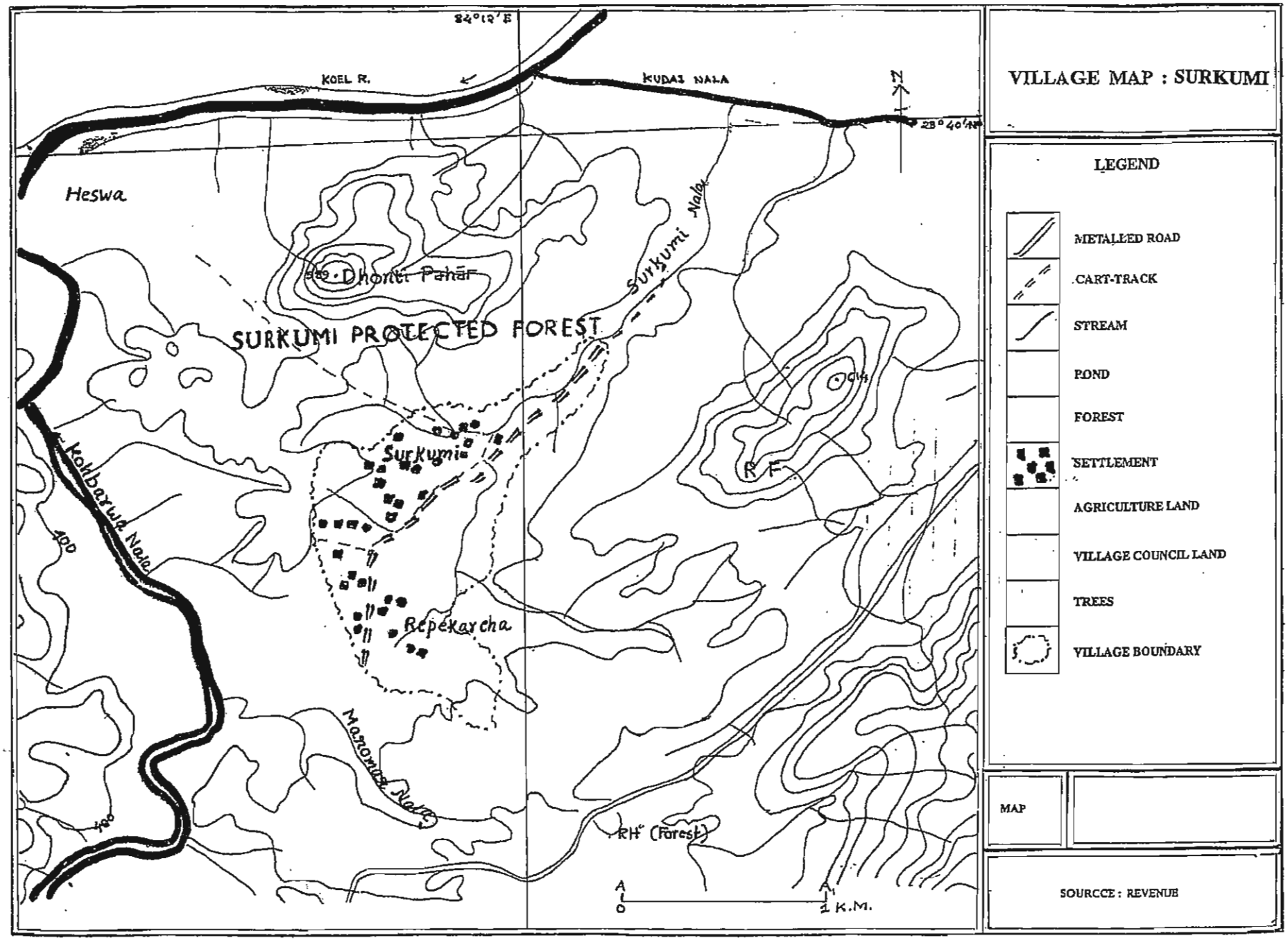
Matrix of Values for Threats and Benefits for the Five Sites

Sl. No.	*A. Parameters of threat*	*VALUES OF SITES**					
		I	II	III	IV	V	VI
1.	Grazing Intensity	2	2	2	3	3	3
2.	Presence of browse lines	2	2	0	2	2	2
3.	Presence of hedging	0	0	0	2	1	1
4.	Evidence of fire	0	0	0	0	0	0
5.	Evidence of felling	0	0	1	1	1	2
6.	Evidence of lopping	1	0	1	1	1	1
7.	Amount of litter	10	10	2	10	10	5
8. a)	Regeneration of key species of trees	1	3	3	3	3	3
b)	Regeneration of key species of shrubs	1	3	3	1	1	1
c)	Regeneration of key species of herbs	0	5	5	5	3	3
9.	Age distribution of key species	5	5	5	5	5	2
10. a)	Percentage of tree cover	4	4	2	4	4	2
b)	Percentage of shrub cover	2	1	2	3	2	2
c)	Percentage ground cover	2	4	3	4	3	1
11.	Level of threat	5	2	5	5	5	5
	SOCIO-ECONOMIC INTEREST						
1. a)	Direct economic interest						
i)	Percentage of medicinally important species, area support/contained	10	10	10	5	10	10
ii)	Percentage of forage/fodder species, area support/contained	15	15	15	15	10	15
iii)	Percentage of economically important species (other than medicinal or forage usage), area	10	5	5	5	5	10
b)	Indirect economic interest Whether the area adds to the availability of drinking water to the locals and their livestock	5	5	3	3	5	3
c)	Socio-cultural interests	5	5	5	5	5	5
2.	Uniqueness	3	3	0	3	3	5
3.	Base of gazettement	3	3	3	3	3	3
4.	Contiguity	0	0	0	0	0	3
5. a)	Percentage of endemic/endangered/rare plant species, area support/contained	2	2	2	0	0	10
b)	Percentage of endemic/endangered mammal species, site contained/support	0	2	2	0	0	10
c)	Percentage of endemic/endangered/rare bird species, site contained/support	2	2	2	0	2	5
d)	Percentage of endemic/endangered/rare reptilian species, site contained/support	2	5	2	0	2	15
6. a)	Richness of plant species per unit area	2	5	5	5	2	10
b)	Richness of mammal species per unit area	2	2	5	2	2	5
c)	Richness of bird species per unit area	2	5	10	2	2	10
d)	Richness of reptilian/amphibian species per unit area	2	2	2	0	2	5
7.	Presence of rich communities of specific						
	conservation interest	10	8	18	10	6	26
8.	Presence of breeding sites	2	2	2	0	0	2

* I. Saili Nara Oran (Doli Kala) III. Saila Nara Oran (Doli Khurd) V. Rada Nara Oran (Doli Rajgura)
II. Bhupta Talab Oran (Doli Kala) IV. Bhandra Nara Oran (Doli Khurd) VI. Aika-Biramdeora Oran

Abstract.bcp Aug. 06 '98

ANNEXURE III a



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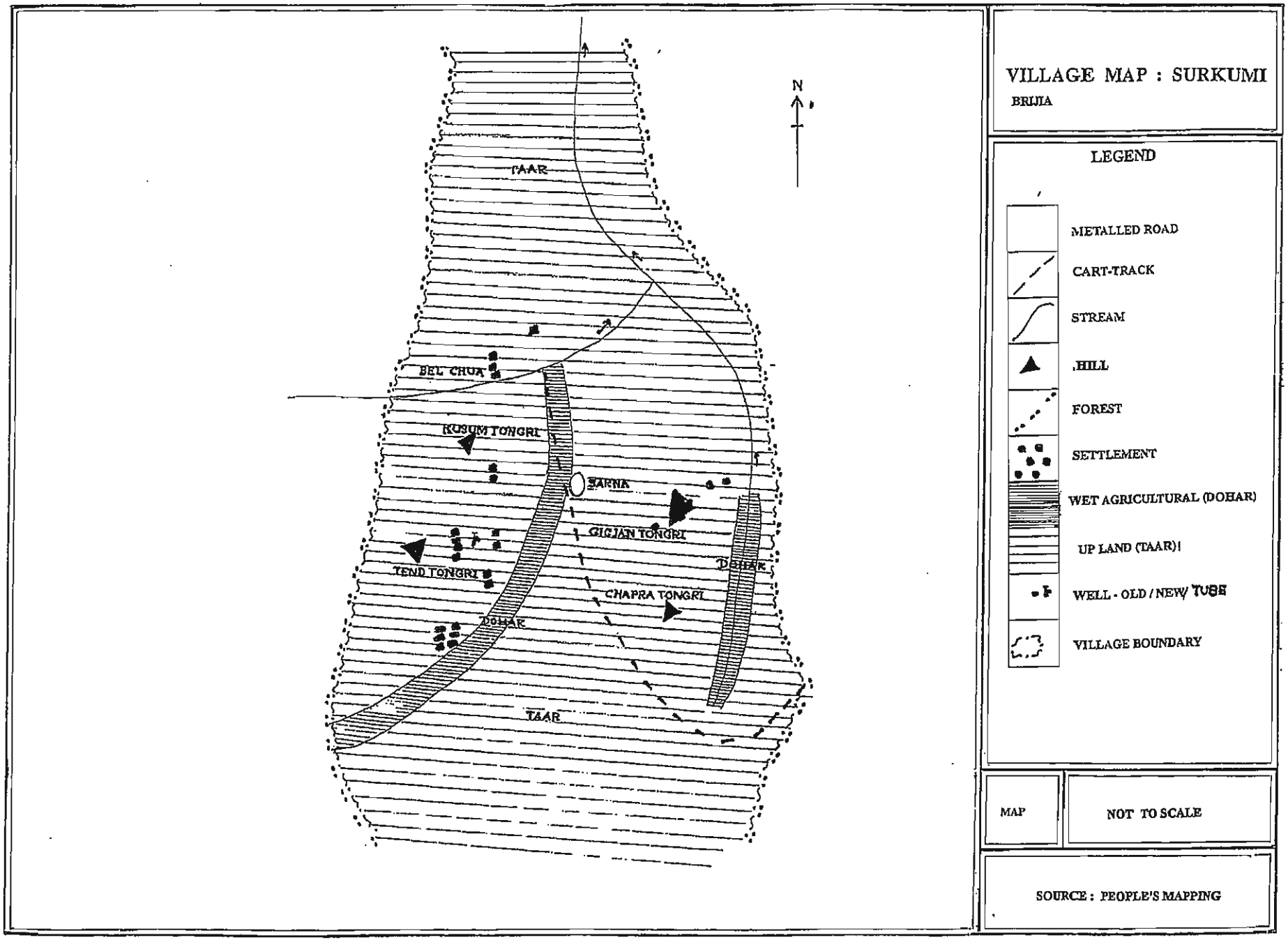

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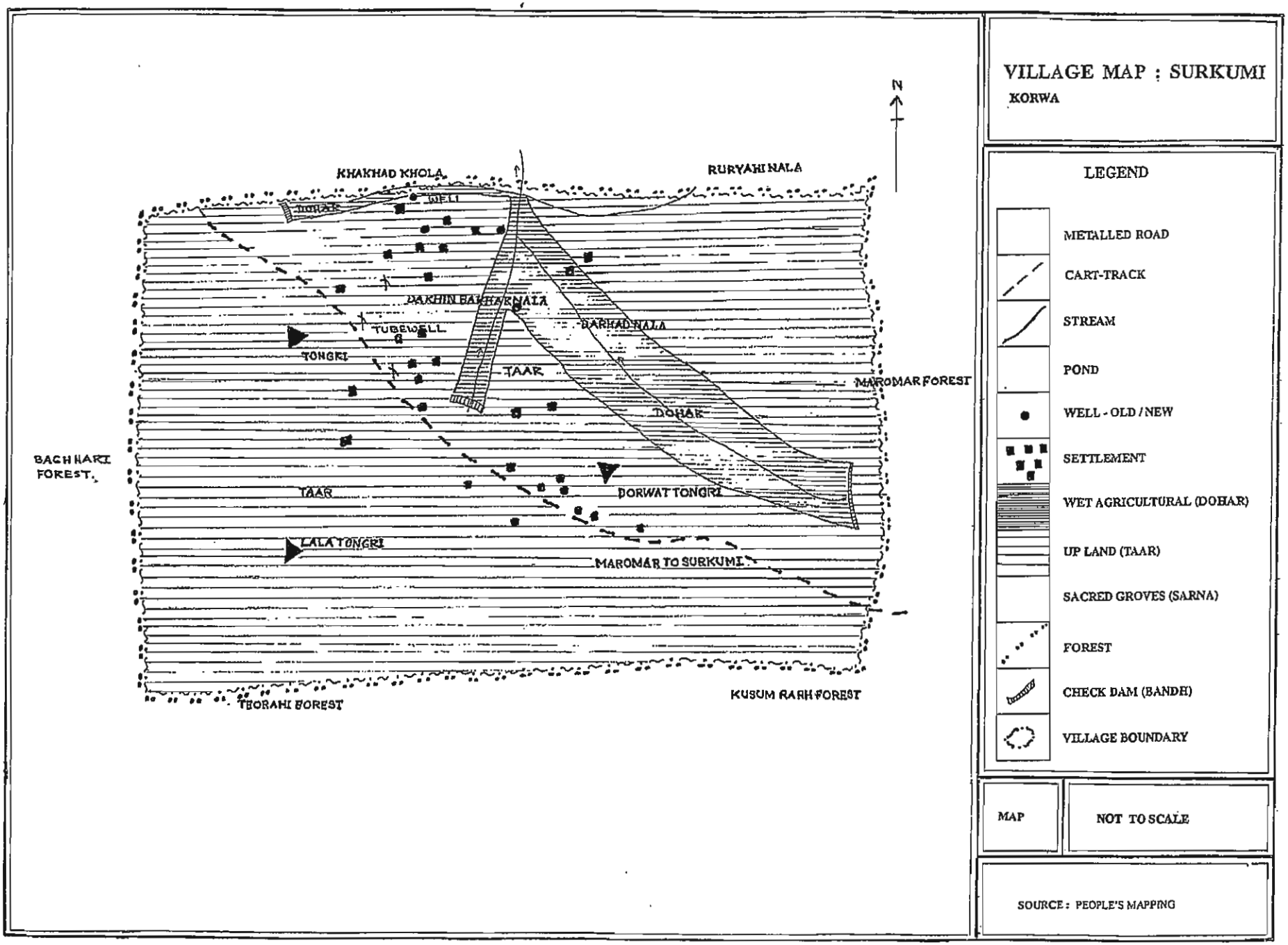

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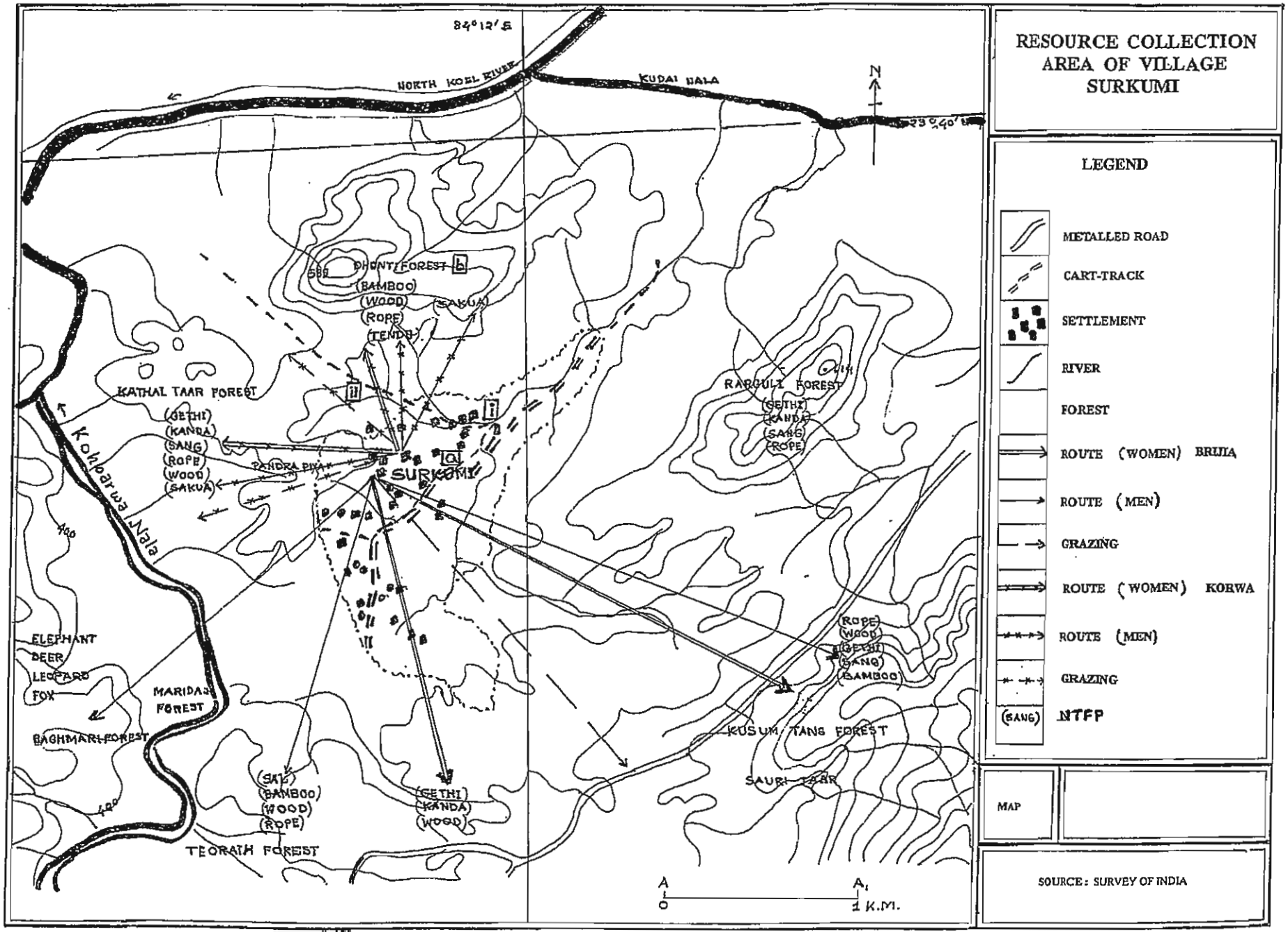

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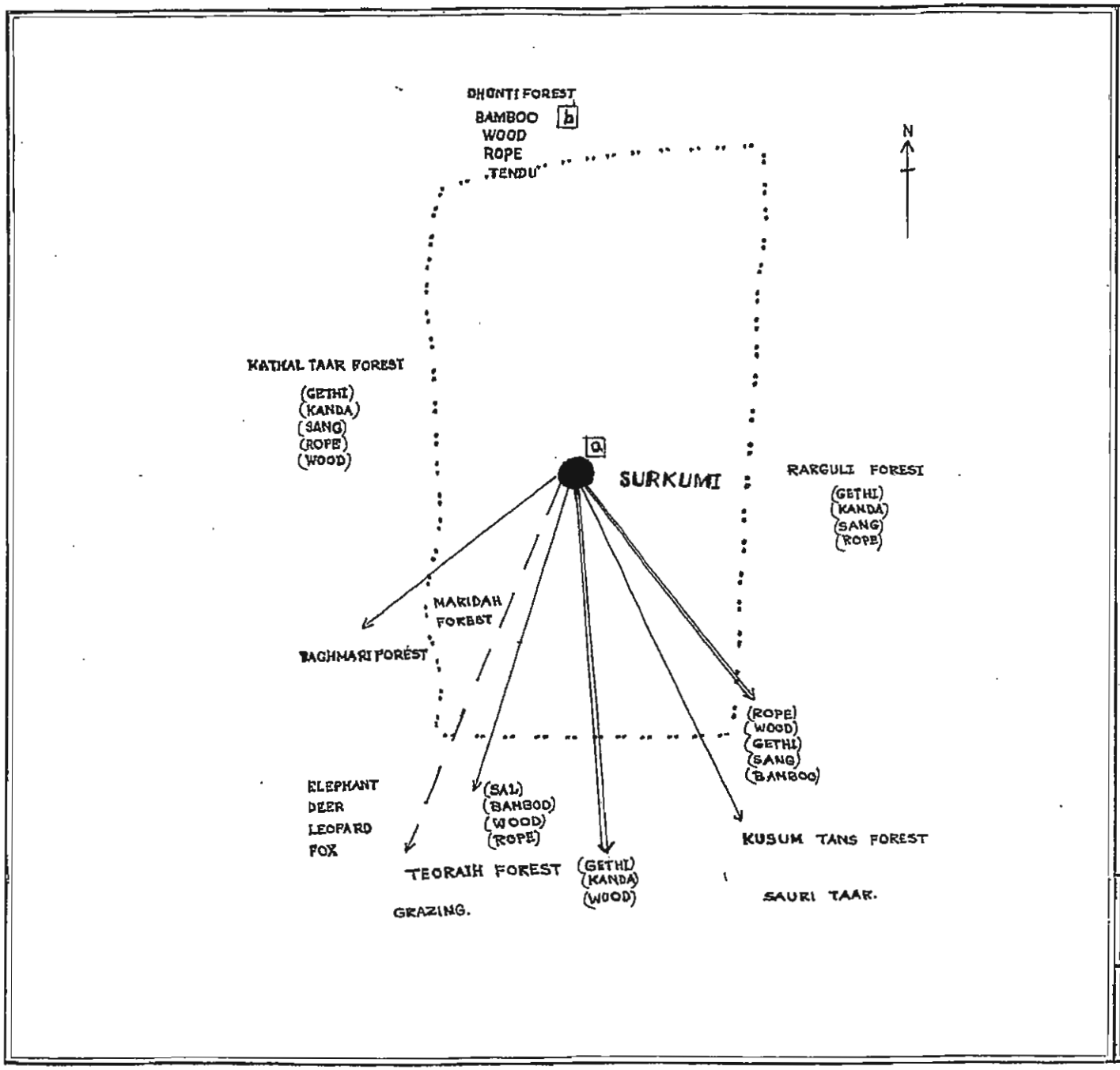


RESOURCE COLLECTION AREA OF VILLAGE SURKUMI

LEGEND

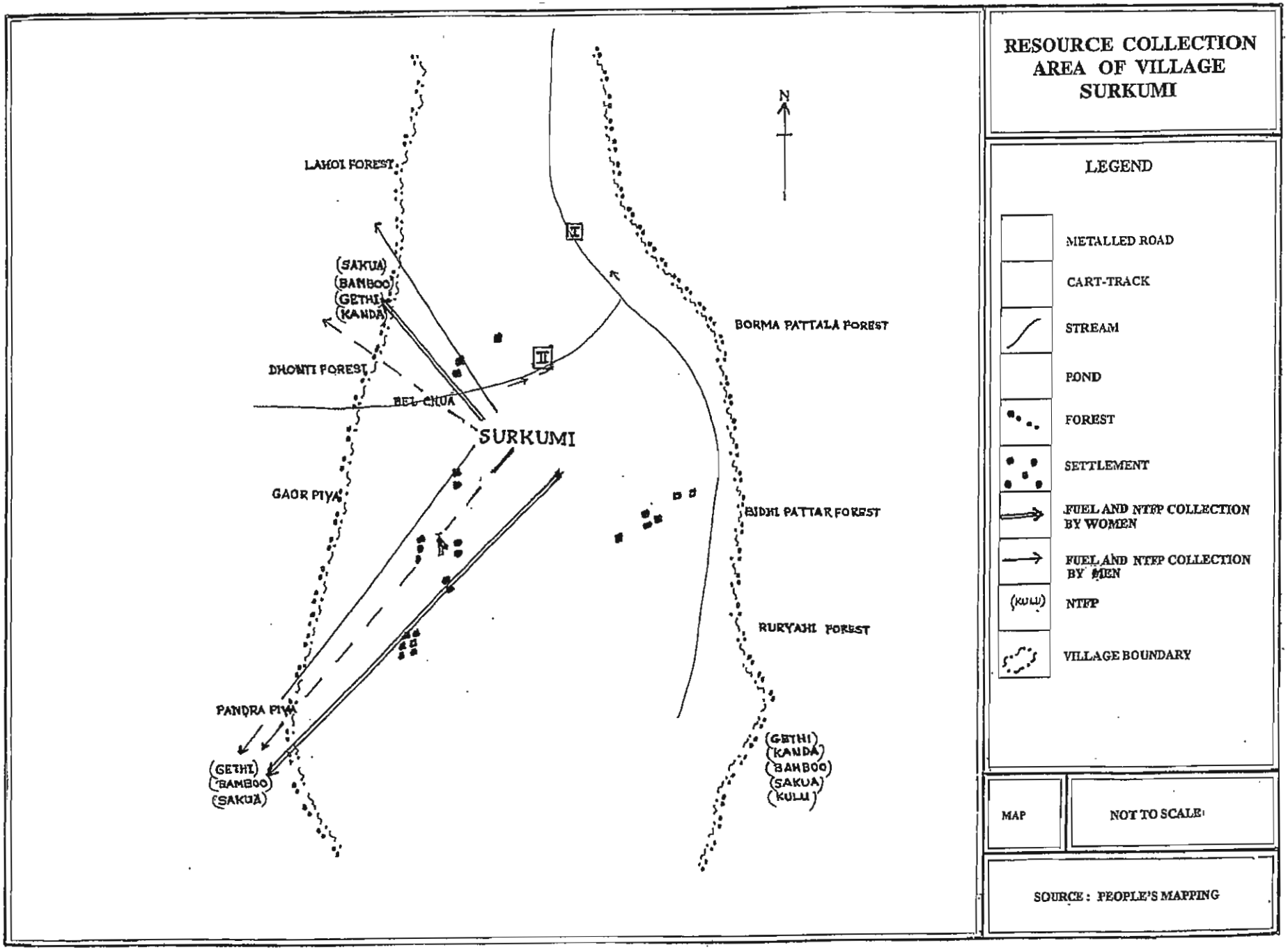
- METALLED ROAD
- CART-TRACK
- SETTLEMENT
- (WOOD) NTFP
- FOREST
- ROUTE: (WOMEN)
- ROUTE. (MEN)
- GRAZING

MAP

NOT TO SCALE

SOURCE: PEOPLE'S MAPPING

ANNEXURE III f



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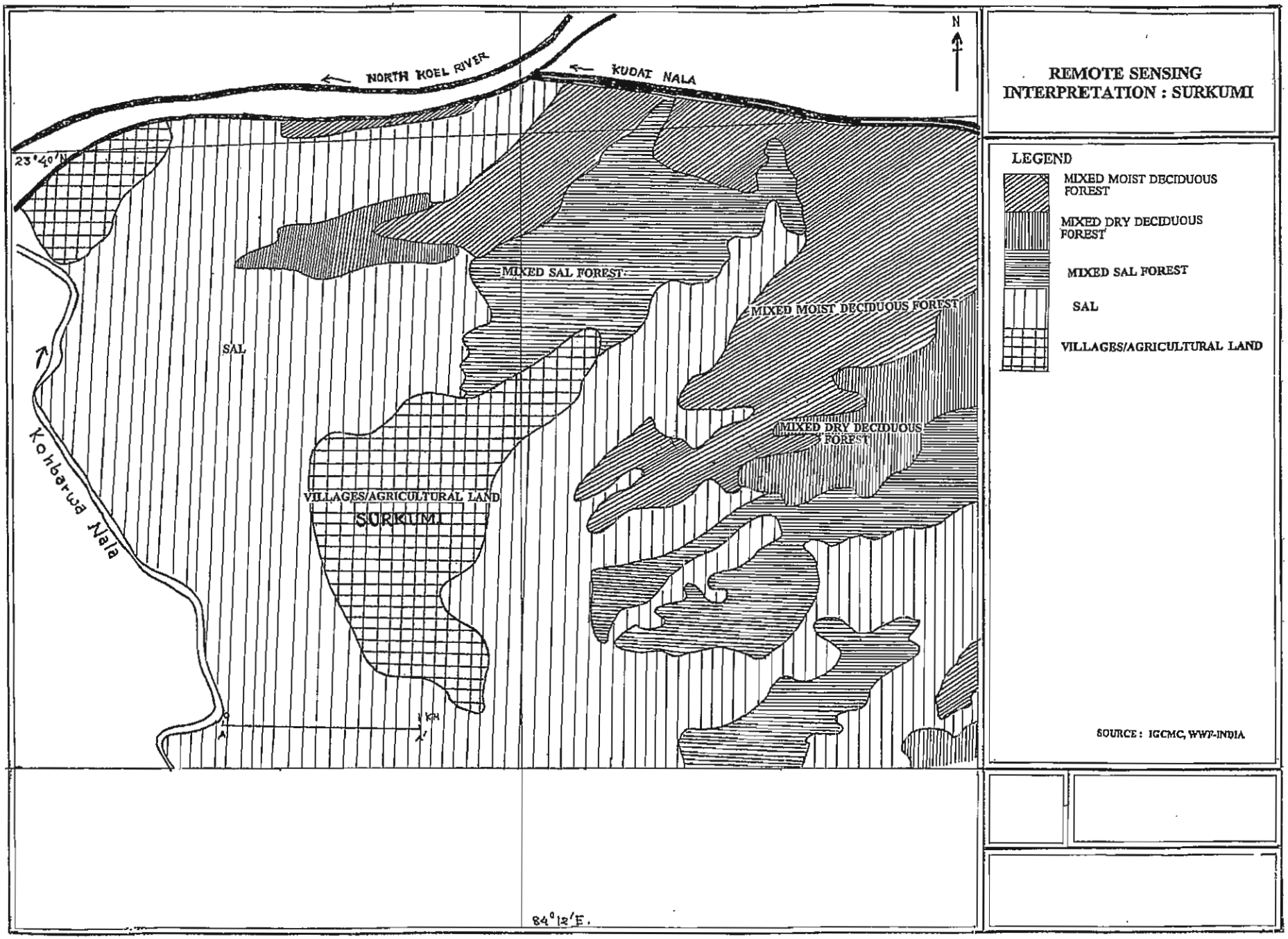
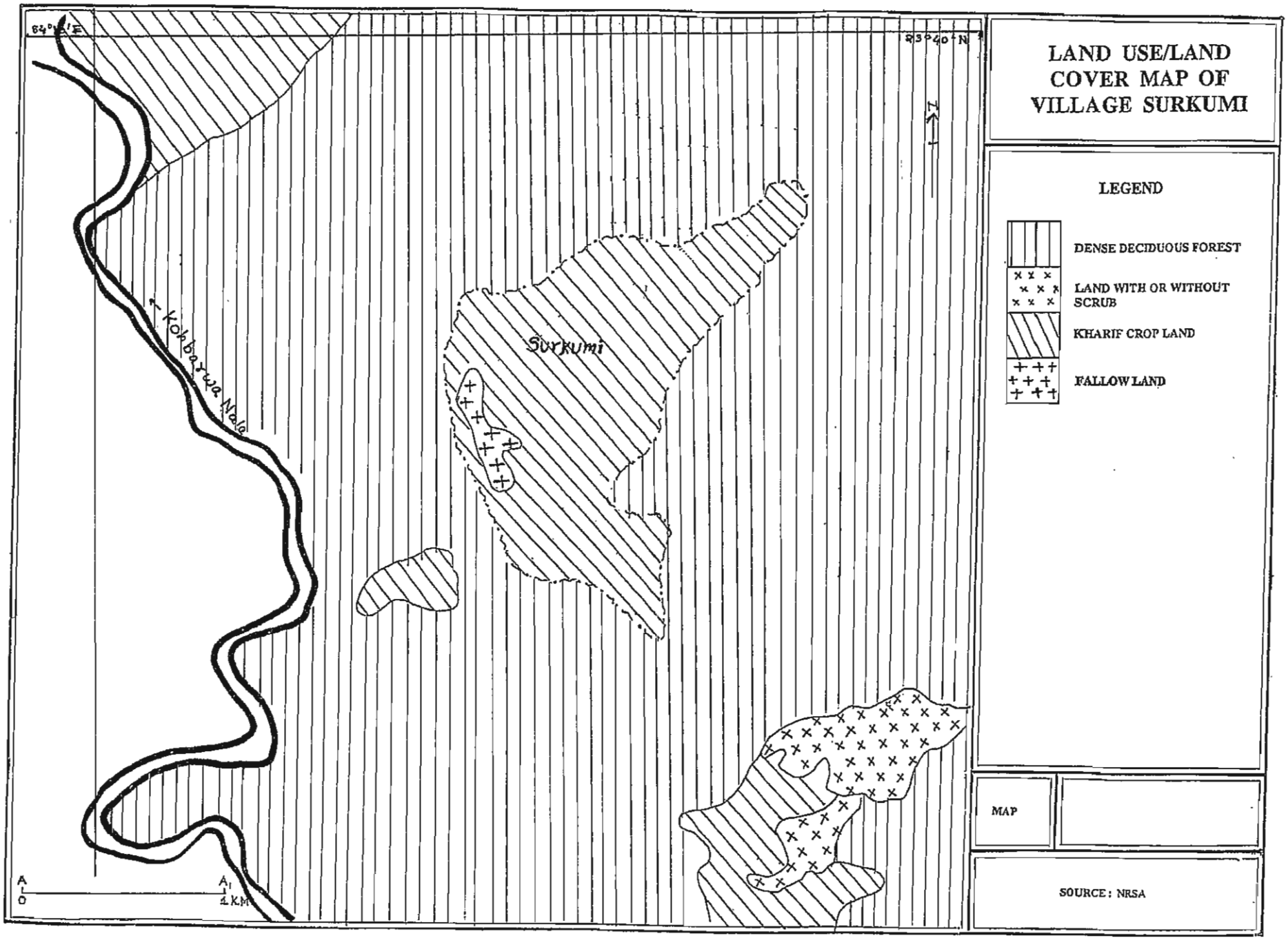


ANNEXURE III h



LAND USE/LAND COVER MAP OF VILLAGE SURKUMI

LEGEND

- DENSE DECIDUOUS FOREST
- LAND WITH OR WITHOUT SCRUB
- KHARIF CROP LAND
- FALLOW LAND

MAP

SOURCE : NRSA

THE PROJECT REPORT

Prioritising Sites

The Prioritisation of Sites
Report of Working Group of the Project Design Workshop

W.A. Rodgers

This workshop took place in New Delhi from 17-19 April 1996, hosted by WWF-India in association with other NGOs and Government, and funded by the Biodiversity Support Programme of WWF (US). The workshop formed the starting point of a larger Biodiversity Conservation Prioritisation Project (BCPP).

The BCPP has the following four primary objectives:

1.1 To develop a *participatory methodology* for setting biodiversity conservation priorities for India.
1.2 To prepare, in a participatory manner, a document describing *priority sites and strategies for biodiversity conservation in India.*
1.3 To develop, in a participatory manner, *site specific biodiversity conservation plans*, for a few sites.
1.4 To assist in strengthening the *capacity of multiple stakeholders* to undertake a scientific, independent assessment of these processes.

The workshop was for two days, preceded by a preparatory day, and consisted of plenary sessions with up to 90 people present, and working group sessions. Three working groups were established, focusing on SPECIES, SITES and STRATEGIES.

This report is for the second or SITES Group.

Report of Group Two
Prioritization Methodologies for Sites

This report summarizes the findings of Group Two. It extends the preliminary summary of results and conclusions that was presented to the full workshop on the second day. The report consists of several parts:

- **An Introduction.** This gives the Terms of Reference for the group. Lists the background reading and introduces the group membership. Annex 1 gives the full list of members. The introduction gives the methodology for the Group's working sessions.
- **A Summary of the Discussions** held on 17/4/96 (before the Meeting) and 18/4 and19/4/96 (the meeting itself).
- The Main Results and Conclusions.

Annex 1: A Conservation Matrix for Ungulate species in India.
Annex 2: A Value versus Threats Matrix for Prioritising Protected Areas in North East India (extracts from *Planning* a Wildlife *Protected Area Network in India,* WA Rodgers and HS Panwar, Wildlife Institute of India, Dehradun, 1988 - Rodgers and Panwar, 1988).

Introduction

Membership and Mode of Working

This group attracted many participants (over 60 at one stage), and included people from government, research and university, NGO and private sectors. These included conservationists, biologists (of several sorts!), resource managers, people activists, socio-economists etc!

The Group met formally on four occasions during the two days. Many members were present at an initial discussion on wetland issues the previous afternoon.

The Group was ably assisted by two rapporteurs, who rapidly word processed minutes and summary conclusions. These were passed back to participants for comment during the meeting itself. An overhead projector and blackboard allowed written and diagrammatic material to be displayed.

The Terms of Reference

These were stated as:

- To make detailed recommendations on the biological, socio-economic and other values to be considered in prioritising sites, including the indicators to be used for the different types of values.
- To recommend a prioritisation between the types of values; and, within types, between different individual values.
- To recommend the strategies to be used to arrive upon, in a participatory manner, the priority sites across ecosystems and categories of protected areas.
- To build up, along with designated nodal persons, an action plan for each type of site, indicating the type of information required, the source and status of such information, resource persons and institutions who could be involved, and a broad time schedule.

There followed a list of Ecosystems (eg forests, wetlands etc) each with a designated nodal person; and a list of three types of PROTECTED AREAS (National Parks/Wildlife Sanctuaries; Biosphere Reserves; and Sacred Sites).

This paragraph required the group to add to the recommended set of values, a practical and usable INDICATOR to assess that value, along with a methodology to identify that indicator.

This listed some questions that needed to be answered within the TOR.

This listed some key references:

No 3	BCPP. Methodology
No 4	Shekhar Singh and Bansuri Taneja. Prioritisation Criteria
No 8	IUCN/WWF. Establishing priorities for the Conservation and Sustainable Use of Biological Diversity
No 9	Ajith Kumar. Biological Values and Criteria
No 11	Kanchan Chopra. Ecological Economics

Comments on Terms of Reference

General Issues

1. The Group noted that there were three sub-groups, each with a different task. These were:

Group 1	Prioritising Species
Group 2	Prioritising Sites, Values and Strategies
Group 3	Addressing Priority Strategies for Conservation

The following comments were made on these TOR and are pertinent to the discussion:

Sites are the focus of in-situ conservation. Sites are categorised initially by the two biodiversity attributes of species values and ecosystem/community values. Group I should therefore have had the task of developing methodologies for both these parameters. Both are important. Both are recognized as key components of biodiversity (the third component-genes- is not easily treated in the same way). One site may be the only site where a particular community occurs, but that the species making up that community may not have especial significance. Another site may have a widespread community but that community is enriched with a species found nowhere else. (We note that some of the literature assumes communities would be covered, but this is not explicit)

Group 2 then would have had the benefit of both of Group One's sets of parameters as to biological value of sites; allowing us to apply the second stage socio-economic filter to the initial prioritisation. We note that the pattern of human use of sites is dictated mainly by the nature of the site communities (ie a forest or a scrub grasslands) not usually by the component species.

2. There was insufficient time to debate WHY we were prioritising species and sites and plans. What was the purpose of these priorities? What was specifically wrong with the present less prioritised system, and why? This would have helped focus our attention on what our prioritisation was for. This leads back to the question as to "Why are we conserving biodiversity?". WHAT ARE THE OBJECTIVES OF CONSERVATION? How can they be stated in a way that can be verified!

Issues Specific to Group 2

We would have benefited by having had access to the conclusions from Group 1 before we started work. This was not possible given the workshop design. In reality the two sub-groups would have been better if they were sequential, not overlapping in time, and shared some group members.

We realised that the value systems of terrestrial dryland communities were different from those of aquatic communities including marine and wetland systems. This is especially true of ecological functions, and of the nature of threats facing the communities. Wetlands can be destroyed by events taking place hundreds of kilometres away.

We had a large and diverse group of people. This made the discussions more rewarding in one sense, especially in the fact that we gained wide consensus. However, in another way, reaching that consensus took time, and time was scarce. The large group meant that many people were not able to participate effectively in discussions!

Key Statements from the Literature that was Distributed

The Group discussed the issue of what would be the main framework for assessing sites:

Ecosystems or Biogeographic Zones?

The documentation distributed at the workshop states:

> "The primary prioritisation exercise is being taken up at an ecosystemic level" "Subsequently, the prioritisation exercise would be analysed in terms of states, biogeographic zones etc"

We were in disagreement with this. This primary prioritisation must be at the level of Biogeographic Zone, not Ecosystem. Ecosystems change so rapidly in space (forest, wetland, grassland within a kilometre; or within 1000m of altitude; mudflats, mangroves and sand-dunes along a shoreline) that they do not allow simple characterisation of sites. Ecosystems also change in time – forests degrade to scrub, grassland undergoes succession to forest.

This issue is taken up in detail within Rodgers & Panwar (1988), where the primary framework is the biogeographic classification at:

Primary level	the Zone	eg The Western Ghats
Secondary level	the PROVINCE	eg The Mountains, not the Plains
Tertiary level	the Land Region	eg The Nilgiri Hills

The ecosystems (or biomes as they are referred to), such as Evergreen Forest, Deciduous Forest, Montane Grassland etc; come fourth in the list: eg The Nilgiri Hills has evergreen forest, deciduous forest and grassland biomes.

The Role of the States?

We were pleased that the documentation mentioned that the STATES would form one level of analysis. However no further comment was made in the documentation.

The workshop Group saw the role of the States as being of great importance. In a way the STATES of INDIA are similar to the COUNTRIES of the WORLD. Each carries responsibility for the resources that it contains. The Convention on Global Biodiversity says that one country has the moral responsibility to conserve its BD values on behalf of the Global Community. Similarly, the STATES have the responsibility to manage their resources, including Biodiversity, for the greater good of the NATION. The Central Government carries a reciprocal responsibility to assist the States, both materially and financially, in the discharge of their duties. There are thus two sets of priority questions:

> What are the priority AREAS that each STATE must create for Biodiversity?
> Which of these areas are priorities for the CENTRE to FUND?

The Sites are the Protected Areas

The documentation is not very clear on this. Document 3 (page 1 para 3) says that in addition to the SITES being prioritised, the PROTECTED AREAS will also be prioritised, using the same criteria. We did not buy this distinction!

A SITE is assessed in terms of its Biodiversity Attributes. If those attributes are of sufficient magnitude, then that site is recognized as a Protected Area. Note that awarding PA status is in itself the first stage of setting biodiversity priorities. PAs are a higher priority for biodiversity conservation than non-PAs.

PAs can be classified within several categories. The greater the value of the attributes of a PA, then the higher the level of classification that should be awarded. Sites could be categorized as a National Park, or as a Wildlife Sanctuary or as a Reserve Forest (or all three in different parts, thus allowing zoning of use INSIDE a PA; or even as overlapping parts if necessary!).

What and where are the sites that we should prioritise? We believe that there are many types of sites (or correctly there are many different lists of sites!). A site prioritization exercise could consider:

> The EXISTING PAs (of which there are over 600),
> POTENTIAL PAs (ie those on Rodgers & Panwar 1988 list, a further 100),
> Wetland Sites (with their own list of almost 200 sites),
> THE RESERVE FORESTS, (a huge list)
> OTHER PATCHES NOT YET IDENTIFIED AS NEEDS OR AS OF VALUE.

Objectives of Conservation and Prioritisation.

Since the Delhi Workshop, BSP (US) have distributed further literature, including:

Nels Johnson 1995 Biodiversity in the Balance:

Approaches to Setting Geographic Conservation Priorities. BSP WWF. Washington DC.

This makes excellent statements on objectives mirroring the discussion in the group in Delhi.

One of the perils of establishing biodiversity priorities is setting them in isolation from clearly defined conservation goals. Goals within the CBD or Agenda 21 are so broad that working definitions are left to countries/institutions to spell out! GEF Definitions capture only global objectives, we are clearly concerned with national and local objectives as well.

What is needed under a broad conservation goal is a series of specific objectives to conserve biodiversity, encompassing the range of biodiversity values (eg scientific, economic, cultural, moral etc).

Note that this breadth of objectives will, in all likelihood require different sets of priorities determined by more than one approach.

He gives examples of goals and objectives.

Conservation Goals and Objectives

The Goal	Protecting and using biological resources in ways that do not diminish the world's or the nation's variety of genes, species, habitats and ecosystems.
Objectives	To maintain (and recover): • Biodiversity in representative natural ecosystems/habitats, • Biodiversity in landscapes where agriculture, forestry, grazing and fisheries are dominant uses. • Threatened and endangered populations of wild species. • Agricultural and other important spp and wild relatives. • Species and habitats of social / sacred significance. • Ecosystems of key evolutionary significance – refugia.

EACH of these may need different priority setting methodologies, different data sets, different stakeholders and even different categories of Protected Areas (as well as non PA methods)!

pp 102–103 in Nels Johnson.

Notes on the Deliberations of the Sites Group on 18/19 April 1996

The Group discussed and accepted certain basic assumptions which would underpin the whole pattern of deliberation of the workshop. This discussion brought together all the diverse members of the Group (ecologists, biologists, managers, social activists, economists etc). The assumptions were as follows:-

General Assumptions

That the Conservation of Biological Diversity is good for Society in general, including Society in India.

That there was need to increase the extent and efficiency of biodiversity conservation activity in India.

That Society has other uses for land, apart from that of conserving biodiversity.

That the efficient Conservation of Biological Diversity is thus a compromise between the above two statements. We need to allocate land to both biodiversity and non-biodiversity uses, according to some agreed statement of objectives and priorities. Our task is to find the methodology for making these priorities. (This task starts with acceptance of the objectives).

Biodiversity is only one of the many values of natural resources. The Group clarified that natural resources have many uses eg: ecological functions, resource production, recreation and aesthetic uses etc. We are primarily interested in biodiversity values, and we note that biodiversity is wholly compatible with some other uses (eg catchment protection), but less so with others (eg intensive timber production).

In-situ conservation (ie creating a system of Protected Areas or PAs) is the preferred conservation strategy. This can be augmented by, but not replaced by, ex-situ conservation measures (eg zoological gardens, seed banks etc). The sites that we are prioritising are these PAs.

India has a global responsibility for the conservation of biodiversity. India's ratification of the Convention on Biological Diversity signifies her acceptance of that global responsibility.

It is recognized that biodiversity values are not distributed equally. Biodiversity richness varies from one locality to another. There is need therefore, for prioritisation. Internationally some countries are richer than others. India is recognized as a 'mega-biodiversity' nation. This unequal distribution is found WITHIN country as well. Some areas in India are 'Biodiversity Hotspots', eg the Western Ghats and the Andaman and Nicobar Islands, and so these areas and the sites they contain become priorities.

Prioritization is necessary as India does not have the available land nor the human and financial resources which are necessary to conserve adequately all examples of biodiversity value. Resources should ensure the maintenance of key or priority areas.

Information Needs

We need adequate information on the biodiversity values of India (species and ecosystems mainly at this stage) so as to:

(a) ensure that biodiversity values are captured in Protected Areas, and
(b) to be able to prioritize amongst these PAs on the basis of their biodiversity values and other criteria.
(c) To monitor the effectiveness of biodiversity conservation efforts.

Although information on biological diversity does exist, there are gaps in this information, and deficiencies in the analysis and dissemination of this information. There is a need to prioritize these information deficiencies and seek urgent mechanisms to collect adequate information.

Whilst there is a need to fill the information gaps, there is an even more urgent need for action in prioritising Protected Areas and ensuring improved conservation measures. Improved Conservation CANNOT WAIT for improved information flows.

Prioritization Mechanisms

Since there have been other prioritisation exercises in the past, in India and in other areas of the world, we must learn from these other exercises and not re-invent the methodological wheel!

Conservation evaluation will need a mixture of top down and bottom up approaches. The management of PAs must involve people. People's issues must therefore be brought into the evaluation and prioritization mechanisms. While society at large, including the International Community, benefit from biodiversity conservation, it is the local people who bear the bulk of the COST of biodiversity conservation. It was stressed by Professor Kanchan Chopra (an economist in the group) that socio-economic issues have to be considered as there is a socio-economic cost involved in the conservation of biological diversity. She felt that in many cases if the local and national socio-economic costs were not considered along with the global biodiversity values the process of site prioritisation would be non-participatory. However, most people in the group felt that biodiversity values should be the primary criteria for prioritisation of sites; socio-economic costs was a necessary secondary filter for prioritisation.

Different categories of sites (PAs) will be needed for different conservation situations. This may include different habitats (eg wetland systems as opposed to terrestrial systems), as well as differing levels of human intervention which may be permissible. These different categories will have to be brought into the prioritisation process.

Key Elements of the Discussion Following the Assumptions

The link between Group Two (Sites) and Group One (Species) discussions was stressed. Sites are not of value in themselves. Sites are of value because of their component species (and communities) values. Sites will be classified (and so prioritized) in the first instance on the basis of their species (and community/ecosystems) complements. Sites with more species etc are intrinsically more valuable than those with fewer species etc. Sites which lose their species components are no longer of biodiversity value!

General

We are concerned with developing a Protected Area system or network, not with identifying individual areas. We are not here to recommend sites or the details of the Network, we are here to suggest a methodology to prioritise the sites (existing and proposed) that make up the network.

The formulation of the basic goals and objectives of biodiversity conservation is the first step towards prioritisation. Objectives need to be stated clearly in a way that allows verification, and would include:

(a) Objectives that fit individual sites, as well as objectives for the PA network as a whole.
(b) The retention of the samples of the full range of species and ecosystems within selected sites (PAs). But what does this mean? For example if the conservation of a rare species is to be an objective, then how do we accomplish that objective? Creating a PA for that species becomes a priority action to meet that objective. But when can that species be stated to be adequately conserved? When the formal status becomes satisfactory (use IUCN categories)! And that definition for ungulates is met when there are TWO PAs, each with 1000 individuals. The priority then becomes TWO sites for that biodiversity value not one! (see annex 2).
(c) The sites (PAs) should include those that address the conservation of rare species, of diverse areas, and of representative ecosystems.

(d) There would be other subsidiary goals like: a certain percentage of the area of a country to be brought under PAs. Protection of natural processes of evolution of species. Equity and participation of people etc.

Some ecosystems eg. grasslands, coastlines (apart from major mangroves) and wetlands do not have specific resource protection categories, (eg Reserve Forest for forests) apart from when those values fall within the NP/WLS categories. There is need for such conservation mechanisms to be considered.

It was felt that the sites selected should be protected at a variety of PA types, which will emphasise conservation (ie core areas as Parks and Sanctuaries) as well as peripheral areas where it is possible to allow people's use of resources, RFs and buffer zones etc, as well as more traditional categories. Important issues rising from this conclusion are:

(a) The process of prioritisation has to be an ongoing one, it will not be a static process. Although gaps exist in the information that is available, there is enough to prioritise on a scientific basis. However, existing gaps need to be highlighted to stimulate gathering new information needed for future prioritisation.
(b) Existing PA boundaries may need to be redefined. This will be needed in cases where areas of high biodiversity lie outside the boundaries of existing PAs.
(c) Many PAs have fragmented habitats. And many of the PAs are too small to be able to provide viable habitats. Questions of viability are important for prioritisation.
(d) New sites with potential for biodiversity conservation need to be identified and prioritised. Identification of the sites should follow identification of the needs.
(e) The objectives of use within PAs may need to change. At present, PAs (NPs and WLS) in India do not allow any resource use. However, sustainable utilisation of some resources in PAs could lead to increased acceptance of biodiversity conservation. This principle has been accepted by the IUCN.

The importance of micro-sites of biodiversity value should not be overlooked. This is of especial interest in the case of conserving plants and wetlands.

Often, there is a conflict between local, national and international priorities. It was stressed that a mechanism was needed to reconcile the conflict between values at international, national and local levels. It was also pointed out that at present there is little integration between biodiversity conservation and developmental activities. One step towards this integration would be to prioritise biodiversity conservation in the way in which developmental activities have been prioritised.

Methodology for Prioritisation

There was broad agreement that both biodiversity values as well as socio-economic values need to be considered for prioritisation. However, the primary criteria should consist of biodiversity values. Socio-economic issues follow as a second set of parameters, by which the first list is "sieved" to remove sites non-suitable on socio-economic grounds or enhance sites which have positive values on socio-economic areas.

The Biogeographic Classification as proposed by Rodgers and Panwar (1988) should be followed as a framework for prioritisation, at least to the levels of Zone and Province. Ecosystems would follow within the Province level.

Biodiversity is classified at the level of genes, species, communities/ecosystems. All these elements of biological diversity require consideration in conservation planning, especially ecosystems and species. Ecosystems have to be classified at greater detail than the broad categories of forests, grasslands, wetlands etc. Use of the "community" classifications of Champion & Seth or the Meher-Homji school (useful south of the Ganges) was advised.

The biodiversity values to be considered at the level of ecosystems, communities, species and genes were agreed upon. These were representativeness, uniqueness, naturalness, endemism, richness, rarity, and major populations and size. This follows from the Species Group 1. The matrix thus developed is given below. Comparisons of richness and endemism should be made within ecosystems.

CHARACTER	*ECOSYSTEM*	*COMMUNITY*	*SPECIES*	*GENES* **
REPRESENTATIVENESS				
UNIQUENESS				
NATURALNESS				
ENDEMISM				
RICHNESS				
RARE SPECIES				
MAJOR POPULATION				
SIZE (and VIABILITY)				

(** we gave little attention to the genetic level. Subspecies of major mammal taxa are already important –eg swamp deer and red deer, consideration of purity in wild buffalo, etc).

Groups of organisms which could be used for defining the values given above include: birds, mammals excluding chiropterons (bats) and smaller insectivores and rodents; and woody plants. Some insect groups – butterflies, Saturnidae moths etc could be used where datasets allow.

Where there is an absence of species data, surrogate indicators like woody plant and grass communities could also be used: using the communities of eg: Champion and Seth classifications.

The nodal persons for each region will have the responsibility of bringing together regional experts on ecosystems and sites, building up an initial list of sites to be considered for prioritisation, and filling up of information gaps. This will be done through a series of regional workshops. The methodology could also be tested at the level of grassroots workers who have extensive knowledge of certain local sites.

It was decided that data for prioritisation would be collected by the Nodal Person for each ecosystem through expert workshops where available information would be used for ranking of sites. However, a few pilot workshops would be held to see how they work and to iron out any difficulties which may arise.

It was also stressed that global experience suggested that determining a single specific number to characterise the value of a site was not practicable. It would be more feasible to rank areas according to their relative importance and priority among each other from among several perspectives. There could be several categories of priority, for example a site being within Priority Class A or Class B etc. In general, a site containing a multiplicity of ecosystems would have a higher rank than a site having single ecosystem.

The group had only discussed the methodology for evaluating large biodiversity sites. The methodology for evaluating micro-sites had not been discussed. Some of the parameters which could be used for micro-sites were: location within a hotspot, presence of certain indicator species, proximity to a PA, location within fragile ecosystems etc.

ALL PUBLISHED METHODOLOGIES FOR PROTECTED AREA SELECTION AND PRIORITISATION RELY ON AN ADEQUATE DATASET OF PRESENCE AND ABSENCE.

Methods which move away from adhoc and subjective selection NEED quantitative data (or at the very least objective qualitative data) on the values of the potential protected area. The literature then abounds with sophisticated computerised techniques, and comparisons of the advantages and disadvantages of these techniques.

However, the literature does not tell you what to do when there is no such dataset! This is the situation that we have in India:

- We do not have for even the larger WLS/NPs a comparable dataset which indicates the bird or mammal faunas (apart from the larger animals),
- There is no sign of an urgent inventory process to collect such information. Note that information on the rarer species is of importance in PA selection. Merely cataloguing the obvious species is not enough.
- For some of the areas we do have information on forest communities (using Champion and Seth categories). But this excludes the non wooded formations. It is worth experimenting with such an attempt to classify PAs using such data. If nothing else, it will stimulate discussion, and start a process of numerical analysis. (Rodgers and Panwar 1988 list C & S categories for larger PAs and some prospective PAs. Further information exists in Forest Working Plans etc).

Socio-economic Issues

The socio-economic values to be used for prioritisation would include natural resources, ecosystem services with water being the most important value, and cultural/ religious values.

It was stressed that the socio-economic values had also not been discussed adequately. One important issue emerging was that when talking of socio-economic values, the distinction between the value of direct goods (biomass and incomes), and value of indirect goods (services of better water and soil regimes), from a biodiversity site needs to be made. In general, while the value of indirect goods/services can be added to biodiversity values, the value of direct goods should be subtracted from them. There was some difference of opinion on the above. It was felt that in case the level of extraction of direct goods is sustainable, their value may not necessarily detract from the biodiversity values of a site.

One way in which extraction of direct goods could be treated would be to differentiate between extraction for subsistence or for commercial use. Another distinction would be that between extraction by the State and by Local people.

The Chairman stated that this issue needed to be discussed in much greater detail, and many more example of areas where a certain level of human interaction is good for biodiversity need to be identified and studied. For this purpose, a working group may need to be set up.

This led to discussion on whether some human disturbance in a natural system is good for biodiversity or not.

There was discussion on what strategy should be adopted in the case of nationally important economic resources eg minerals, oil etc. being found in biodiversity

rich sites. It was felt that if the extraction of resources from a biodiversity rich site would lead to its obliteration, whether it should be resisted or not would depend on the relative importance of that particular site. In case of it being a unique site, every effort should be made to resist its take over for commercial/economic purposes. However, if the site in question was one among several representatives of an ecosystem, it could, perhaps, be sacrificed. In this connection, the possibility of using zonation as a strategy could also be used.

The need for having a variety of sites ranging between strict nature reserves to sustainable resource use areas was reiterated, especially keeping in mind issues relating to social equity and justice.

The issue of evaluating threats for the purpose of prioritisation could not be resolved. It was suggested that a working group was needed to look at this issue in detail.

Wetlands Issues

Discussions focused on terrestrial systems and so rather neglected the wetlands and coastal & marine areas. It was felt that while wetlands could be ;discussed in the larger group, a separate group was needed to look at coastal and marine areas. The deliberations of this sub-subgroup are not reflected later in this report.

The workshop session on 17 April discussed the values and criteria that could be used for setting priorities of *wetlands* conservation. These notes were presented to the full workshop group without disagreement and are used here.

Wetlands values which are of conservation value include:

Biodiversity values
Hydrological/Ecological values
Socio-economic values for local people (eg. fishing, support to livestock maintenance etc)
Socio-economic values for society at large (eg. aquaculture leading to earning of foreign exchange)
Recreational values (eg. Tourism)
Cultural/Religious values.

Note that a parallel set of values for prioritising forests would be:

Biodiversity values
Catchments for important waterbodies
Socio-economic values for local people (eg. Non-timber forest produce-NTFP- extraction)
Socio-economic values for society at large (eg. timber extraction, industrial raw material etc)
Recreational values
Cultural/Religious values.

The size of a wetland was queried. Can this be used to determine priorities, with small sites being excluded? Size cannot be the only determining factor. For example, the tanks in Saurashtra are individually very small. However, together, they form a network which supports important species like Demoiselle Cranes. A similar example is that of the tanks of Tamil Nadu. A parallel was drawn with dry grassland systems in that the small fragmented habitats of the Great Indian Bustard in the GIBS Sanctuary in Maharashtra are important as a network, but are insignificant if looked at individually.

The discussion looked at strategies needed for effective protection of wetlands. It was pointed out that there is no legal provision for managing or protecting a wetland unless it is notified as, or is a part of, a National Park, a Sanctuary or a Reserved Forest. However, the existing provisions of the Wild Life Protection ct (WLPA), the Indian Forest Act (IFA) are not adequate for protecting wetlands. It was felt that either a completely new act is needed for providing legal protection to wetlands, or the EPA (Environment Protection Act) should be utilised for this purpose.

Often the problems of managing or protecting a wetland originate in its catchment. Therefore, it may be strategically better if the existing legal provisions are used for protection of the catchments of wetlands.

It was felt that the traditional core/buffer concept of management of forests was not applicable to wetlands since both biodiversity and pressures on it were concentrated on the edges of wetlands rather than at their centres. One way of promoting awareness of issues in wetland protection could be through highlighting their cultural values.

The criteria to be used for determining the biodiversity value of wetland sites were discussed. These were:

Has an important flagship or indicator species
Is an important breeding ground
Has a unique ecosystem, or habitat of a unique species
Has high species diversity
Is a natural ecosystem
Is important for migratory species
Supports mobile non dependent species in droughts, and in the dry season

Communities of species can be used as criteria for determining the importance of a site.

The RAMSAR Bureau has developed a set of criteria for determining the importance of wetlands. However, the lack of availability of data on wetlands is a problem. There was also a problem with the total number of wetlands identified. While it was thought that a comprehensive listing may not be possible, one could look at the following:

RAMSAR sites
Wetlands within National Parks and Sanctuaries
Directory of Indian Wetlands and site questionnaires.

Given the lack of data about wetlands, it was felt that perhaps a task force needed to be set up to develop criteria for values of wetlands and identify information gaps as well as methodologies for plugging them.

The need to develop a national wetlands management policy which would also take into consideration wetlands which are located in revenue areas was stressed.

Coasts and Marine systems

While mangrove ecosystems were taken into consideration by the sub-subgroup on coasts and marine areas, dry coasts were not built into the appraisal. Further, in the prioritisation of coastal and marine areas, Olive Ridley turtle nesting sites (eg Orissa) and sites in the Andaman and Nicobar Islands were completely left out.

The members of the marine group were not aware of past prioritisation efforts (eg based on the coastal geography classification as in Rodgers & Panwar 1988). Several biodiversity values and issues were left out. It was suggested therefore that their FRAMEWORK be used for discussion in another sub-group meeting after relevant material had been disseminated.

Conclusions

The Chairman presented the conclusions from the deliberations of the sites group to the Plenary Session. Details are given below.

It was pointed out that there was insufficient time to give detailed recommendations on all the tasks assigned to the group. The group did however give general guidelines on methodologies, and, most importantly, suggest the way forwards.

Overall Conclusions

That prioritization cannot take place in a vacuum. Of overwhelming importance are the **Objectives of Conservation,** and the **Strategy** by which those conservation objectives are to be met. Objectives (and strategies) have to be spelled out in considerable detail.

(a) **The Overall Goal** is the Conservation of Biodiversity Values in India.
BUT there are several **Specific Objectives:** (We thought of a few as an indication – not as a full analysis. BUT A FULL ANALYSIS IS NEEDED).
Maintain (by reservation) a network of sample sites (Protected Areas) which included all species and ecosystems.
To provide a supportive habitat framework to core PAs, so as to extend the effectiveness of the PA. With the small average size of PAs in India this becomes an essential prerequisite to success.
Where possible, allow the sustainable use of biodiversity resources. Build in methodologies as to the use of socio-economic indicators.

(b) **We prioritise because:**
The present network is inadequate, i.e. there are gaps. WHAT are the PRIORITY SITES to fill those gaps? And WHAT are the PRIORITY GAPS to be filled?
The areas are not adequately managed to reduce or mitigate threats. WHICH are the PRIORITY THREATS TO DEAL WITH? There area inadequate resources (including funds) to allow better management. WHICH are the PRIORITY SITES to PROTECT?
Therefore we need to focus attention and resources, and obtain or lever the necessary political will.

The issue of *SCALE* at which prioritization takes place is important. A three part scale was identified, at landscape level.

- Core Protected Areas (NP, WLS, Biosphere Cores);
- The surrounding area which can provide the support framework to the PAs, (policy issues operate here; i.e. in Reserve Forest; in revenue and private land);
- Micro sites at village level (Prof. Gadgil's ideas).

Most of our discussions were at the core protected area level. WE URGED THE STRATEGIES GROUP TO ASSESS HOW TO CREATE THE NECESSARY CONSERVATION FRAMEWORK AROUND FORMAL PAs. THE ISSUE OF STATE PRIORITIES OR CENTRAL PRIORITIES OR GLOBAL PRIORITIES IS ALSO A QUESTION OF SCALE

The Biological Values (species and communities!) were agreed as the most basic of all value systems, and they alone determined the actual and potential biodiversity VALUE of a site. This therefore was the first determinant. We can rank sites as to their VALUES.

Socio-economic values of the site, and threats to the values of the site, follow as secondary descriptors. The socio-economic values and threats then determine the priority that is attached to investing management inputs to that site.

Tasks 1: Recommend Biological and Socio-economic Values in Prioritising Sites

We do this at two scales: Macro - PAs
Micro - Village sites

(Note that the required framework around a site is a strategy process, not a site issue).

I. MACRO SCALE BIOLOGICAL VALUES

A. These operate at ecosystem, community, species, and genetic levels. (We did not have time to think of genes).

All potential components are valuable; see below:

Some values work at ecosystem/community level only

— Representativeness
— Naturalness
— Size
— Uniqueness (Leads to irreplaceability, if a site is unique it is irreplaceable).

Other values work at both the ecosystem/community and species level

— Endemism (usually refers to species only, but some communities are restricted to eg India or the Ghats etc)
— Rarity (species & community)
— Richness (species & community)
— Presence of a major population (links to species viability)

Naturalness was seen as permitting evolutionary processes; and an area could not be representative if it was not also natural. Naturalness attracted the caveat of degree of and time scale of non-naturalness. For example, light grazing in the Valley of Flowers NP enhances biodiversity; so does grass removal within Bharatpur NP.

B. These values are best considered within a hierarchy – a hierarchy of biogeographical zones and ecosystems.

One cannot compare a grassland with a forest by saying "forest has 500 species, grassland 100 species, therefore forest is more important".

One cannot compare within forests "that wet evergreen has 1000 species, dry deciduous has 500 species, therefore wet forest is most important".

THIS LEADS TO THE FIRST GENERAL PRIORITY STATEMENT:

All biogeographic and ecosystem classes have importance in the first instance. We prioritise within these frameworks, not between them, at the all India level.

At the *International Level*, there is a globally recognized priority need for PAs within "Centres of Biodiversity and Endemism (Hotspots)". This need will be accommodated within India's prioritisation process.

C. Sites can be described in terms of these values. A matrix looking at these values against components (ecosystems, species etc) can be prepared and used for each site. Sites to be included in the matrix come from:

Existing PAs and proposed PAs, detailed (and updated) lists are given in Rodgers and Panwar (1988).

Proposals for further gaps: NOTE this requires that GAPS be recognized first!

Wetlands (LIST OF 170 sites plus).

Other data come from: the Indian Institute of Public Administration - IIPA Directory Reviews, databases at the Wildlife Institute of India, the Indira Gandhi Conservation Monitoring Center, the Bombay Natural History Society, Botanical Survey of India, Zoological Survey of India, etc.

It was agreed that Rodgers and Panwar would be the basic reference document. WII was urged to complete the update as soon as possible!

D. These lists of PAs will total over 700 sites – actual and potential. These can *only* be addressed in a series of **expert workshops.**

Expert workshops would be convened at Biogeographic Zone level

Key Taxon groups were mammals (excluding bats and rodents), birds, possibly Lepidoptera (butterflies and some moths), woody plants, and woody communities (eg. Champion and Seth). However flexibility in the use of groups was needed. Some zones may have other taxa of importance (amphibia in the Ghats for example).

Data inputs would be of two types:

Presence/Absence lists of key taxa for the PAs

Some level of abundance for selected taxa. Note we may not need absolute numbers, but could use number bands eg. <50, 50-100, 100-150 etc.

The group saw merit in attempting to give the matrix a real attempt within expert groups. It was recognized that these would involve much work and so a fallback mechanism was to prioritise the revised Rodgers and Panwar Report and the Wetland Report.

E. Nodal persons would be involved in planning such Expert Workshops, with the Steering Committee. Nodal persons should be re-recognized FOR ZONES.

They would help identify zonal zoologists, botanists, conservationists, resource managers, local leaders etc. with

perhaps different specialists per zone (eg mammals, birds, plants).

They would identify key resources; maps, lists, publications, data bases, etc. before hand.

F. It was suggested that a *trial* or *pilot* expert group workshop be attempted to see if the method worked.

II. MACRO SCALE SOCIO-ECONOMIC VALUE

A. Three **value groups** were recognized, these were:

- DIRECT USE/PROVISION OF GOODS FUNCTION
  Of two forms: Consumptive and Non-Consumptive
  And Consumption can be at two distinct types:
  State/Commercial level consumption,
  Local/Subsistence level consumption
  (Note that tourism can be + or – factor)
- INDIRECT USE/SERVICES FUNCTION
  One was seen as important – water catchment. (Others were general – soil, nutrients, carbon etc.).
  NOTE: Wetlands and coasts have separate service functions eg. hydrological values – water recharge, ecological values – pollution buffering, etc.
- CULTURAL/AESTHETIC FUNCTION (SITE SPECIFIC*)

Some socio-economic values were seen as adding to biodiversity values, so that:

Total Site Value = Biodiversity Value + Water Catchment Value + Carbon Storage Value etc.

Note that Education and Eco-Tourism values are not necessarily properties of the site itself, but reflect socio-economic factors which can change independently of what happens at the site.

Some socio-economic values can detract from the Biodiversity Value unless strong regulatory/mitigation measures are planned and implemented: eg heavy use pressure. We can re-state the equation as:

Total Site Value = All Positive Values (BD + Water + Carbon etc) – USE PRESSURE

We recommend that a further expert workshop explore this issue in detail.

B. THREAT (This is the opposite of feasibility)

This is not a value; but forms a different axis or set of parameters with which to contrast the biodiversity values.

The ease of Gazettement as a PA is a mixture of awareness of the Biodiversity Values and the Threat Parameters. Do the decision makers know the agreed OBJECTIVES of the state or nation as to the conservation of biological diversity. Are they aware that the site in question has +ve values which indicate that it becomes a priority? Are they aware that the area is under heavy use by people or is a major timber producer etc.

Example of a Threat Value Matrix

High value	A	B	C
	D	E	F
Low value	G	H	I
	Degree of Threat		
	Low (feasible)		High (Not feasible)

The matrix suggests that sites A, B, C are equally high in value but that A has very low threat (pressure) and so will be easy to gazette or manage. C however has great threat (pressure) and will be more difficult to manage.

G, H and I are low in value. I (and maybe H?) would probably not be bothered with as pressures are high. Should G be included? Yes as we have the secondary objectives of conservation of eg 33% forest cover, At least 5% as Protected Area etc! WE STRESS THE NEED FOR CLEAR STATEMETNS OF OBJECTIVE.

Using a Matrix: Where Does One Assign Priority ???

Do we invest in the difficult areas? Because if we do not then they will certainly disappear? Do we invest in eco-development, education, alternative employment etc?

Or do we write off the difficult areas, and invest in those with medium threats where intervention stands a chance?

These are NOT SCIENTIFIC QUESTIONS THAT CAN BE DECIDED BY QUANTIFICATION! THESE ARE POLITICAL QUESTIONS AND DEPEND ON POLITICAL COMMITTMENT!

A brief record of the questions (and some answers!) raised after the presentation is given below:

The corridor values or contiguity of habitats was not considered. (This is the advantage of working at Biogeographic zonal/province level; these needs can be built in. Corridors become essential when site viability

*Some level of aesthetic use (existence use for example) exists for all sites, or sets of sites eg. all those sites with forest or elephant have some aesthetic value)

is in doubt as sites may be too small etc).

The effect of exotics and weeds on the ecosystem health and integrity and other parameters affecting the biodiversity value of ecosystems was not cnsidered while discussing the methodology for prioritisation of sites. (These issues could be raised under naturalness = disturbance).

Doubts were raised as to how participatory this process of site selection was going to be. Specifically, it was mentioned that the methodology did not take into account the opportunities or feasibility values which may be available at the local level due to certain initiatives of the people. For example, people may have organised themselves into forest protection or ecodevelopment committees spontaneously, without any pressure being exerted on, or incentives being offered to, them. There are several levels of potential prioritisation:

Scientific stakeholder involvement, ALL stakeholders should join the expert group workshops. Non-scientists should also be present.

ALL Stakeholders should be present at the determination of OBJECTIVES. These become SOCIETY's objectives for conservation!

Local people become the key stakeholders at sessions dealing with use and threats.

It was felt that prioritisation should be done both at the state as well as the national level. (This was agreed).

The Way Forward

The general approach to prioritisation of sites has been agreed to by a large, cross-disciplinary group of conservationists, resource managers and socio-economists. What is needed now is a series of smaller expert groups to flesh out specific issues of importance. These would include:

(a) Setting out the objectives of conservation clearly and precisely.

Two areas need special consideration:

— separation of prioritisation at STATE and CENTRAL levels,

— policy guidance on how much should be invested in difficult as opposed to non-difficult areas!

(b) Refining the socio-economic issues – HOW will they act as a second stage filter in prioritisation?

(c) Reviewing the actual sites to be considered for prioritisation, including sub-groups of:

— Terrestrial sites (Core & framework),

— Wetland sites,

— Marine and coastal areas.

NOTE that it is now time to remove the separation of species and sites people. They should join up in these working groups.

Convening the first of the ZONAL expert groups/ workshops. Choose one that is discrete, and not too huge (3 – deserts, 4 Semi-arid, or 8 North-East India for example). Convening will entail:

Preparing list of participants: biologists, ecologists, conservationists, resource managers, social economists, political leaders, state bureaucrats.

Preparing list of sites to be considered, with basic data on location, size, status and tenure etc.

Preparing baseline data/information on biological values and on threats, uses and social values.

Testing the approaches as discussed in this report. Give enough time for experimentation and actual methods testing.

Increasing the tempo of biodiversity database development and biodiversity information collection analysis. Where are the distribution maps for large tree taxa, for larger mammals etc? Where are the bird atlases and the Important Bird Area information sets? (Whilst it is too late to collect new data for the first of the expert workshops, it is not too late to commission mapping and analysis).

Building the awareness of, and momentum for, improved biodiversity conservation. Publicize conservation needs. Draw attention to linkages to productivity etc. This will be needed when it comes time to put priority plans into action.

Annex 1: Conservation Parameters for Ungulate Species in India

This annexure is based on work done for the Rodgers and Panwar analysis of Protected Area Needs in 1988. We consider the methodology to be adequate, the actual dataset may be out of date!

IUCN's Ungulate Specialist Group in their of books on conservation priorities (edited by Rod East) introduced the concept of a SATISFACTORY status for a species (or sub-species). This status was achieved when:

There are two populations of over 1000 individuals each in an adequate Protected Area

This reinforces the needs:

that PAs are essential parts of conservation.
that TWO areas are needed in case one has a chance calamity.
that viable populations are needed – 1000 individuals equals 250 breeding pairs (more are non-mature). These are needed to reduce loss of genetic diversity, avoid in-breeding etc.

We analysed Indian ungulates-from Mouse deer to elephants. The results are presented on the following table.

We listed the following parameters:

Number of States in which the taxon occurs (And which bear the responsibility for its conservation!)

Numbers: On a scale: 1 is low < 1,000, 2 medium > 1,000, 3 high > 10,000.

Distribution: L is localised, W is widespread. (Done for species not censused)

Abundance: Numbers are assessed as low, medium, high. (Done for species not censused).

Protected Areas with < 1000 individuals.

Status: E Endangered, T Threatened, R Rare, S Satisfactory, Ext Extinct.

Endemism: To India, is noted.

Totals show that, out of 33 taxa:

(25%) are Satisfactory, A QUARTER! 14 (40%) are Endangered,
3 (10%) are Threatened, 6 (20%) are Rare.
2 (5%) are Extinct.

Species (Subspecies)	*No. States*	*Numbers*	*Distribution*	*Abundance*	*PAs>1,000+*	*Status*	*Endemic*
Argali/Nayan	2	1			0	E	
Barking Deer	23	3			3	S	
Bharal	4	2	L	M	0	T	
Blackbuck	15	3			3	S	E
Buffalo	2	2			0	R	
Chital	18	3			3+	S	
Chinkara	13	2	W	M	2	S	E
Chowsingha	13	2	W	F	0	R	E
Elephant	13	3+	W	M	0	T	
Goral	9	2	W	F	0	R	
Himalayan Tahr	3	1			0	E	E
Hangul (Sub Species)	1	1			0	E	E(SS)
Hog Deer	5	3+			3+	S	
Ibex	2	2	L	M	0	R	
Markhor	1	1			0	E	
Mouse Deer	8	2	W	F	0	R	E
Musk Deer	5	1			0	E	
Nilgai	17	3+			3+	S	E
Nilgiri Tahr	2	1			0	R	E
Pygmy Hog	1	1			0	E	E
Rhinoceros	3	2			1	T	E
Sambar	26	3+			3+	S	
Sangai (SS)	1	1			0	E	E(SS)
Shou	1(?)	1			0	Ext	
Swamp Deer	2	1			0	E	E
Takin	1	1			0	E	
Tibet Gazelle	1	1			0	E	
Tibet Antelope	1	1			0	E	
Tibet Wild Ass	1	2			0	E	
Urial	1	1			0	E	
Wild Ass (Rann)	1	1			0	E	
Wild Boar	20	3			3+	S	
Wild Yak	1(?)	1			0	Ext	

Satisfactory = > Two populations with over 1,000 individuals.

Endangered = Less than 1,000 individuals with no significant conservation PA or action.

Threatened = More than 1,000 animals but No or only one population > 1,000 in a PA (rhino = 1)

Rare = Localised populations only, > 1,000 so not endangered.

Annex 2: An Example of a Values Threats Matrix

Group 2 spent a little time looking at, and commenting on, the draft matrix developed for PA prioritisation in North East India (Rodgers 1986/7 Unpublished, part of the Biogeography and PA Planning exercise). It was thought that the ideas were relevant to the exercise here and should be reproduced more widely. This allows that dissemination.

The exercise consisted of three parts:

1. Assembling and defining the parameters for both values and threats, and giving scores to these values and the degree of threat.
2. Examining each Protected Area and Potential Protected Area in North East India in terms of these parameters and scores.
3. Constructing a Matrix of Areas and their scores on two axes: Values and Threats.

But, the next stage INTERPRETING THE MATRIX, What does it mean? What do we do? Was not done!

Table 1: Parameters of Threat and Value

1A	**Assembling the Parameters of Threat**	
	(a) *Presence of cultivation/crops*	
	Much	5
	Some	2
	(b) *Presence of grazing*	
	Much	3
	Some	1
	(c) *Presence of MFP collection*	
	Much	3
	Some	1
	(d) Presence of logging interests	
	Much	4
	Big plantations	3
	Some	2
	(e) *Varied problems*	
	Fire difficult to control and a problem	1
	Accelerated erosion is a problem	1
	(f) *Political/Development Pressure*	
	Area used by Military	4
	Area is not RF/PF	3
	Area is Tribal land	2
	Area is Encroached	3
	(g) *Area under threat of dams/reservoir/industry*	
	Serious large scale plans	5
	Small scale plans/ideas	2
	Total Negative Score	**40**

Contd....

1B Assembling the Parameters of Value and Threat.

(a) ***Presence of ecosystems of especial conservation interest:***		
Mangroves, unspoiled coasts or deserts		5
Evergreen forests, wetlands, high altitude areas		3
(b) ***Presence of rich communities of specific conservation interest***		
Lesser cats, primates (Hoolock etc)	all	3
Hornbills, pheasants, waterfowl	all	3
Orchids, high meadows, swamps,	all	3
High altitude fauna	all	3
(c) ***Presence of species of conservation significance (endangered/endemic)***		
Rhino, P Hog, H Hare, Golden langur, Buffalo,	all	3
Tahr, Takin, Ibex, Bharal, Serow, Tibetan – Ass, Antelope, Gazelle		
Tiger, elephant, gaur, swamp deer, gibbon	all	2
(d) ***Size of core area or potential core area:***		
> 500 sq km		5
250-500		3
< 250		1
(e) ***Contiguity***		
Forms a Corridor between PAs		3
Cross National Boundary PA		3
Cross State Boundary PA		2
Adds to an existing PA (ie adjacent)		3
(f) ***Richness of Biogeographic Zone and Ecosystems***		
More than one Biogeographic Province		5
Four or more Biomes		5
Three Biomes		3
Two Biomes		1
Significant altitude variation > 2,000 m		5
(g) ***Uniqueness*** (!)		
Are there NO other similar areas (Biome in Zone)?		10
Are there 1/2 other sites?		5
Are there 3/4/5 other sites?		3
(h) ***Ease of Gazettement***		
Approved by State Government ?		5
Approved by CCF/CWLW/State Wildlife Board?		3
Proposed as a National Park		5

Table 2: Summary Table for Biogeographic Province 9 A Assam Plains State of Assam Data for Proposed Protected Areas (see Rodgers and Panwar 1988)

Proposed Area	*NP/WLS*	*Size*	*Biomes Included*	*Special Features*	*CCF*	*Priority*	*Notes*
Laokhawa Extension	W	195	Floodplain	Rhino, Tiger	+		
Orang	W	92	FP	Rhino, Tiger	+		
Panpur	W	60	FP	Rhino, waterfowl	+		
Desangmukh	W	90	FP/canebreaks	Rhino, waterfowl	++		
Karwa	W	40	FP MDF Bamboo	Rhino, waterfowl, T	+		
Mayong Pobitara	W	60	FP MDF	Rhino	++		
Garampani Ext.	W	14	SEF	Ept, Gaur, Hornbi 11	+		
Tinkhopani-Namphar	W	56	EF, Hollock	E, T, G, Prim, Cats	++		
Sonai-Rupa	W	175	EF, SEF, Sub-Himalaya	E,T,G,P,C, Hornb	+		
Dibru	W	425	FP Reed Cane Hollock	E, T, Buff, C, WWDuck	+++		
Poba	W	90	SEF Sub-Himalaya	E, T, Cats	+		
Zamzing	W	40	SEF Swamp FP	E, T, Cats	+		
Nameri	W	137	SEF Hollock	E,T, G, Prim, Cats	++		State PA
Ripu-Chirang	W	300	SEF, Bhabar MDF	E, T, P,C, GLangur	++		Corridor
Kaziranga NP Ext.	NP		FP SEF Cane	E, T, RH, G, P,C,	+++		TR
Manas Upgrade to NP	NP		SEF, MDF, FP	E, T, R, G, B, C, HH, GL	+++		TR

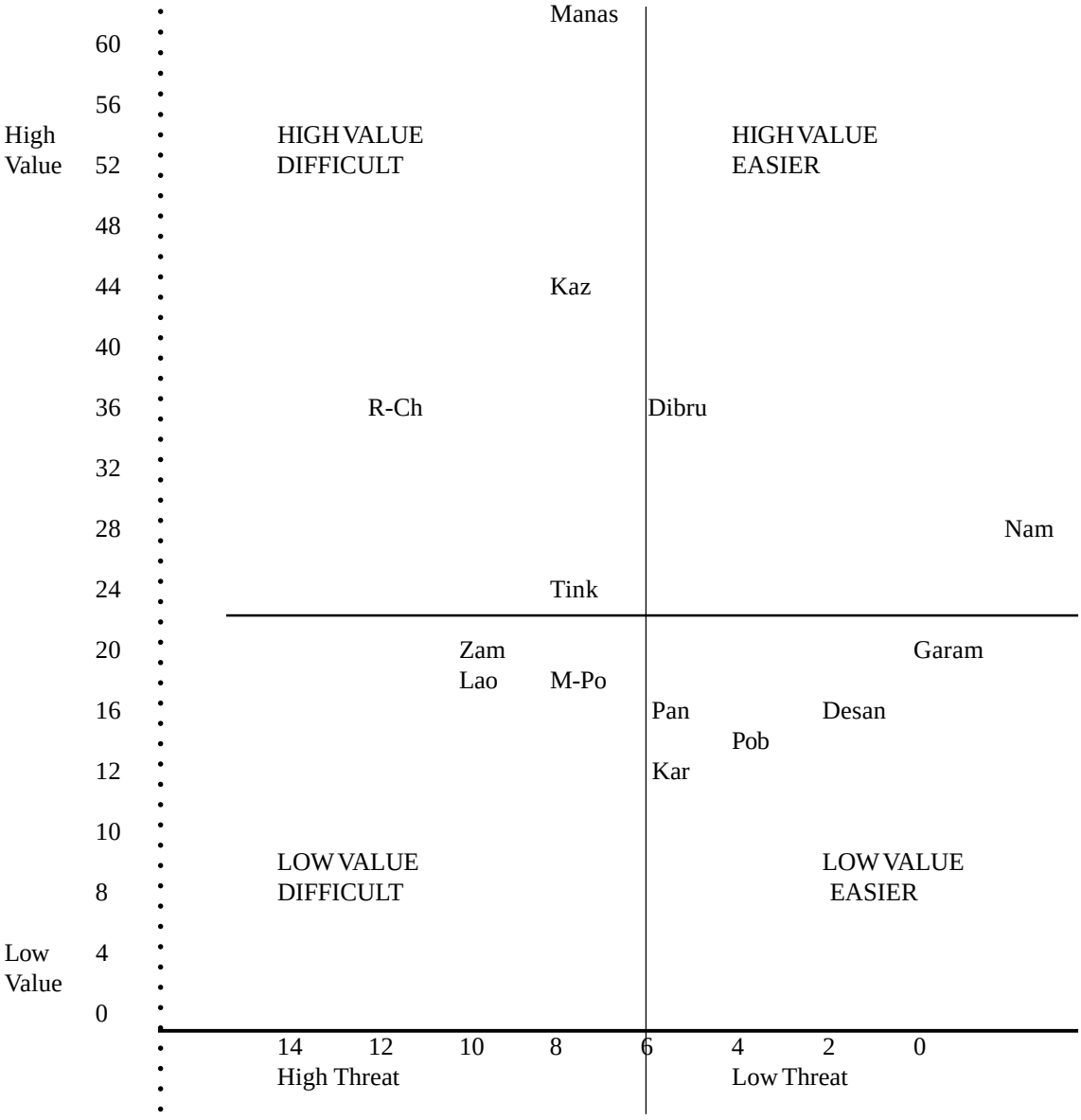
Table 3: Assessment of Positive Criteria Province 9A Assam Plains or Brahmaputra Valley

Proposed Area			*a*	*b*	*c*	*d*	*e*	*f*	*G*	*Total*
Laokhawa Extension	w	195	3	3	5	1	3		2	17
Orang	w	92	3	3	5	1			2	14
Panpur	w	60	3	6	3	1			2	15
Desangmukh	w	90	3	6	3	1		1	2	16
Karwa	w	40	3	3	5	1		1		13
Mayong Pobitara	w	60	3	6	5	1			2	17
Garampani Ext.	w	14	3	6	4	1	3		2	19
Tinkhopani-Namphar	w	56	3	6	12	1		1	2	25
Sonai-Rupa	w	175	3	6	10	1			2	22
Dibru	w	425	6	9	13	3		3	2	36
Poba	w	90	3	6	2	1			2	14
Zamzing	w	40	3	6	7	1		1	2	20
Nameri	w	137	3	6	10	1	2	1	2	25
Ripu-Chirang	w	300	3	12	12	3	3	1	2	36
Kaziranga NP Ext.	NP	500?	3	9	19	5	5	1	2	44
Manas Upgrade to NP	NP	550?	6	12	29	5	10	3	2	66

Table 4: Assessment of Negative Criteria Province 9A Assam Plains or Brahmaputra Valley

Proposed Area			*a*	*b*	*C*	*d*	*e*	*F*	*Total*
Laokhawa Extension	w	195	5	3	1	3			12
Orang	w	92		1		1			2
Panpur	w	60	2	3	1			1	7
Desangmukh	w	90		1	1			1	3
Karwa	w	40	2	3	1			1	7
Mayong Pobitara	w	60	2	3	1	2		1	9
Garampani Ext.	w	14		1	1			1	3
Tinkhopani-Namphar	w	56	2	1	1	3	1		8
Sonai-Rupa	w	175						3	3
Dibru	w	425	2	1	1	3			7
Poba	w	90	2	1	1	3			7
Zamzing	w	40	5	1	1	2		2	11
Nameri	w	137							
Ripu-Chirang	w	300	2	1	1	7		1	12
Kaziranga NP Ext.	NP	500?	2	1	1	2		2	8
Manas Upgrade to NP	NP	550?		1	1	5		2	9

Graph Plot of the Cumulative Scores for Value and Threat:
Protected Areas in the Brahmaputra Valley



(see tables above for abbreviations)

The graph plot allows an overview of the relative pressures and values of these potential (and existing) Protected Areas.

It allows one to say that THIS AREA is of greater value (on these parameters) THAN THAT AREA

It allows us to say that THIS SITE is under greater pressure than THAT SITE.

The graph plot DOES NOT TELL US WHAT TO DO ABOUT THAT INFORMATION

The graph plot DOES NOT TELL US WHICH OF THESE AREAS SHOULD BE CHOSEN - OR HOW MANY SHOULD BE CHOSEN!

The graph plot does not tell us if the priority should be the difficult ones (which will disappear if not supported); or the easier ones, which will certainly benefit from extra input.

The graph plot may look like a lot of complex and robust analysis, even 'science"!

But: The choice of parameters was subjective

The scores to put against the parameters was subjective "WHY did this get a maximum of 5 when that got a maximum of 2?"

Where did the data-set come from? Who agreed to the answers?

We could have altered questions and scores to give a different set of results – perhaps!

The value of these exercises is that it forces people to think!

Prioritization of Biodiversity Rich Sites of Conservation Significance in the Andaman and Nicobar Islands

J.L. Ellis, S.N. Yoganarasimhan, M.R. Gurudeva and Mrs. Papiya Ramanujam

Biodiversity in an area or region is the outcome of summation of varieties of genes, species and ecosystems over millennia, their adaptability and sustainability being the reflection of biolife in an environment in which they live.

Objectives

The main objectives of this study were:

- Classification of Andaman and Nicobar Islands into subzones based on biological characteristics.
- Identification in each of these zones of priority sites for conservation, using the accepted BCPP methodology, irrespective of whether these are within established national parks/sanctuaries, or not.
- Assessing the socio-economic value of these prioritised sited.
- Recording the methodology used for the three above (a, b, & c).

Process and Methodology Used

- Secondary data on the biodiversity of the Islands was gathered from various sources.
- Primary data was collected by making field visits to the selected/prioritized sites in the Islands for about a month.
- The non-government organizations and government agencies involved in biodiversity programmes in the islands were identified.
- Systematic interaction with the non-government organizations and government officials was carried out.
- The sites for prioritization were selected tentatively following the methodology of Singh & Taneja (1996).
- Field visits were made to all the selected prioritized sites to gather primary data.
- Interaction with local communities, village panchayats and government officials were carried out at each of the prioritized sites.
- Biodiversity inventory of the sites was gathered by listing of flora and fauna from the secondary data and primary data collected during the field visits to the prioritized sites.
- Threats prevailing in the sites for conservation of biodiversity was discussed with local community/non government organization or government agencies.
- The conservation strategies adopted were discussed with the non-government and government officials.
- The socio-economic aspects in each of the prioritized sites were also evaluated.
- The floristic elements in each of the prioritized sites were analysed, and endemic plants identified for evolving conservation strategies.
- The interest of the local government in the implementation of the programme was discussed with the government officials.

Details of Methodology Adopted for Assigning Biodiversity Values

Following Singh & Taneja (1996), biodiversity values were assessed as follows.

- Biological similarities of a particular site with other similar sites or with an ecosystem type, in terms of the number and percentage of defining characteristics of that ecosystem the site has, determining its representatives, the ecosystem with no or relatively few protected sites.
- Uniqueness of the site with regard to the ecosystem, rarity of the genera and species.
- The natural state of the site as observed in field visits, vis-à-vis human intervention.
- Richness and diversity predominance at species level in the prioritized sites.
- The percentage of endemic species in a prioritized site was assessed to evaluate endemism.
- Significance of other areas of biodiversity values - the presence of key-stone species, nesting grounds/

wintering grounds/migratory routes, refugia for other species were evaluated.

- Potential for high diversity value analysed depending on the percentage of unexplored areas in the islands.
- Socio-economic values - the direct, indirect, optional, socio-cultural and scientific values were considered by interacting with the local community and with government officials.
- Conservation feasibility values - In this criteria, protection status as reported both by non-government organizations and government agencies, the level of threat prevailing due to the local and international community, the management capacity by the government and legal status depending upon the size of the area and the vulnerability were considered.
- Ten sites were identified and finalised for prioritization.

Research Findings

Biodiversity is the species richness of plants, animals and microorganisms, in an ecosystem or habitat. It is the sum total of genes, species and ecosystems of a region which has come into being after millennia of evolutionary history. The biosphere is dependent on this biodiversity for its sustainability and renewal of biomass, soil and water, each being recycled in combination with oxygen, carbon, nitrogen and phosphorous. This interacting system consists of communities which together make the ecosystem. These ecosystems in a region constitute the biosphere.

There are generic diversities referring to variability of genes within species, species diversity and ecosystem diversity in a region. The species number is given high priority in this regard along with taxonomic diversity showing relationships among themselves. The ecosystem diversities have broader perspectives, making them hard to measure, but their number and distribution can be measured. Cultural diversity is also a part of biodiversity and helps people to adapt to changing conditions.

Biodiversity is the source of food material, clothing, biomass, energy, medicines and raw materials. Loss of any of these is detrimental to the country's wealth and economy. Strategies have to be made for the replenishment of such losses.

India has about 1,26,188 taxa of plants and animals put together, making 8 per cent of the biodiversity in 2.4% of the land area. It has 12 biogeographical provinces from among the 193 in the world and falls in the Indo-Malayan realm. India has over 500 national parks and sanctuaries. In the Andaman and Nicobar islands, there are 103 national parks and sanctuaries, and large areas designated as Tribal Reserves.

Physiography

The islands are situated in between 92° to 94° E longitude and 6° to 14° N latitude, having an area of 8259 sq km, with Andaman district having an area of 6408 sq km and Nicobar district 1814 sq km, separated from each other by the 10 degree channel. The forest area is 7171 sq km, including reserved, protected and proposed forests. The configuration of the islands is a long, highly indented, coast line. The surface of the Andamans and major portions of the Nicobars are irregular and hilly. Flat lands are present in the Nicobars. The dry period, from February to middle of May, is important in encouraging monsoonic weather. The rainfall is 3180 mm, mainly brought by the South-west and the North-east monsoons. The temperature varies between a maximum of 29.8° c and minimum of 23.13°c, the humidity often reaching the maximum even during the winter. The soil is poor, and porous. Clayey soil is invariably restricted to low lying areas. The soils are categorized as immature, loose in texture with poor drainage and poor moisture retentive capacity and are made of micaceous sand-stones, silt stone and with clayey beds. Geologically, the two groups of islands of Andaman and Nicobar belong to the younger hill ranges of the world. The Andamans have older igneous rocks of both intrusive and volcanic varieties.

Vegetation

The vegetation belongs to the Island Ecosystem. Though climatically not much variation is perceptible in these islands, the vegetational types are mainly the outcome of the climate of edaphic factors and of the availability of fresh water. The vegetation differentiated on the basis of climate and soil are of the following types: 1. the Andaman moist deciduous; 2. the Andaman tropical evergreen, and 3. Giant evergreen forests. Edaphically, tidal swamp forests (mangroves), littoral forests, Andaman semi-evergreen forests called also low altitude evergreen forests, southern hill-top evergreen forests, can be differentiated. Champion and Seth (1968) recognise 9 types: giant evergreen forests, Andaman tropical evergreen forests, cane brakes, wet bamboo brakes, Andaman semi-evergreen forests, Andaman moist deciduous forest, Andaman secondary moist deciduous forests, littoral forests, tidal swamp forests.

The endemic flagship species of Andamans are: *Dipterocarpus andamanicus, Dysoxylum andamanicum, Planchonella kangiana, Litsea leiantha* and *Glochidion subsessile* while the keystone endemic species are *Garcinia andamanica* var. *andamanica, Mangifera andamanica, Syzygium andamanicum, Syzygium kurzii* var *andamanica, Syzygium manii, Canthium andamanicum,*

Canthium gracilipes, Phyllanthus andamanica. The endemic flagship species of the Nicobar group of islands are: *Nothaphoebe panduriformis* var. *paucinervia*, *Nothaphoebe nicobarica*, *Macaranga nicobarica*, *Trigonosstemon nicobaricus, Amoora wallichii* and *Terminalia manii,* while the Keystone Endemic species of this region are: *Embelia microcalyx, Dillenia andamanica* and *Maesa andamanica* (Nayar 1996).

The People and Stakeholders

The population of these islands can be divided into the following three broad categories, who may be termed as the stakeholders of the biodiversity of these islands.

A. The tribal people who are the aborigines and constitute about a sixth of the total population of the territory. They consist of (a) the Negroid group comprising the Andamanese, the Onges, the Sentinelese, and the Jarawas, and (b) the Mongoloid group comprising the Nicobarese and the Shompens.

B-C. The local people and the mainlanders comprising of:

1. Old settlers who came before 1947;
2. New settlers who came after 1947

Out of these, the tribal people and the old settlers deserve to be categorised as stakeholders. It is interesting to note that originally the tribes of these islands mainly depended upon the forest produce for their livelihood and were basically lovers of biodiversity.

Prioritised Sites

The following regions have been chosen as the sites for biodiversity prioritisation programme. The biodiversity values were assessed following Singh & Taneja (1996) for each site.

Andamans

North Andamans - Diglipur division

1. To the north of Diglipur the areas in the vicinity of the villages Madhupur, Lakshmipur, Milangram, Swarajgram, Radhanagar and Shymanagar were earmarked.
2. **North Andamans** - Saddle Peak vicinity.

North Andamans - Mayabundar division

3. Karmatang village vicinity.

In the above 3 sites, from discussions with village elders and interactions with some members of the Panchayats, it is evident that the villagers are aware of the importance of conservation. It is gathered that many of the villagers are early settlers, before the Bangladesh war. The influx of Bangladesh refugees has threatened the very survival and sustenance of the forests amidst which the villages have come up. It is feared and even realised by the local people that the carrying capacity of several areas of the region has exceeded the limit and further increase will certainly damage the delicate ecosystem of the islands. It however seems to be a fact that the subsequent arrival and settling of the Bangladesh refugees will act as an encouragement for competition which the earlier settlers do not want to encounter.

From the primary studies carried out, it is observed that the forests are being exploited for fuel and other produce. The delicate ecosystem has already been affected and there are definite signs of deterioration in the quality of forests. Though the mangroves are protected and felling and exploitation is very much minimised, the signs of decline in the area studied indicate that the mangroves are still being exploited illegally. Likewise the fauna, particularly the marine fauna very rich in corals, fish, dugongs, etc., are exploited in a large way. Further, this area has been earmarked for the establishment of the proposed North Andaman Biosphere Reserve.

South Andamans

4. Mt. Harriet region.

It is the second highest peak in the Andaman group of islands with a very rich tropical evergreen type of vegetation possessing a dense canopy. At the top of the hill, the trees become stunted because of wind action. The floristic diversity is very rich harbouring many endemic plants of interest. The mangrove vegetation is very thick. The main disturbance to the biodiversity is from the tourists and the local people. The marine life is also rich and a large number of fish and crocodiles are present in the area.

5. Wandoor Marine National Park.

It is the largest marine national park with a variety of animals and corals. Different types of forests are found in this area. The littoral forests are very dense and a number of interesting species occur. Preserved mangrove ecosystems with plenty of fish and other animals are found here. The main threat is from tourists. Further protection to this site is necessary to preserve the biodiversity.

Little Andaman

6. Dugong creek - Onge settlement area.

This site shows the anthropogenic effects of the Onge tribals settled here. The changes are very much evident in the types of vegetation The biodiversity of the site is very rich. The mangroves, littoral forests and tropical evergreen

forests are luxuriant. There are also sandy beaches. The main threat is by settlers who encroach on the hunting grounds of the Onges, whose main food is the wild boar and fish.

Nicobars

Nancowry Islands

7. Kamorta island
8. Teressa island

These islands are situated in the Andaman sea and are hilly in configuration. The peculiar occurrence of grass heaths amidst the tropical evergreen forests is the interesting feature. No one is certain about the origin of these grass heaths. Though the islands are protected from other settlements, the vegetation needs to be protected from the ever increasing local needs and also other illegal activities.

Great Nicobar

9. Galathea National Park
10. Indira Point (Pygmalion Point) area.

The Great Nicobar is the largest island in the group and is situated closest to the equator. The terrain is rugged and it has very dense evergreen type of forests in the interior. The island has five rivers flowing through it with many fringing evergreen species. The estuaries are very dense and crocodiles and other animals are plentiful. The declared biosphere reserve is situated in the south-west of the island. The biodiversity is very rich varying from casuarina vegetation along the coast line to populations of *Areca catechu* and *Pandanus leram*. It is also the nesting ground of the famous endangered megapode bird. The main threat is from poachers and the illegal activities of foreign vessels. There is also encorachment of land by the settlers.

Community Participation

Non-Government Organizations Interested in Biodiversity

The following Non-government organizations were found to be actively interested in the biodiversity programmes in the islands.

1. Society for Andaman Nicobar Ecology (SANE) based at Port Blair, with about 25 members, mainly consisting of scientists, carrying out several biodiversity related programmes particularly in the North, Middle, and South Andamans.

2. Andaman Prakriti Samsad, based at Port Blair, concentrates its work on educational programmes relating to biodiversity.

3. Parirakshak, based at Campbell Bay, Great Nicobar, carries out educational and biodiversity preservation work in the Nicobar region.

Other than these three, the governmental agencies, particularly the Andaman and Nicobar Forest Department, is the main organisation looking after biodiversity conservation with support from the Botanical Survey of India, the Zoological Survey of India, the Central Agricultural Research Institute and the Anthropological Survey of India and, to some extent, the Government College at Port Blair.

Floristic Diversity

It is found from published records that about 1727 native species of Angiosperms and Pteridophytes occur in the islands, though some estimate the number of Angisoperms to be around 2500. Out of the 1727 species, the Pteridophytes number 132. There are 592 species of trees, 320 shrubs, 175 climbers and 491 herbs. It is found that the number of tree species in Andamans is 475, which is much higher than the 284 number of species recorded from the Nicobars. Many of these plants do not occur anywhere else in mainland India and show affinities towards the Burmese and Malaysian flora.

Endemic Flora

Laying stress on the endemic flora and fauna, Nayar (1996) has estimated that 239 species, from among the 2300 species found, i.e., 10%, are endemic to the Andaman and Nicobar islands and do not occur anywhere else in the world. Small islands are the death-traps of endemic species which being isolated find no alternate habitats or refugia if disturbances of any kind occur, and finally becoming extinct. Of the 239 endemic taxa, 96 are trees with 60% being endangered. In the Andaman islands, there are 132 exclusive endemic species, whereas there are about 45 endemic species in the Nicobar group of islands.

Faunal Diversity

The viability of an ecosystem can be judged from its diversity of species. The diversity of species indicates the survival value of the community. A rich gene pool means a higher adadptation potential. It leads to increased stability in an ecosystem. From the studies made so far in the islands, 5,100 species belonging to all major groups have been recorded. There are about 100 species of freshwater animals, which include mostly introduced species. Terrestrial animal communities are represented by 2,100 species and marine include 2,900 species. The former

include 1500 species of insects, while in the latter molluscs and fishes together constitute 1540 species. From a zoogeographical point of view, The Andaman and Nicobar Islands occupy an important position. Their terrestrial fauna shows a high degree of endemism and has affinities to Indo-Chinese and Indo-Malayan sub-regions. Their proximity to the marine faunistic centre or "centre of dispersal" made it possible to recruit several marine faunal elements so that endemism is not very prominent as regards marine fauna. There is a remarkable diversity in marine animal life. In addition to fishes, there are other groups like prawns, lobsters, shells, corals, starfishes, etc., many of which play an important role in the economy of the Islands[Subba Rao 1989]

Animals of the Andaman and Nicobar islands can broadly be divided into two categories : the inland animals inhabiting land and fresh water within the insular limits and the marine ones occupying the entire marine zone covering these islands. Among these, the inland animals are more interesting, particularly to the zoologists, because islands are treated as 'evolutionary laboratories' since the Darwin-Wallace era. From the faunistic point of view, most interesting is the absence of large mammals and the presence of a considerable number of endemics among the inland vertebrates . The total number of mammals in the islands are 58 (including 3 marine species), out of which 32 species are considered endemic; the birds number 242, out of which 95 are endemic and the Reptiles number 72, out of which 23 are considered endemic to the islands. Among the mammals it may be mentioned that the crab eating macaque of the Nicobars, the wild pig of Andaman and Nicobar islands and the palm civet of the Andamans. The dolphins and the dugongs are the marine mammals. Among the avi fauna, the most important ones are the storm petrels, tropic-birds and pelicans, herons, ergets and bitterns, ducks, hawks, the Narcondam hornbill, the megapode, partridge, quail, peafowl, button quail, rails and coots, plovers, pigeons etc. [Tikader & Das 1985].

Conservation Threats

The conservation threats to the biodiversity of the islands are of two types: (a) local and (b) international. Due to the phytogeographical location, the marines resources are easily accessible to international poachers who frequent the islands both from the North Andaman side and also from the South Nicobar side. Added to it, the influx of mainlanders and the increase in the local settlers and their eagerness to encroach on the forest land and make use of the marine resources for their living has a marked threat on the conservation of biodiversity. The introduction of deer and the increase of left over feral elephants and goats have increased the threat to the natural forests, and to the ecosystem in general, of the islands.

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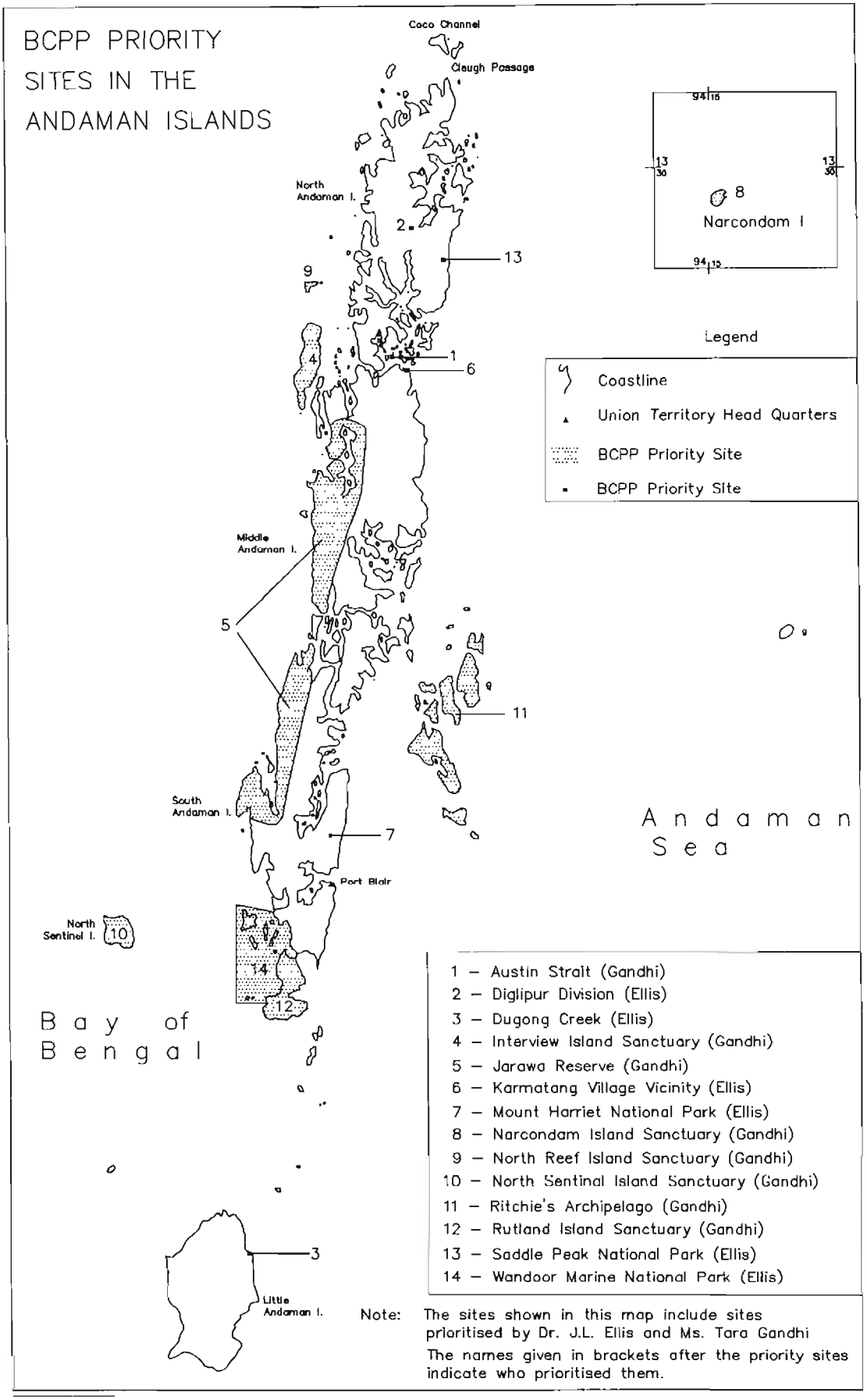


Map Prepared by the Indian Institute of Public Administration

BCPP Priority Sites in the Nicobar Islands

Car Nicobar

A n d a m a n
S e a

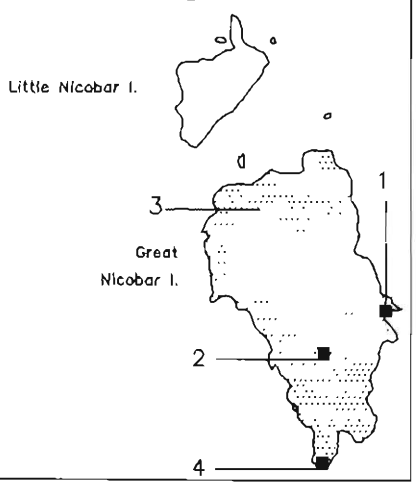
1 – Campbell Bay National Park (Ellis)
2 – Galathea National Park (Ellis)
3 – Great Nicobar Island (Gandhi)
4 – Indira or Pygmalion Point (Ellis)
5 – Kamorta Island (Ellis)
6 – Teresa Island (Ellis)

Legend

- Coastline
- BCPP Priority Site
- BCPP Priority Site

B a y of
B e n g a l

Sambrero Channel



Note: The sites shown in this map include the sites prioritised by Dr. J.L. Ellis and Ms. Tara Gandhi
The name given in brackets after the priority sites indicates who prioritised them

Map Prepared by the Indian Institute of Public Administration

Prioritising Sites for Biodiversity Conservation in Andaman and Nicobar Islands: With Special Reference to Fauna

Tara Gandhi

Introduction

The Andaman & Nicobar islands in the Bay of Bengal are peaks of a submerged mountain range arching from Myanmar in the north to Sumatra, Indonesia in the south, between latitudes 6°45' and 13°41'N and longitudes 92°12' and 93°57'E and are a southern extension of the Arakan Yoma mountain range. The island group comprises of over 300 islands and over 260 rocks covering a total area of 8249 sq. km. The two major island groups are the Andaman group and the Nicobar group which are separated by the ten degree channel.

For the purpose of the BCPP prioritisation exercise, the Andaman & Nicobar islands have been placed within the overall framework of the island ecosystem sub-group .Characterised by an extraordinary variety of habitat types ranging from dense forested mountains to coral reefs and sandy beaches, the islands are a treasure-house of biodiversity Their location in the equatorial belt has endowed them with an abundance of flora and fauna. Furthermore, their geographic isolation has rendered a number of species endemic and restricted to small areas. The Andaman & Nicobar islands are internationally accepted as one of the global "hot-spots" for biodiversity.

It is well known that on account of their isolation, fragility, and extreme vulnerability to environmental deterioration, the biodiversity of islands particularly small islands, is among the most threatened in the world. Habitat degradation with resultant species loss, pollution, introduction of alien species and the adverse impacts of tourism are among the serious threats. In Andaman & Nicobar, human pressures on the restricted land space are now in excess of the carrying capacity of the islands and are causing heavy damage to biodiversity. Forestry operations, construction of roads, mining, clearing for cultivation, and habitations continue to take place in the fragile ecosystem. Coral reefs in many areas are damaged by siltation, coral .mining, collection of decorative corals, and disturbance by careless tourists. Demands on biological resources are further exacerbated by the conflicting requirements of aboriginal tribal communities who are entirely dependent on ecosystem resources, and settlers from the mainland.

The exercise of prioritisation of sites for biodiversity conservation therefore needs to take into consideration not only the distinctive biological features of this extraordinary island chain, but also the complex human element. Even in uninhabited islands which have protected status as sanctuaries and national parks, (over 105 protected areas have been declared in A&N) there are problems caused by human interference like encroachment, poaching of marine fauna, illicit wood extraction and destruction of coral reefs. On the other hand, some areas such as the Jarawa Reserve and North Sentinal Island, which are not national parks or sanctuaries, are well protected by the tribal inhabitants.

For these reasons, the sites for biodiversity conservation prioritisation in this report have been selected irrespective of whether they fall within the protected area network or not. As there is no comprehensive documentation of the biodiversity of Andaman & Nicobar, and much of the existing information is scattered, the selection procedure (described in detail in the "Background and Methods" chapter) involved putting together available data collected from diverse sources, including consultations with experts in the field. This report attempts to reflect these, rather than formulate fresh inferences. Strategies for conserving these sites will have to be drawn up carefully in a participatory manner, and need to be site-specific, taking into consideration the fragility of the ecosystem, the special conservation imperatives for the flora and fauna, and requirements of different categories of user groups, including the scientific community. Currently determined priority sites can only be recommended as potential sites for biodiversity conservation until further work is carried out to to delineate the boundaries of each site and to assess their actual capacity for conservation of the species and habitats therein.

Biodiversity and Faunal Resources

The forests on the islands are classified into twelve different types, which together with the coral reefs and marine habitats support an extraordinary faunal diversity. Many exclusive species as well as subspecies are found in each of the two major island groups on account of their geographic separation.

The main terrestrial mammals are the Crab-eating Macaque which is found only in the Nicobars, wild pigs of which there are two subspecies endemic to each island group, civets, several species of bats, rats and shrews. There are no larger cats or other naturally occurring large mammals. Spotted deer, which were introduced, are now widespread, and there is a feral population of elephants in the North Andaman area around Interview island. The bird diversity is remarkable with a total number of 270 bird species and subspecies (Sankaran & Vijayan 1993) of which 126 are exclusive to Andamans and 56 to Nicobars. The Nicobar Megapode and the Narcondam Hornbill are the well known flagship species. Several varieties of snakes, geckos and lizards are found including the Andaman Water Monitor. Four species of endangered marine turtles nest on the sandy beaches of the island. Sea grasses in shallow coastal waters and sheltered bays support a highly threatened population of dugongs, one of the most prominent marine mammals. Other marine mammals include the Common Dolphin which can be seen near the shore or in the open seas beyond, as well as Blue Whale and Sperm Whale.

The mangroves of Andaman & Nicobar are considered to be among the least disturbed and best preserved and estimated to cover 1152 sq. km. in Andaman and 35.33 sq. km. in Nicobar (MoEF Status Report, 1987). The mangrove ecosystem supports a rich animal community, ranging from polychaetes, barnacles, crabs, hermit crabs, gastropods, bivalves, fishes, reptiles and birds, many of which use the habitat as a breeding ground (Rao & Khan, 1990). The value of the mangrove ecosystem in conserving soil, and protecting creeks and harbours from siltation and erosion, cannot be over emphasised, particularly in the small islands.

Coral reefs surround each of the islands covering over 1000sq.km. (Soundararajan pers.com.) consisting mainly of fringing reefs with a barrier reef only on the western side. The coral reef ecosystem is considered to be the marine equivalent of tropical rainforests in its extraordinary biodiversity. Andaman & Nicobar coral reefs are the richest among all the coral reefs found in India with 135 species belonging to 59 genera and perhaps form the largest reef formations of the Indian continent. The reefs harbour a rich diversity of sponges, coelenterates, worms, molluscs, echinoderms, etc. which have enormous potential value in the pharmacological industry.

Endemism is a prominent feature of Andaman & Nicobar fauna. Of the 5357 species of fauna covering all major groups recorded by Rao (1989) 487 (9%) are endemic. If marine species (none of which are endemic) are excluded, 13% (487 of 3704) are endemic (Sankaran 1995).

Background and Methods

Ten sites were prioritised in the Andaman & Nicobar Islands through a study conducted in 1997 by the Karnataka Association for the Advancement of Science, for the BCPP project. In their report titled, *Prioritisation of Biodiversity-rich sites of conservation significance in the Andaman & Nicobar Islands*, Dr.J.S.Ellis, Dr. S.N. Yoganarasimhan, Dr. M.R. Gurudeva & Dr. Papiya Ramanujam identified the following sites as priority sites for conservation.

1. Diglipur division, North Andaman
2. Saddle Peak vicinity, North Andaman
3. Karmatang village vicinity, Mayabundar division, North Andaman
4. Mt. Harriet region,
5. Wandoor Marine National Park, South Andaman
6. Dugong Creek – Onge settlement, Little Andaman
7. Kamorta island, Nancowry group, Nicobars
8. Teressa Island, Nancowry group, Nicobars
9. Galathea National Park, Great Nicobar
10. Indira Point area, Great Nicobar

The present study commenced in February 1998. The eight sites prioritised in this report focus primarily on faunal values including marine fauna and coral reefs, and are intended to be seen *in addition to* the ten sites described in the earlier report.

The specific purpose of this study was to prioritise sites for conservation of:

(i) faunal diversity
(ii) endemic and rare faunal species
(iii) threatened species of animals and birds
(iv) coastal and marine habitats (mangroves and coral reefs)

On account of the shortage of time, no primary studies were carried out at this stage of the exercise. Prioritization of sites therefore was based on data collected and compiled together from several different sources.

Data Collection

Literature Search

Relevent publications on all the above topics were studied and specific references to geographic distribution and status were noted. Special effort was made to look for

quantitative data and recent status reports. Scientific institutions, NGOs and individuals on the mainland as well as on the islands, with expertise in biodiversity of A&N islands, were contacted for recent records, publications, maps, charts and other information.

Discussions and Consultations with Experts

Discussions were held with officials of the Wildlife Institute of India, Indian Institute of Remote Sensing and Forest Survey of India, Dehra Dun, scientists and NGO experts in Delhi and elsewhwere on the mainland.

A visit was made to Andamans from 6 -16 March '98. Extensive discussions were held with forest officials, scientists of Zoological Survey of India, Botanical Survey of India, Central Agricultural Research Institute and with representatives of NGOs in Port Blair. A consultative workshop was held in Port Blair to present the findings to date, and to seek further information on certain specific topics. Maps were distributed to the participants so that they could fill in priority sites according to their own knowledge and perception

Field Visits

Parts of South Andaman and Middle Andaman Islands, including a portion of the Austin Creek and some off-shore islands, were toured. Discussions were held with forest officials in Mayabundar and Wandoor.

Selection of Priority Sites

Data collected as above were analysed and potential priority sites (which could be a group of islands, individual islands or part of an island) were selected using the following procedure:

- Distribution of endemic animals and birds in each major group of islands in the Andamans and Nicobars was marked out on maps. Selection of potential sites in each island group was done by overlaying the maps to determine where the distribution patterns overlapped. Similar maps were prepared for other important fauna such as marine turtles, saltwater crocodiles, etc. and superimposed to identify significant areas.
- Tables were prepared based on literature survey of old records as well as contemporary records (<10 years) indicating the distribution of endemic birds, to determine which individual islands or group of islands showed occurrence of the largest number of species (Table IV).
- Sites showing significant number of endemic species (e.g. occurrence of >50% of the endemic birds) were selected.
- Areas with records of significant faunal diversity, eg. diversity of reptiles (Table V), amphibians, birds or butterflies were selected.
- Coral reefs and mangroves with luxuriant growth and diversity were selected .

Values assigned in the BCPP methodology paper by Taneja and Singh (Appendix I) were applied to each site.

Rating of Sites

Of the sites selected through the above process, higher rating was given to the following criteria

- Sites important for faunal species that are endemic as well as threatened
- Sites where endemic threatened faunal species are restricted
- Important habitats for endangered fauna eg. dugongs, sea turtles, salt-water crocodiles
- Sites for unique species
- Pristine unexplored areas
- Sites where biodiversity has not been adequately documented or studied
- Sites of ethnic and indigenous interest
- Sites where traditional methods of biodiversity conservation are being practiced
- Sites threatened by human interference
- Sites harbouring wild relatives of cultivated plants and/or significant number of threatened plants
- Sites identified in this study which corroborated the recommendations proposed by Rodgers & Panwar (1988) for further potential areas for protection in Andaman & Nicobar

Only those sites that fulfilled several (at least five or more) of the above criteria were finally identified as prioritised sites

The Sites

North Reef Island and Interview Island

Interview is the largest island sanctuary in the Andaman & Nicobar islands, with an area of 133sq.km. while North Reef is only 3.48 sq.km. The islands have rich coral reef formations with associated species such as sea cucumbers, *Trochus* and other shells . They are among the last refugia for the endemic endangered Andaman Teal *Anas gibberifrons albogularis* which appears to migrate between these two islands Edible nest swiftlets also nest on Interview. Among endangered reptiles, there is a saltwater crocodile population, and marine turtles (Hawksbill and Green turtles) nest on the beaches. Uncontrolled collection of sea cucumbers, shells and corals, crocodiles, and valuable timber by poachers from Myanmar, Thailand and

other southeast Asian countries pose the largest threat to these islands. Though both the islands are legally protected areas (sanctuaries) they need to be included as priority sites. Rodgers & Panwar (1988) have proposed that North Reef island should be upgraded to a national park status.

Values: Endemism, Richness, Important species, Scientific value, High level of threat, Protected status

Narcondam Island

Narcondam island is notified as a sanctuary for protecting the Narcondam Hornbill *Rhycticeros narcondami*, which is listed in the IUCN list of threatened species and is restricted to this island. As this tiny island (6.81 sq. km.) which is believed to be of volcanic origin has the distinction of being the only place on earth where the bird species exists, it deserves special recognition for prioritisation.

The island is about 140 km. to the east of Diglipur in North Andaman and is heavily forested, with Andaman tropical evergreen forest, Andaman semi-evergreen forest, Andaman moist deciduous forest, Littoral forest and Mangrove forest types (Pande et. al). Very little is known about the threatened flora and fauna of this island. Researchers from SACON are currently conducting a study in Narcondam.

Values: Uniqueness, Endemism, Important species, Scientific value, Protected status

Austin Strait

Located to the north of Mayabundar, this area is a rich mangrove habitat with extensive creeks, lined by dense, luxuriant growth of mangrove trees. The prioritised site extends along the coastline up to Mohanpur and includes Mohanpur. The habitat is as yet fairly undisturbed and supports a variety of typical mangrove fauna such as crocodiles, snakes, birds, fishes, crabs and prawns. Recent surveys report the presence of Andaman Teal in Mohanpur (Vijayan 1997). Local people collect crabs, fish and honey for their own consumption as well as for sale. This site is supported by Rodger & Panwar's recommendation to create a mangrove sanctuary from Austin to Kishorinagar.

Values: Representative, Naturalness, Richness/ diversity, Important species, Direct socio-economic value

Jarawa Reserve - Middle and South Andamans

The Jarawa reserve area which is roughly 65000 ha. extends as a long strip from Middle to South Andamans along the western coast. It is characterised by a mosaic of forest types with dense forest cover of >40% (IGCMC Forest Cover Map 1987 - 90, Andaman & Nicobar), particularly in Middle Andaman which has evergreen forests, deciduous forests, and mangroves. The area has been set aside for the Jarawas, a hostile* aboriginal Negrito tribe, who are isolated from modern civilisation and entirely dependent on the forest and marine resources for their existence.

Their hostility to intruders in their territory have made it impossible to carry out any detailed surveys of the flora and fauna of the reserve. It is however evident that the reserve area is rich in living resources as it provides them full sustenance by way of edible plants, protein sources of meat and fish, wood and material for building their huts, medicinal plants and all other requirements for their daily lives.

Recent surveys have shown that of the Andamans group, the forests of Middle and South Andamans are richest in bird and butterfly diversity (Davidar et. al.1995). These two islands also have the largest number of endemic and threatened plants. Consultations with wildlife officials has established that the reserve is a rich area for the endemic Andaman wild pig. As a substantial portion of the best forested area of both these islands is covered by the reserve, the biodiversity within the reserve is expected to be exceptionally rich.

The greatest threat to the reserve is the Andaman Trunk Road which cuts right through it, causing irreversible damage and disturbance to the forest. Rodgers & Panwar recommended that all or part of these reserves should be declared as wildlife sanctuaries, so as to allow traditional people to pursue their way of life, and to give a strong deterrent to any incompatible land use.

Values: Naturalness, Richness/diversity, Endemism, Socio-cultural value, Scientific value, High level of threat

North Sentinal Island

This is a 47 sq.km. island to the west of Wandoor National Park (Mahatma Gandhi Marine National Park) inhabited by a hostile Negrito tribe the Sentinalese, who are completely isolated from the rest of the world. Their isolation is even greater than the Jarawas as they are the sole inhabitants of the island. Awaradi refers to Sentinal island as 'the last bastion of the Andaman Negrito'. The Sentinalese are perhaps the only people left on earth to successfully retain and defend their pristine lifestyle and territory. They have no interaction whatsoever with people outside their tiny island , actually vigorously repulsing any attempt made by Government teams or others to communicate with them by aggressively attacking intruders in their territory with arrows and spears. Their population is difficult to estimate and there is no

*Since end 1998, groups of Jarwas have been emerging from the forest, putting aside their hostility. The exact reason for their change in attitude is not known

information about whether the population is increasing or decreasing.

The biodiversity of the island has not been studied or recorded. The forest cover is dense > 40% (IGCMC Forest Cover Map 1987 - 90, Andaman & Nicobar) and it is evident that the forest and surrounding coast which the tribal community has protected for centuries, provides all their living requirements of food, shelter and medicine.

Values: Naturalness, Richness/diversity, Socio-cultural value, Scientific value

Ritchie's Archipelago

A portion of this archipelago has now been given national park status and has been renamed as Rani Jhansi Marine National Park. Though many of the islands of the group are uninhabited, there is much disturbance on account of fishing, tree felling, logging operations etc. (Rao 1990). Butterfly and bird diversity is rich in the forested islands of Henry Lawrence, John Lawrence and Havelock (Davidar et. al. 1995). The mangroves are also noteworthy and the freshwater swamps support a good population of Andaman Teal.

Coral reefs are in good condition and pearl oysters are also found in the coastal waters. There are luxuriant growths of sea grasses which, along with growths of food forming algae in shallow coastal waters, support one of the few remaining dugong populations in the Andaman group. They are especially found around the uninhabited islands such as Outram, Henry Lawrence, John Lawrence, Peel, etc. Green turtles nest on the beaches.

Values: Richness/diversity ,Endemism, Important species, Importance to other areas, Protected status

Rutland Island

Among the islands of the South Andaman group, this is the second largest, 70 km long and 80 km at its widest. Despite selective logging being carried out in the rich evergreen forests of the island for the past 14 years, the forests on the hill tops are still in good condition. Over 90% of the plants endemic to Andamans are found here, including wild relatives of mango, wild betel vine, wild rice, species of spices, canes and bamboo (Dr T.V.R..S Sharma pers.com.). Several medicinal plants which are used by Ranchi settlers (who have come from Bihar and settled here) occur here. The island also possesses freshwater streams which are a precious resource in the Andamans.

Rutland is rich in diversity of butterflies (Mohanraj et. al. 1997, Davidar et.al. 1995) and birds. Andaman Teal and Edible-nest Swiftlets are found and several threatened animals such as the Andaman Wild Pig, Andaman Water Monitor, and Estuarine Crocodile occur on the island, while some beaches are nesting areas for endangered marine turtles.

Threats to biodiversity include rice cultivation and forestry operations which are causing siltation of the coastal areas. As this island borders the Mahatma Gandhi Marine National Park (Wandoor N P, a site already prioritised in the first BCPP study by Dr. Ellis and his team in A&N)) the siltation is affecting the coral reefs there. Rutland island is another site proposed for conservation by Rodgers and Panwar. Several scientists and NGOs in A&N recommend this prioritisation.

Values: Richness/diversity,Endemism, Important species, Importance for other areas, High level of threat

Great Nicobar

The Great Nicobar island located below the 10 degree channel is the southern-most island in the archipelago. The island has about 85% primary forest (Pande et. al. 1991) and is endowed with immense genetic resources of wild plant species, of which 30% are South East Asian flora not occurring elsewhere in India. There is a high degree of endemism among the flora and fauna of the island, and there are special animal -plant interrelationships. Great Nicobar island is almost the last refuge for the endemic and threatened Nicobar Crab-eating Macaque *Macaca fascicularis* and the Giant Robber crab *Birgus latro*, the largest land crab in the world. The flagship bird species is the flightless Nicobar Megapode *Megapodius nicobariensis*.

The Nicobar islands have been designated as one of the 221 major 'Endemic Bird Areas' of the world. Of the 45 endemic species and subspecies of birds of the Nicobar islands, 18 are either endangered, vulnerable or near threatened, and 6 are data deficient (Sankaran 1995). Great Nicobar has the highest number of endemic birds of the Nicobar group and also the highest number of 'near threatened' species. Edible- nest Swiftlets are found nesting in the north-eastern and southern parts of the island.

Two very rare and threatened butterfly species, *Lenthe europa tamuna* and *Pachliopta coon sambilanga* listed in the IUCN list of threatened species have recently been rediscovered on Great Nicobar (Mohanraj et. al. 1994,1997)

Along the coasts, luxuriant mangroves are found at the mouth of Alexandria and Galathea rivers and in the creeks and bays, with coral formations beyond. Marine turtles nest in large numbers on the sandy shores. Dugongs are reported frequently around sheltered bays and along the east coast. Of all the islands of the archipelago, the sea around Great Nicobar is ideal for conservation of the highly endangered dugong.

Two distinct mongoloid tribal groups, the Shompens and the Nicobarese, live on the island. The Shompens live in the forest interior and are basically nomadic hunter-gatherers, though they do practice some cultivation and pig-rearing. The Shompens subsist entirely on forest and marine produce, and possess immense ethnomedical knowledge as well as a thorough knowledge of the properties of plants and trees. They have the ability to utilise all the biological resources without adversely impacting the island's ecology. The Nicobarese, on the other hand, live along the coast, and unlike the Shompens, have always had interaction with the outside world as sea farers and traders. They too have a tradition of hunting, and have great ethnobotanical knowledge. With the rate of settlements of mainlanders increasing rapidly, along with road building, quarrying and other development activities, the unique culture and life style of the tribal communities as well as the rich and varied terrestrial, coastal and marine biodiversity of the fragile Great Nicobar island ecosystem are under great threat.

Values: Uniqueness, Richness/diversity, Endemism ,Important species, Naturalness, Socio-cultural value, Scientific value, High level of threat, Protected status.

Constraints

On account of shortage of time, no primary studies could be carried out, so the present prioritisation exercise is entirely based on the compilation and analysis of data and information gathered from available literature and consultations with experts.

While significant work has been done by way of actual documentation of the living terrestrial, coastal and marine resources of the Andaman & Nicobar Islands, there is still considerable data deficiency with regard to status and distribution of plants and animals. As few population studies are available it is difficult to determine the actual status of most species. Even the status of some forest areas and coral reefs is not clear in the absence of an ongoing monitoring system. However, it is encouraging to note that several scientific institutions and NGOs are currently engaged in quantitative studies which will produce valuable results for the future.

Most of the experts and participants of the consultative workshop expressed their reservations about prioritising on the basis of available information. They felt that accuracy would be sacrificed if sites were identified for prioritisation without first making detailed studies, though they did generally agree that primary studies would take too long. The basic purpose of the prioritisation exercise and expected outcomes appeared to be somewhat unclear. Without a predetermined system of rating and assigning values, it was felt that the evaluation procedure lacked uniformity and accuracy.

There was also some discrepancy in views regarding occurrence and abundance of some species such as the dugong. Another concern raised by the participants was that in tribal reserves such as the North Sentinal Island, it is not possible to conduct studies or carry out conservation work since the tribals are hostile and aggressive, attacking intruders in their territory Some participants felt that the existing protected area network consisting of national parks, sanctuaries and biosphere reserves were sufficient prioritisation in themselves. There was general consensus that in-migration of settlers from the mainland was the most serious problem in the islands.

Though some prioritised sites were determined mostly on the basis of the experts' own experience and knowledge of particular areas, they were given high rating particularly if the site was found to have a combination of values. While it may be argued that sites that are well studied tend to receive high priority though other lesser studied areas may possibly be better, these inputs were considered valuable as they were provided by persons who were in a position to give authentic information. Attempts were made to avoid any over-emphasis or oversight by cross checking with persons from other disciplines with an interest in the concerned topic.

During this study no interaction was possible with local people living in or around the prioritised sites. This report therefore does not contain any opinions or direct responses from community representatives.

Appendix I

Values and Criteria for Biodiversity Conservation

Biodiversity Values

1. Representative
2. Uniqueness
3. Naturalness
4. Richness/diversity
5. Endemism
6. Significance for other areas
7. Cyclic significance
8. Important species
9. Potential value

Socio-Economic Value

10. Direct
11. Indirect
12. Option
13. Socio-cultural
14. Scientific

Conservation Feasibility Values

15. Protection status
16. Level of threat
17. Management capacity
18. Size

Source: Taneja and Singh

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Table 1: Number of Species/Subspecies and Endemics known from the A&N Islands

Name of the Group	*No. of Species/ Subsp.*	*Endemic Species/ Subsp.*	*Percentage of Endemicity*	*Remarks*
Sponges	70	2	-	All marine
Coelenterates	147	-	-	All marine
Corals	179	-	-	All marine
Earthworms	21	7	33.33	All terrestrial
Leeches	2	-	-	All terrestrial
Polychaetes	161	-	-	All marine
Termites	39	19	48.71	All terrestrial
Insects	1500	-	-	All terrestrial. No data on marine species
Spiders and scorpions	62	28	45.16	All terrestrial
Pycnogonids	8	-	-	All marine
Centipedes	17	-	-	All terrestrial
Millipedes	5	-	-	All terrestrial
Crustaceans	407	-	-	Includes terrestrial, freshwater and marine
Molluscs: Terrestrial	100	75	75.00	Includes one introduced species which is a serious pest of garden plants
Freshwater	51	12	21.56	A few species are intermediate hosts for helminth parasites
Marine	790	-	-	Some of the species are of ornamental value. Important resources material, some serve as food for tribals
Echinoderms	331	-	-	Includes species of economic importance
Meiofauna	324	193	-	All marine
Fishes	750	-	-	Mostly marine, a few freshwater
Amphibians	10	2	20.00	Freshwater and mangrove
Reptiles	83	23	31.94	11 Marine
Birds	242	95	39.26	
Mammals	58	33	60.00	3 Marine

Source: Pande, et.al.

Table 2: Some Wildlife Resources of the Andamans

Name	*Species*	*Status*	*Use*
Sea cucumbers	Holothurians 40 species including commercial species	Wide distribution	Food (export)
Shells (molluscs)	Many species including *Trochus, Turbo*	Some abundant, most status unknown	For mother of pearl and fancy work (export)
Lobsters	12 species	Abundant	Food
Prawns	12 species	Abundant locally	Food
Crabs	60 species including 3 commercial species	Abundant	Food
Sea weeds	55 species including commercial species	Abundant	Food
Oyster	Blacklip pearl oyster	Status unknown	For mother of pearl and fancy work (export)
Giant Clam	*Tridacna*	Common	Food
Fish	Many species	Most status unknown	Food, sport
Deer	*Axis axis, Muntiacus muntjak*	Abundant in most areas but not Little Andaman	Food, sport, skin, velvet (export)
Wild pig	*Sus andamanensis*	Abundant on some areas of the islands.	Food for tribals
Crocodile	*Crocodylus porosus*	Unknown	Food, leather, medicine (export)
Sea turtles	Four Species	Common	Food, leather, calipee (export)
Water Monitor lizard	*Varanus salvator*	Abundant in some areas	Food, leather (export)
Venomous snakes	Six species	Status unknown	Venom (export)
Orchids	Many species	Some species abundant on felled trees	Export market
Bee honey	Several species	Seasonally abundant	Trade item for tribals
Butterflies, moths, other arthropods	Many species	Some species abundant most status unknown	Export market
Swiftlet nests	*Collocalia fuciphaga*	Status unknown	Trade item for tribals (export)
Medicine herbs	Many species	Status unknown	Medicines (export)

Source: Endangered Andamans (Whitaker 1985)

Table 3: Number of Species of some Taxa with Endemics in the Andaman and Nicobar Islands

		A	*N*	*TOT*	*E*
PLANTS	1079	770	1416	187	Rao 1986
BUTTERFLIES	150	84	270	?	Khatri 1989
AMPHIBIANS			10*	2*	Rao 1989
REPTILES			83*	23*	Rao 1989
BIRDS	92	65	104	13	Ripley & Beehler 1989
MAMMALS#			55*	33*	Rao 1986

A = Andamans
N = Nicobars
TOT = Total
E = Endemic
* = including subspecies
# = including marine mammals
Source: Davidar et al.

Table 4: Distribution of Endemic Birds

	Andamans				*Nicobars*					
	North	*Middle*	*Suth*	*Little*	*Teressa*	*Kamorta*	*Trinkat*	*Katcall*	*Little*	*Great*
No. of endemic bird Species	40	48	53	34	26	31	28	27	26	31

Source: This table is based on information compiled from several literature sources.

Table 5: Diversity and Distribution of Reptiles and Amphibians

Number of Species Recorded in Different Islands

	Andamans					*Nicobars*						
	North	*Middle*	*South*	*Little*	*Bara-tang*	*Rut-land*	*Inter view*	*Great*	*Little*	*Car*	*Kamota*	*Nan-cowry*
Reptiles	10	12	32	7	9	4	5	25	6	5	10	4
Amphibians	5	3	9	2	2	1	2	9	1	3	1	

Adapted from database of I.Das & H. Andrews, ANET.

Table 6: Distribution of Endemic and Threatened Plants of Andaman and Nicobar Islands

	Andamans					*Nicobars*			
Total No.	*North*	*Middle*	*Nar-condam*	*South*	*Little*	*Car Nicobar*	*Katchal*	*Kam-orta*	*Great*
Total Endemic Plants	17	16	2	61	7	1	-	-	29
Total Threat-ened Plants	6	14	2	54	-	-	10	11	38

Compiled from the following sources: (1) Threatened Plants: Pande et.al.
(2) Endemic Plants: Saldanha and Balakrishnan

Table 7: Number of Endemic Avifauna Species and Subspecies According to Island Groups

Islands Groups	*A*	*B*	*C*	*D*	*E*
Great Nicobar	32	1	5	17	9
Nancowry	36	1	4	19	12
Car Nicobar	27	0	5	10	11

A = Total No. of endemics present.
B = Endemic species exclusive to the subgroup.
C = Endemic subspecies exclusive to the subgroup.
D = Endemic species/subspecies common to other Nicobar Islands.
E = Endemic species/subspecies common to Andaman Islands.

Table 8: Number of Endangered, Vulnerable, and Near Threatened avifauna species according to Island Group

Island Group	*En*	*Vu*	*NT*
Great Nicobar	0	0	10
Nancowry	0	6	9
Car Nicobar	1	1	6

En = Endangered; Vu = Vulnerable; NT = Near Threatened
Source: Sankaran 1995.

Prioritising Sites for Biodiversity Conservation in Lakshadweep Islands

D.N. Mathew and Tara Gandhi

The Union territory of Lakshadweep comprise 36 islands of which 10 are inhabited and the rest uninhabited. The total land area of all the islands put together is roughly 28.5 sq.km. Lying between 8° and 12°30' N latitudes and 71°and 74° E longitudes, the group of islands consist of coral formations built upon a submarine ridge, the north-south Lakshadweep ridge, rising steeply from a depth of about 1500-4000 m and at distances of 200-400 km off the Kerala coast. These islands represent the only atoll formation in India

All the islands, including the inhabited ones, are very small, the largest island, Androth, being less than 5 sq km in area There are wide expanses of sea between them. Most of the islands are crescent shaped with an extensive lagoon on the western side. The height of land above sea level is not more than 1-2 m in any of the islands. Their idyllic beauty with clear turquoise lagoons and palm-fringed beaches have made them a popular tourist destination in recent years

The Lakshadweep islanders, belonging to two different language groups (Malayalam in all the islands, and Divehi in Minicoy) are a well-integrated, industrious community. The literacy level is high. Over 95% of the population is Muslim and considered a scheduled tribe. Coconuts, coconut products and fishery are the mainstay of the people of the islands.

Biodiversity of Lakshadweep

Most islands, particularly those in the tropical regions, are characterised by having a large number of endemic, restricted and unique species that have evolved to survive only within the islands' ecosystem. However, in the Lakshadweep archipelago, there is a surprising absence of unique endemic land species. It has, in fact, been found that these islands do not have a distinct biogeographic identity, with the majority of terrestrial and marine species being widely distributed in other oceanic atolls of the Indo-Pacific region. (Fauna of Lakshdweep 1991, Zoological Survey of India).

Habitat diversity and species diversity on land are also particularly unremarkable - for instance, the list of land vertebrates, excluding avifauna, is made up of just one species of frog, a few geckos, garden lizards, skinks, a single snake species (Wolf Snake found only in Minicoy), and mice (see Table I). There are no native land mammals on these islands. (Fauna of Lakshdweep 1991, Zoological Survey of India).

Table 1: Approximate Number of Faunal Species

Group	*Number of Species*
Crustaceans	150 (Sudhakar Rao et. al 1989)
Mollusca	139 (Appukuttan et. al 1989)
Echinoderms	255 (DB James 1989)
Sponges	91 (Thomas 1989)
Corals	103 (Pillai et. al 1989)
Fishes	603 including 300 spp of ornamental fishes (Jones and Kumaran 1980)
Frog	1
Turtles	4 (Lal Mohan 1989)
Lizards	1 (Mannadiar 1977)
Land snakes	1 (Mannadiar 1977)
Marine Mammals	4 (Lal Mohan 1969
Birds	101 (Mathew et. al 1992)

The natural vegetation of the islands comprises mostly of herbaceious and shrubby bushes with very little inter-island variation. Rao and Shastry (1972) have classified the vegetation as Strand Coral which usually has an open pioneer zone, woodland zone, and coastal zone, each with its characteristic tree or plant species. This original vegetation however is seen only on some islands such as Androth, Agatti and Minicoy, and occasionally in a few places on other islands, because almost all the islands are now densely covered with coconut plantations. There is only one tract of 2500 sq.m. of the mangrove *Bruguiera parviflora* in Minicoy island. Barring this, the absence of any type of forest is an interesting feature.

In contrast to the low terrestrial diversity, the marine biodiversity of Lakshadweep is abundant and spectacular with many characteristic species. The lagoons and sea around the islands support several species of endangered marine fauna. The exceptional productivity of the coral reef ecosystem supports an abundant diversity of marine life About 105 coral species belonging to 37 genera have been recorded, which by far exceeds the number found on the coast around the entire Indian mainland. Corals are the most valuable natural resource of Lakshadweep and therefore deserve special mention. The reefs and lagoons provide the ideal niche for important commercial species, namely the bait fishes that are essential for tuna fishery The coral reef ecosystem is perhaps the least studied ecosystem, so there is still much to be learnt about coral fauna and associated organisms in Lakshadweep.

Kaliaperumal et. al. (1989) have recorded 114 species of sea weeds (marine algae) in the Lakshadweep. 6 species of sea grasses have also been found in ten of the islands. These are an important food source for marine turtles, and are valuable in preventing erosion of the coastline.

The most important and remarkable birds of Lakshadweep are the sea birds of which the most significant are four pelagic species - Sooty Tern (*Sterna fuscata)*, Noddy Tern (*Anous stolidus)*, Large Crested Tern (*Sterna bergii)*, and Brownwinged Tern *(Sterna aneathetus)*, that nest and roost in large colonies, particularly on Pitti Island. Terns have many important roles in the islands' economy and ecology. They serve as indicators of tuna and fertilise the islands with guano.

The fish diversity is phenomenal with 603 species, of which half are ornamental varieties. Skipjack Tuna (*Katsuwonus pelames*) forms the major fishery of the islands. Four species of turtle, the Olive Ridley (*Lapidochelys olivacea),* the Leatherback (*Dermochelys coriacca)*, Hawksbill (*Eretmochelys imbricata)*, and Green Turtle (*Chelonia mydas)* occur in Lakshadweep. The littoral and subtidal sediments of the lagoons support a rich variety of the smaller meiofauna af diverse groups of free-living invertebrates Macrofauna comprise of burrowing deposit and filter feeders such as polychaetes, shrimps, crabs, large hermit crabs, gastropods, bivalves, sea urchins, sea cucumbers and starfish. Giant clams with huge shells and octopus are quite common in the reefs.

Methodology and Process of Prioritisation

Barring some terrestrial areas of special biodiversity significance on the islands, the exercise of prioritisation of sites focused to a great extent on coastal and marine sites, taking into consideration their ecological and economic value, and threats to their biodiversity.

The first author visited Kavaratti in April 1998 to hold expert consultations and to examine recent documents and records.On account of the shortage of time no original field studies were carried out. The prioritisation of sites was done on the basis of secondary data compiled from several different sources. The following procedure was followed:

Data Collection

1. Published and unpublished literature such as scientific and semi-scientific papers, government records and popular articles were surveyed. Tables, charts, maps and other relevent information was also collected. A special effort was made to look for records of the current status and distribution of species, and to access latest information on the status of terrestrial and marine natural habitats.
2. Data from the authors' own previous scientific studies, observations and field visits to the islands were also used.
3. Discussions and consultation were held with:
   - scientists in institutions on the mainland such as Central Marine Fisheries Research Institute (CMFRI) in Cochin and Chennai, National Institute of Oceanography (NIO) in Goa, Indian Council for Agricultural Research, New Delhi, the University of Calicut and other universities
   - scientists and officials of the science & technology department, fisheries department and other institutions and offices in the islands
   - government officials of the administration of Lakshadweep, including retired officials, officials of the wildlife department and environmental wardens
4. Discussions and interactions with local community members, NGO representatives and fishermen were also held.

Analysis of Data

- tables were prepared from records such as flora and fauna surveys, species lists, distribution data, etc. to locate areas with high diversity (for example Table 2 on *marine species diversity in different islands*)
- distribution of important terrestrial and marine species were marked out on maps to locate significant sites
- sites recording breeding of threatened or endangered species, such as marine turtles, were noted
- locations of important ecosystem-types such as mangroves, sea grass beds, etc., were noted
- status reports of coral reefs, lagoons, and other natural areas were examined to locate relatively undisturbed

areas as well as vulnerable spots
- Information from various sources regarding pollution and other threats to the marine environment was compiled and evaluated to identify areas of greatest threat.
- opinions of fisherfolk and local community members regarding species important for their livelihoods, such as bait-fish, and areas where they are available, were noted
- locations important for fishery, such as breeding areas for bait fish, were identified

Table 2: Marine Species Diversity in Different Islands

No. of Species	*M*	*S*	*Kv*	*Kl*	*An*	*Ag*	*Bn*	*AM*	*KD*	*Ki*	*Ch*	*Bi*	*Pi*	*Ti*
Corals	73	11	38	23	15	27	8	37	43	42	57	15		
Turtles :														
nesting		1	1		2	3	3	1	3	1	2	3	1	3
sightings only	2	1	1	2	1			2						
Marine algae	52	33	47	64	38	37	32	27	30	33	34	18		
Sea grasses	4	1	4	3	1	2	1	1	2	1				

M - Minicoy, S=Suheli, Kv=Kavaratti, Kl=Kalpeni, An=Androth, Ag=Agathi, Bn=Bangaram, Am=Amini, Kd=Kadmat, Ki=Kiltan, Ch=Chetlat, Bi=Bitra, Pi=Pitti, Ti=Tinnakara
Note: Compiled from several sources

Parameters for Prioritisation

- Sites recommended for inclusion in the protected area network by other studies such as by James & Pillai (1989), Rodgers & Panwar (1988)
- Sites harbouring rare flora or fauna
- Presence of plants not found elsewhere on the islands
- Sites import for endangered species such as marine turtles
- Breeding sites for pelagic birds
- Sites important for fisheries
- Sites with luxuriant sea-grass beds
- Coral reef sites (i) with high species diversity (ii) in good condition and relatively undisturbed (iii) in good condition but vulnerable to damage
- Sea coasts threatened by erosion
- Undisturbed lagoons
- Threatened lagoons

The criteria for prioritisation listed by Taneja & Singh were applied to the sites. Sites conforming to three or more of the above parameters were finally selected as prioritised sites.

Prioritised Sites

The following islands, their lagoons and a portion of the sea around them are the priority sites for conservation, in Lakshadweep:

1 Kalpeni Island

Kalpeni island is 2.3 sq.km in area and is an inhabited island. This island, along with the three satellite islets of Cheryam, Tilakkam and Pitti (not the same as the bird-island Pitti), lie enclosed in an extensive lagoon which is the best and most beautiful lagoon in the islands. The coral growth is exceptional with a profusion of ramose corals in excellent condition(Srivastava & Koya). *Acropora humilis* and *Acropora palmate* are common on the reef, and the reef flats have massive *Porites*. The reef flat connecting Kalpeni with Cheriyam gets fully exposed at low tide. The lagoon has extensive sea-grass beds. The island is still free from the problem of oil pollution, which is otherwise a major problem in some of the Lakshadweep islands. (Srivastava & Koya, 1997).

2. Kadmat Island

This is an 8 km. long island, extending from north to south, and only 0.5 km. at its widest section. It has a large lagoon on the western side which gets fully exposed at low tide. The island rests on a hard coral stone substratum, and the soil supports rich coconut groves.

The coral diversity in the lagoon is good and the condition of the corals is generally satisfactory and fairly rich with *Acropora* and *Porites*. Dead corals can however, be seen in some areas. The northern half is richer than the southern half. The lagoon reef flat harbours a healthy coral growth Massive *Porites* dominate in many places.

Kadmat is an inhabited island which has been opened to domestic tourists. The land area is altered on account of sand stone and lime extraction. The beach is sandy and three species of endangered marine turtles nest there.

3. Suheli

This is a barrier reef enclosing a huge lagoon. Two uninhabited islands, Cheriyakara and Veliyakara, lie within the lagoon. There are half a dozen enterance channels on the reef surrounding the lagoon. Both the islets are just one metre above sea level and, unlike the other islands, lack a hard substaratum, being made up entirely of sand banks. It is one of the most productive islands with rich growth of algae and corals. Birds like the Grey Heron nest in Suheli and Hawksbill and Green turtles (*Eretmochelys imbricata* and *Chelonia mydas)* come ashore to lay their eggs. A rich diversity of lagoon fauna associated with coral reefs is found in a fairly undisturbed state.

Islanders from Kavaratti go to Suheli for fishing but do not stay there long. Suheli is a good site for protecting turtles and birds. The site has been recommended as a site for a Marine Park in the by the Zoological Survey of India, as well as by James and Pillai (1989).

4. Pitti Island

Pitti is a completely barren rocky islet, 1.2 ha. in size, with a small reef and a tiny sand bank to the south. The island has deep sea around it with no lagoon to break the strong waves and currents. A remarkable feature of the island is the total absence of any kind of vegetation, because of its coral rock substatum.

Pitti is an important breeding ground for four species of terns - Sooty Tern (*Sterna fuscata)*, Noddy Tern (*Anous stolidus)*, Large Crested Tern (*Sterna bergii)*, and Brownwinged Tern *(Sterna aneathetus)* (Mathew et.al. 1991). Flocks of these birds congregate in large colonies on the island, laying their eggs on the stony ground. This site has special significance since most of the terns found in India have their nesting sites as far north as Ladakh, Tibet and Eastern Europe, or to the south in Sri Lanka and Maldives. For Noddy and Sooty terns, this is possibly the only breeding site in the Indian territory.

These pelagic birds are valued by local fisherfolk as they indicate the location of tuna fish shoals. Terns feed on small fishes or sprats (*Spratelloides sp.*) that are also the main food of tuna. As flocks of terns hover around areas where concentrations of sprats are found and these are also spots where tuna congregate, fishermen are able to easily locate the shoals tuna.

Rich deposits of guano from the accumulated birds' droppings are found on the island. This provides essential nutrients in the food chain of the tuna fish, as well as contributes to soil fertility on islands with coconut plantations, thereby making a major contribution to the Lakshadweep economy. The population of terns has declined over the past three decades and one species, the Brownwinged Tern, has not been observed there since 1963. Though the island has been declared a bird sanctuary, illegal egg-collection continues during the breeding season.

Marine turtles nest on the island and it is an ideal habitat for several species of molluscs. Rodgers and Panwar (1988) have recommended a national park status for this island.

5. Minicoy

Minicoy is the southern most island in the archipelago, only 120 km. north of the neighbouring Maldives. It is inhabited and has a distinctive character because of the Divehi dialect spoken there, unlike all the other islands where only Malayalam is spoken. The people have an ancient seafaring tradition.

The island is crescent- shaped, about 10 km long and 0.8 km at its widest. The western side has a reef enclosing a large lagoon. The beaches have fine sand. A small rocky islet called Viringli, to the north, attracts several bird species and the southern part has large tracts of screw-pine jungle. Minicoy is the only island in Lakshadweep which has a 2500 sq.m. tract of mangrove, *Bruguiera parviflora* which needs to be protected.

Coral diversity recorded in Minicoy is exceptional with 73 out of the total of 103 (Pillai 1989) species found in Lakshadweep, but the present status is not good (Srivastava & Koya 1997) as the corals have been damaged because of various reasons including attacks by the coral-predatory starfish *Acanthaster plancii*. Minicoy has some coral species such as *Lobophylla* and *Diploastrea* that are common to adjecent Maldives but rarely found in the northern islands. There is also good diversity of marine algae and sea grasses. The coral formations in the lagoon provide an ideal habitat for many important live-bait fishes belonging to the families Pomacentridae and Apogonidae and are a traditional site for live-bait fishing. Viringli islet is a good source of the live bait *Spratelloides delicatulus.*

Threats to the Islands

It is well known that on account of their isolation, fragility, and extreme vulnerability to environmental deterioration, the biodiversity of islands, particularly small

islands, is among the most threatened in the world. The effects of climate change, global warming and sea -level rise have disastrous consequences on islands, particularly small islands that are low and flat, like the Lakshadweep islands. Natural phenomena like the El Ninõ effect also take their toll on the islands by causing mass bleaching of corals, as was reported in Andamans and in Maldives in May 1998. (Soundararajan pers.com).

While the total population of the islands is low, Lakshadweep is one of the most densely populated territories in India (2000 per sq.km in 1991). Anthropogenic pressures on the islands and lagoons are high with demands for housing material and food, apart from the requirements of the coconut and fisheries based economy. Domestic waste and waste products of the coconut industry are a serious threat to the land, the lagoons and the sea. During recent years, changes in the lifestyle of the local people are generating more non biodegradable solid waste, such as aluminium cans, bottles and plastic bags, which are virtually impossible to dispose of. The Lakshadweep Administration has initiated action to ban plastic bags on the islands, and to reduce pollution (Srivastava & Koya 1997).

Illegal collection of sea birds and their eggs from the Tern Sanctuary, Pitti Island, is depleting the once abundant bird population. Though local fisherfolk have always been collecting eggs from Pitti, for their own consumption as well as for limited sale, the activity has now become unsustainable, perhaps on account of the additional demands of the rising population.

Coral reefs and lagoons are the most threatened on account of pollution from the land and from the sea, over-collection of fishes - particularly bait fishes, corals and shells, coral mining, dredging of the lagoons leading to further problems of coastal erosion. Erosion takes place on acount of natural causes like wave action as well as due to destruction of coral reefs. While cement tetrapods are effective for controlling erosion, they prevent marine turtles from coming ashore to lay their eggs.

Tourism is an important source of income for the islands' population and Lakshadweep is becoming increasingly popular with both domestic and foreign tourists. Unless their numbers and their activities are carefully monitored and controlled, there is a threat to the ecology of the islands. Carelessness by tourists can disturb bird breeding colonies, damage corals while reef-walking, or cause pollution because of garbage and sewage waste.

Passenger and cargo ships dumping untreated waste into the sea around the islands and discharging waste oil cause severe pollution. Lakshadweep falls along the main route for oil tankers plying between the Middle East and south/south-east Asia Any oil spillage is a serious potential threat for marine biodiversity. The effect of oil on corals, sea grasses, lagoon fauna and other marine resources has not yet been adequately studied.

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Annexure I: Number of Genera and Species of Marine Algae Collected from Lakshadweep

Name of the Island	*Total*	
	Genera	*Species*
Chetlat	29	34
Kiltan	26	33
Kadamat	26	30
Amini	25	27
Bitra	17	18
Bangaram	29	32
Agatti	28	37
Androth	30	38
Kavaratti	38	47
Kalpeni	46	64
Suheli	28	33
Minicoy	38	52

Source: Adapted from Kaliaperumal.

Annexure II: Distribution of Sea Grasses

Species	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
Cymodocea rotundata						+	+		+	+		
C.serrulata	+		+	+			+		+	+		+
Holodule unirervis												+
Syringodium isoetifolium									+			+
Halophila ovata											+	+
Thalassia hemprichii		+	+					+	+	+		

1. Chetlat, 2. Kiltan, 3. Kadmat, 4. Amini, 5. Bitra, 6. Bangaram, 7. Agatti, 8. Androth, 9. Kavaratti, 10. Kalpeni, 11. Suheli, 12. Minicoy

Source: Kaliaperumal.

Annexure III: Nesting Sites or Sighting of Turtles in Lakshadweep Islands

Name of Islands	*C.mydas*		*L. olivacea*		*E.imbricate*		*D.coriaea*	
	N	***S***	***N***	***S***	***N***	***S***	***N***	***S***
Chetlat	X	X	X	X	-	-	-	-
Kiltan	-	-	X	X	-	-	-	-
Kadmat	X	X	X	X	X	-	-	-
Amini	X	X	-	X	-	X	-	-
Bitra	X	X	X	X	X	X	-	-
Agatti	X	X	X	X	X	X	-	-
Bangaram	X	X	X	X	X	X	-	-
Tinnakara	X	X	X	X	X	X	-	-
Pitti	-	-	-	-	-	-	X	-
Kavaratti	-	X	-	-	-	-	X	-
Suheli (Valiakara)	X	X	-	X	-	-	-	-
Kalpeni	-	X	-	X	-	-	-	-
Androth	-	X	X	-	X	-	-	-
Minicoy	-	X	-	X	-	-	-	-

N = Nesting; S = Sighting only.
Source: Lal Mohan.

Annexure IV: Coral Diversity in Lakshadweep

Islands	*Scleractinia Corals*	
	No. of Genera	*No. of Species*
Minicoy	28	73
Suheli	7	11
Kavartti	18	38
Kalpeni	11	23
Androth	7	15
Agatti	10	27
Bangaram	5	8
Amini	15	37
Kadamat	21	43
Kiltan	19	42
Chetlat	23	57
Bitra	6	15
Total	37	103

Annexure V: Status of the Coral Growth in Lakshadweep

	1989 *(Gopinadha Pillai)*	*1997* *(Srivastava and Koya)*
Agatti	good, diversity high	good, high diversity
Amini	many dead due to siltation	lagoon unsuitable for growth, bad.
Androth	good	good
Bangaram	many corals destroyed by movement of fishermen	unsatisfactory
Bitra	good	satisfactory
Chetlat	good, but lagoon was shallow,	good
Kavaratti	50% dead due to natural erosion & sedimentation	bad
Kalpeni	growth of corals profuse.	good
Kadamat	some mining of lime stone on land, coral growth rich	satisfactory
Minicoy	most corals dead due to mining and fishing activity, predation by star fishes, dredging, siltation etc. killed its coral life.	bad
Suheli	healthy, thriving coral life	very good

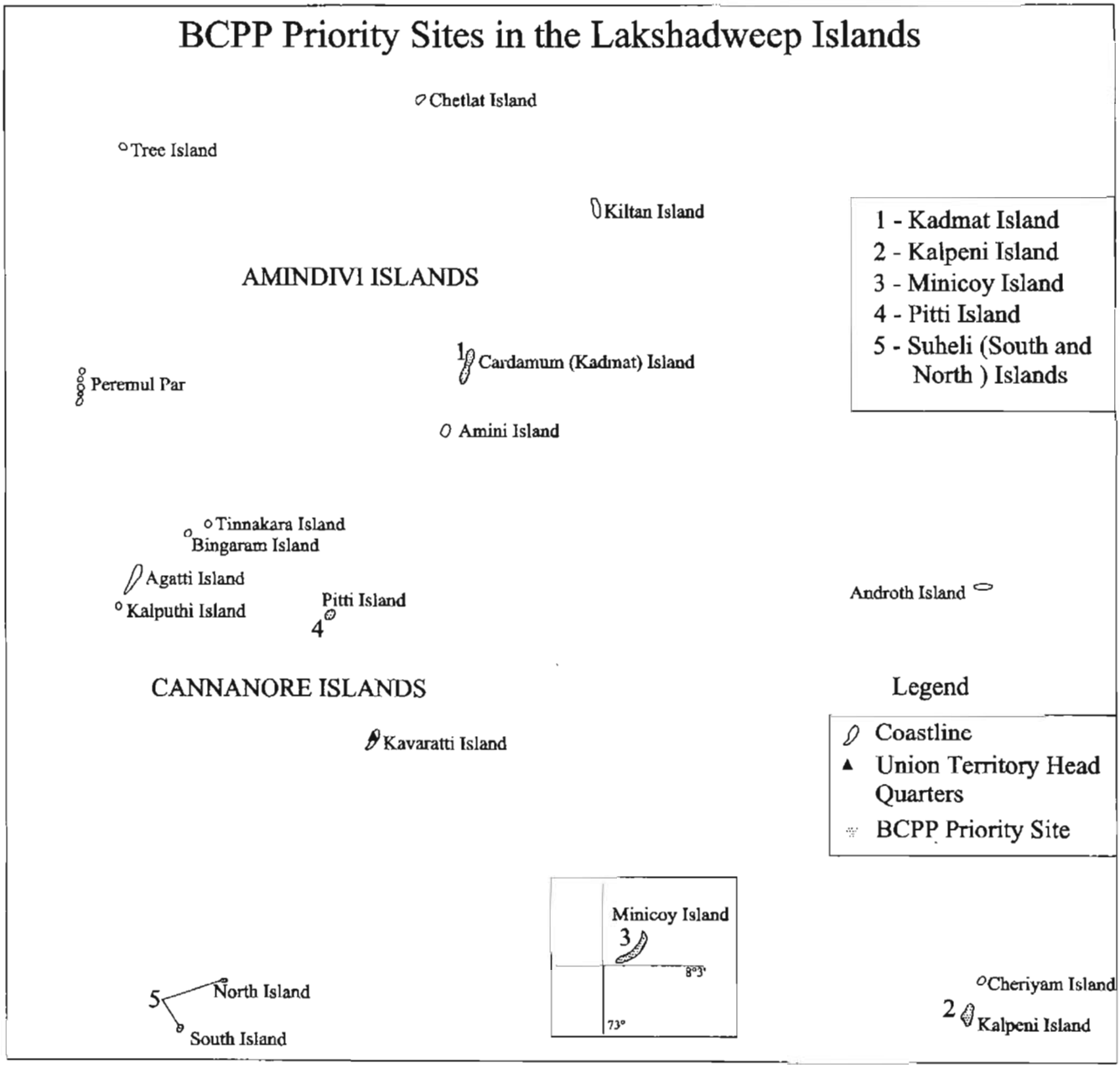
Annexure VI: Distribution of the Birds in Various Islands of Lakshadweep

Common Name	*Scientific Name*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*
Brownwinged Tern	*Sterna anaethetus*	x	xxx	xxx	xx	x	xxx		x	-	x	x
Sooty Tern	*S.fuscata*	x	xx	xx	xx	x	xx	x	x	-	x	x
Large Crested Tern	*S.bergii*	x	xx	xx	x	x	xx	x	-	-	-	-
Lesser Crested Tern	*S.bengalensis*	-	x	x	x	x	xx	-	-	x	-	-
Noddy Tern	*Anous stolidus*	x	xxx	xx	xxx	x	xxx	x	-	x	x	x
Reef Heron	*Egretta gularis*	x	x	x	x	x	x	-	x	-	-	x
Grey Plover	*Pulvialis squatarola*	xx	-	-	x	x	-	x	-	-	-	-
Golden Plover	*P.dominica*	x	-	-	-	-	-	-	-	-	-	-
Crab Plover	*Dromas ardeola*		-	x	-	-	-	x	-	-	-	x
Kentish Plover	*Charadrius alexandrinus*	x	-	-	x	-	x	x	-	x	-	-
Whimbrel	*Numenius phaeopus*	x	x	x	-	-	x	x	x	-	-	x
Curlew	*N.arquata*	x	x	x	x	x	-	x	x	-	-	x
Common Sandpiper	*Tringa hypoleucos*	x	-	-	x	-	x	-	-	x	x	x
Turnstone	*Arenaria interpres*		-	-	x	-	-	-	-	x	-	-
Little Stint	*Calidris minutus*	x	x	x	-	-	-	-	-	x	x	-
Pond Heron	*Ardeola grayii-*	-	x	x	x	-	-	-	-	-	-	-
Rufous Turtle Dove	*Sreptopelia orientalis*	-	-	-	-	-	x	x	-	-	-	-
Koel	*Eudynamys scolopacea*	-	-	-	-	-	-	-	-	-	x	-
Common King fisher	*Alcedo athis*	-	x	x	x	-	-	-	-	-	x	-
Swallow	*Hirundo rustica*		-	-	x	-	-	-	-	-	x	x
White Eye	*Zosterops palpebrosa*	x	x	x	x	x	x	-	-	-	-	-

1. Agatti 2. Bangram 3. Tinnakara-Parali 4. Bitra 5. Kadmat 6. Suhelli 7. Kalpeni 8. Androth 9. Chetlat 10. Kiltan 11. Amini

x— Stray xx— 5 to 100 numbers xxx— more than 100

Source: Lal Mohan 1989.



Map Prepared by the Indian Institute of Public Administration

Prioritization of Potential Sites for Marine Biodiversity Conservation in India

A.G. Untawale, V.K. Dhargalkar and G.V. Deshmukhe

Introduction

There are about 30 million species of living organisms estimated on earth. Marine Biodiversity is known to be one of the richest among all the living ecosystems. There is a rich marine biota in different parts of the oceans, from the surface to the deepest part and from the estuarine region to the offshore regimes. Ocean waters can support life from the microscopic bacteria to the gigantic whale. As compared to the information available on terrestrial biodiversity, much less information is available on the marine biota.

Tropical marine ecosystems of the Indian subcontinent harbour a large number of species belonging to various habitats that include mangrove swamps, estuaries, lagoons, muddy, sandy/rocky shores, and oceanic islands. In India, although the marine biological research has been going on for a long time, there are several groups of living, or endangered (some extinct!) organisms, about which there is no proper scientific information available.

There is a definite food chain present in the oceanic system. The famous "Trophic Prism" indicates the intimate and intricate relationships among the primary, secondary and tertiary levels. At the same time, different ecosystems are mostly interdependent but self-sufficient. Various biological, biochemical and reproductive processes of a complex nature support numerous life forms in the ocean. The value of biodiversity lies in the functioning of these components supported by the interactions of organisms, populations and communities.

There are various ecosystems and species that are threatened as a result of several developmental activities like over-exploitation, pollution, reclamation, etc. These include coral reefs, mangroves, marine algae and seagrasses, conventional fishery resources, the rare groups of faunal elements and various micro-organisms responsible for different activities.

Rapid industrialization has resulted in the destruction of habitats and the consequent extinction of several marine organisms. On the advent of the industrial revolution, the coastal regions have become threatened by industrial pollution, and by habitat destruction because of dredging, sand mining, reclamation and rapid urbanization. Only a fraction of these species affected are known to science. The IUCN has categorized this biota into extinct, endangered, vulnerable, rare indeterminate, out of danger and insufficiently known. It would be premature to decide the specific priorities based on the scattered and inadequate data available.

Various marine ecosystems such as the estuaries and islands, along with mangroves, seaweeds, seagrasses, corals, fisheries and sand dunes including associated flora and fauna, are ecologically as well as economically important to mankind. Human beings are utilizing the riches of the ocean since time immemorial for food, feed, chemicals, minerals and energy.

Though data on marine species and ecosystems is still sparse, on the basis of available data it is possible to identify the undisturbed areas along the coast where biodiversity is rich. There are, fortunately, already some Biosphere Reserves, Sanctuaries, National Parks declared along the Indian coast. Similarly, detailed inventories can be prepared separately for the marine flora and the fauna in order to identify priority areas for conservation.

Status of Marine Biodiversity in India

The real impetuous to the study of marine biology came out of the International Indian Ocean Expedition, during 1964. Several countries participated in this program and, as a result, lot of marine biological samples were collected along with very valuable data on their qualitative and quantitative resource evaluation. Different atlases have been prepared to show their distribution and biomass. Taxonomical information has also been recorded.

Although some data on the distribution, abundance and other ecological functions of marine biota are available, much of this information is on individual groups, various other ecological and environmental parameters. The biodiversity concept is recent and, for this purpose, it is necessary to compile all the available data pertaining to various groups of marine biota.

Microorganisms

These include microscopic forms such as bacteria, actinomycetes, fungi, yeasts, viruses, flagellates, ciliates, diatoms and other planktonic forms. The numbers and kind of microbes occurring in the marine world are influenced by environmental conditions and the presence of higher organisms. Microbial habitats in the marine environment are broadly divided into six categories, i.e. (1) Nearshore habitats (air-sea interface), (2) Planktonic (free floating), (3) Fecal sestonic (organic debris), (4) Epibiotic (attached to surface), (5) Endobiotic (symbiotic/pathogenic), (6) Benthic (seafloor).

So far 96 species and 66 genera of marine fungi have been reported from the Indian coast. Among the yeasts, 24 yeast species were reported from EEZ of west coast and 9 from EEZ of east coast (Ranu Gupta and Prabhakaran, 1990).

Phytoplankton

These are microscopic, planktonic unicellular plants drifting along the sea surface. These are the main primary producers in marine ecosystems and are placed at the bottom of the Trophic Prism. Phytoplanktons are classified on the basis of their cell size as Microplanktons (2 - 200 µm), Nanoplnktons (2-2 µm) and Picoplanktons (0.2-2 µm). Majority of them belong to unicellular Chlorophyceae (green algae), Bacillariophyceae (diatoms), Vouchariaceae and Xanthophyceae (golden algae) and Dinophyceae.

Zooplanktons

These organisms are known as secondary producers and occupy the second lower level of the prism. They are considered as the major index of utilization of aquatic biotope because of their intermediary role between phytoplanktons and fishes. Zooplanktons are characterized by their faunal diversity and include organisms varying in size. No single system of classification has been adopted universally. These are being classified on the basis of size as follows:

Ultraplankton <5 µm; Nannoplankton 5-60 µm; Microplankton 1-500 µm; Mesoplankton 0.5 - 1.0 mm; Macroplankton 1 - 10 mm and Megaplankton > 10 mm.

The physico-chemical boundaries play an important role in zooplankton distribution.

Macro-Algae

Marine macro-algae, commonly known as seaweeds, are benthic forms of the lower plant group. They are classified into four major groups based on their pigmentation and stored food. These are as follows: Chlorophyceae, Phaeophyceae, Rhodophyceae and Cyanophyceae.

A total 624 marine algae are reported from the Indian coast and classified into 64 families, 215 genera (Table 1). Their distribution along the Indian coast is given in Table 2, (Untawale *et al.*, 1983).

Seagrasses

Seagrasses are marine flowering plants and are highly productive in the sea or in the estuary. Twelve species belonging to seven genera are reported from Indian waters. The seagrasses are mostly found in lagoons or in the intertidal regions. Two species of *Halophila, H. beccarrii* found mainly in intertidal mangrove mudflats and *H. ovalis* is associated with mangroves.

Sand-Dune Vegetation

The strand or sand dune vegetation which are also termed as Psammophytes, are generally observed growing on the sandy areas beyond the supra-littoral zone. These are angiosperm species, belonging to different families with an ability for sand binding, which results in control over the movement of sand. There are about 148 species representing 115 genera and 49 families, reported from the east and west coast of India (Untawale, 1980). The west coast has been observed to have more diverse species than the east coast.

The dominant species representing strand flora are *Spinifix littoreaus, Hydrophylax meristima, Ipomea pes-caprae, Asparagus dumosus, Cyperus conglomeratus, Halophyrum mucronatum* and *Sporobolus trimulus*.

The supra-littoral region with sandy substratum has been divided into three zones, i.e. Pioneer zone, Midshore zone and Backshore zone. These three zones show varying type of environmental conditions and also different floral elements such as herbaceous, shrubaccous and trees. The natural arrangement of these three groups gives a gradual slope of vegetation which diverts the wind blow coming from the seaward side and thus minimizing the sand erosion.

Marine Fauna

Marine fauna comprises of several phyla, orders, classes, families, genera and species. There are innumerable species in the coastal as well as offshore environment. It is practically difficult at this stage to enlist various species family wise. These faunal complex elements, therefore are indicated as separate groups like zooplankton, benthos, corals, fishes, amphibians, reptiles, birds, mammals, etc.

According to the scientific data available, there are 23 groups of faunal elements which have been reported from the Indian coast line. Due to lack of space, it will be difficult to deal with all the marine faunal groups here. However, some important ecosystems are being described separately for their biodiversity.

Coastal Biodiversity

Marine biodiversity has been classified into two sectors, i.e., coastal and offshore, for convenience. The coastal areas are shallow and cover ecosystems like estuaries, nearshore intertidal areas where strand flora and mangroves are available. The intertidal and subtidal regions also harbour the biota like marine algae, seagrasses, corals and the associated flora and fauna.

Mangrove Ecosystem

Mangrove is an assemblage of different flowering plants that can grow in the saline or brackish water along the estuaries, on deltas, back waters, creeks, etc. In India, mangroves occur in various habitats such as delta, estuarine, backwater and sheltered-insular bay types. Deltas are found along the east coast. The great rivers deltas, such as those of the Ganga, Brahmputra (Sundarbans, West Bengal), Mahanadi and Bhitarkanika (Orissa), Godavari and Krishna (Andhra Pradesh), Pichavaram and Gulf of Mannar (Tamil Nadu coast) are mangrove formations along the east coast. On the west coast however, the estuaries display fringing growth.

Mangrove forests serve as a link between terrestrial and marine ecosystems. The energy flow through the nutrients, from land to the sea, and enrichment due to the detritus formation, makes mangrove ecosystem rich in relation to the primary and secondary production. The swamps also serve as nursery grounds for variety of fishes and prawns. The mangrove ecosystem also contributes to the economy of the coastal zone. Timber is one of the biggest resources extracted from mangroves. Other products such as honey, tannins, charcoal, etc. are also extracted from the mangrove forests.

The mangrove ecosystem comprises all the biotic components starting from microscopic forms to large size forms. Table 3 displays the number of species belonging to various biotic components of the mangrove ecosystem.

Phytoplankton

As mentioned earlier, the phytoplanktons are the primary producers. The mangrove or estuarine ecosystem is well mixed, weakly or strongly stratified. About 20% of primary production (PP) is contributed by phytoplanktons of 20 µm in size (Qasim, 1973). Species belonging to genera such as *Skeletonema, Nitzschia, Coscinodiscus* and *Navicula* contribute to the phytoplankton abundance. Mandovi-Zuari estuarine system of Goa is a tide dominated estuary. About 80 species of phytoplanktons have been recorded from Goa. Out of this, 63 species were diatoms, 14 dinoflagellates and 3 blue green algae (Devassy and Goes, 1988).

Zooplankton

Zooplankton population of the mangroves comprises of epibenthic forms and organisms living in the water column. Zooplanktons of the mangrove region have received very little attention, as most of the research pertained to the flora. Along the mangroves of Goa coast, Goswami (1992) described the seasonal variability in the zooplankton standing structure and eco-physiological adaptation. Crustaceans, fish larvae tintinnids, rotifer are the common groups reported from central west coast. Copepods (83.5 to 84.1%), mysids, decapods, polycheates, chaetognaths, cladocerans, coelenterates, fish eggs and fish larvae are abundant in this region. In the Sundarban mangrove region, Sarkar *et. al.* (1986) reported that copepods are the most dominat group, followed by meroplankters and chactognaths.

Algae and Seagrasses

Marine algae in the mangrove environment are either floating or attached to the sea floor and mangrove bark or pneumatophores. Little is known about the algae associated with mangrove regions. There are a few reports on the distribution of algae in mangrove (Jagtap, 1986). A total of 48 species belonging to 30 genera are reported from the central west coast of India.

Caloglossa leprieurii, Catnella impudica, Ulva reticulata and *Enteromorpha clathrata* are characteristic algal species that occur throughout the year. Economically important algae such as *Monostroma oxyspermum* (edible) and *Gracilaria verrucosa* (agarophyte) also grow in mangrove areas with high salinity. *Dichotomosiphon salina* - a Vauchariaceae member, has been reported only from the Goa mangroves (Untawale *et al.*, 1980) Mangrove environment is distinguished with unstable soils and wide fluctuations in salinity, temperature, turbidity and nutrients, resulting in poor distribution of marine algae in mangrove areas. The maximum number of algal species occur during October to April, when generally a high salinity level is recorded. Blue green or cyanophycean species dominate during monsoon season.

Seagrasses: The polyhaline and mesohaline zones of mangrove areas are generally associated with *Halophila*

(Hydrocharitaceae). *Halophila beccarrii* is an exclusively mangrove related seagrass, whereas *H. ovalis* also occurs in the sheltered euhaline regions (salinity > 30%). of west coast during March-June and throughout along the east coast.

Yeast, Bacteria and Fungi

Microbial flora consisting of yeasts, bacteria and fungi, play a significant role in the decomposition of mangrove litter resulting into the protein rich detritus. About 50 bacterial strains are reported from the mangrove area, mostly gram positive. *Micrococcus, Brevibacterium* and *Kurthia* are reported as predominant. Bacterial species such as *Lactobacillus, Corynebacterium, Listeria, Bacillus* and *Clostridium* are also found in this area. Bhaumic *et al.* (1986) reported 24 bacterial strains abundant in Sunderban mangroves. The most dominant strains belonged to genera *Brevibacterium, Clostridium, Kurthia, Lactobacillus, Micrococcus* and *Pseudomonas*. Cellulose sulphate reducing bacteria have been reported. Although only a few bacterial species have been recorded, there is a great potential for their population, distribution and diversity in the mangrove ecosystem.

There are 184 species of terrestrial fungi reported, while 76 species are known to be manglicolous fungi of great commercial value. Most of them belonged to Ascomycetes, Basidiomycetes and Deuteromycetes (Chinnaraj, 1993). Two lichen species are also reported from the mangroves of west coast of India.

Mangrove and Associated Flora

Mangroves are defined as characteristic littoral plants found in the tropical and subtropical coasts (SCOR/COE, 1981). They are a diversified group of trees and shrubs. There are 59 mangrove species belonging to 41 genera and 29 families present along the Indian coast. The west coast harbours 34 species, whereas 46 species are present along the east coast. The total mangrove area cover in India is approximately 700,000 hectares (Sidhu, 1963). The east coast, including Andaman-Nicobar Islands, contributes about 82%, while west coast about 18% of mangroves. East coast mangroves give a slightly better picture than the west coast mangroves, in species composition and area covered..

Geomorphology, environmental and hydrological conditions are mainly responsible for the distribution for mangroves. Apart from physical conditions such as soil type, rainfall, tidal inundations, and fluctuations, salinity gradients, and biotic factors are also important. Polyhaline and mesohaline zones (salinity 5-30 %) shelter many mangrove species. The oligohaline zone (salinity 0.05-5 %) supports limited species such as *Kandelia candal, Sonneretia caseolaris* and *Acrostichum aureum*.

Among the west coast states, Maharashtra has the most diversified mangrove flora composed of 19 species, followed by Goa and Karnataka. Gujarat, despite having largest mangrove coverage of 37,000 ha., displays a poor assemblage of 9 species. *Avicennia alba, A. marina, A. officinalis, Rhizophora mucronata, R. apiculata, Acanthus ilicifolius, Sonneretia alba* and *S. apetala* are some of the dominant species along west coast. Shrubby vegetation including *A. ilicifolius, A. marina, Salicornia brachiata* and *Sueda* sp. occurs above the high tide mark. Due to the deforestation as well as development activities and domestic exploitation, species of *Nypa* and *Xylocarpus* have become extinct from the west coast, whereas other species like *Ceriops tagal, Lumnitzera racemosa, Sonneratia apetala* are found only in certain areas (Untawale, 1987). A very distinct discontinuous, distribution of mangrove plants has been observed along both the coasts of India due to various factors.

The east coast mangrove vegetation is comprised of 47 species with almost 70% of the total mangrove cover of India. The maximum number of 27 species has been reported from the Mahanadi delta. Mangrove species like *Avicennia* spp. and *Aegiceras majus* are dominant along the Godavari, Krishna and Cauvery deltas, whereas *Ceriops decandra* and *S. apetala* are dominant in the Mahanadi delta. The dominant flora of Gangetic Sundarbans delta comprises of species like *Exoecaria agallocha, Heritiera fomes* and *Xylocarpus moluccensis*. Mangrove species like *Nypa, Xylocarpus, Heretiera* and *Acanthus ebracteatus*, etc. are confined to east coast only.

The **associated flora** are the plant species that can sustain various levels of salinity in the elevated regions above the spring tide mark. About 30 terrestrial species are known to grow in these areas. The most common mangrove associates are *Clerodendron inerme, Thespesia populnea, Pongamia pinnata, Sesuvium portulacastrum, Myriostachya wightiana, Hibiscus tiliaceus, Fimbristylis ferruginea, Aeluropus lagopoides, Cressa cretica*, etc.

Benthic Fauna

Benthic fauna can be divided into two major groups: macrofauna and meiofauna. Dominant macrofaunal species recorded from the Goa mangroves were *Modiolus metcalfei, Perna viridis, Diopatra neapolitinia, Meretrix casta, Paphia malabaricus, Cerithidea fluviatilis, Diogene custus* and *Glycera alba*. While polychaetes are dominant macrofauna, meiofaunal species belonging to family Chromadoidae and Desmodoridae, followed by copepods, are also quite abundant. The upper 2 cm layer of the mangrove sediment harbours 60% of the total meiofauna.

From the east coast, Mandal and Misra (1986) reported 78 macrobenthic faunal species from the mudflats of Lower Bengal. The most dominant group was Crustacea (27 species) followed by Molluscs (25) and Coelenterata (17). Kasinathan and Shanmugam (1986) studied molluscan fauna of Pichavaram mangroves. They reported 14 molluscan species. Subba Rao and Mukharjee (1975) reported 22 species from Mahanadi estuary.

Wood borers of India are represented by about 26 species belonging to class Crustacea and Mollusca (Turner and Santhakumaran, 1989). Biodeterioration of mangrove wood is severe along the Indian coast. Species such as *Dicyathifer manni, Lyrodus pedicellatus, Banka rochi, B. campanellata, Nausitora hedlevi, N. dunlopei, Bactrosophorus* sp., *Martesia* spp., *Lignopholus chengi* cause sever damage to the woods.

Fishery Potential

The mangrove environment of India harbours 105 species of Fishes, 20 species of shell fishes and over 225 species of crustaceans. Commercially important species such as *Meretrix* sp., *Crassostrea* sp., *Penaeus* sp., *Scylla serrata* and *Mugil cephalus* are important. Finfish resources are abundant in mangrove creeks and estuaries The milk fish *Chanos chanos*, mullets (*Mugil cephalus*), *Atroplus* sp. are suitable for culture in mangrove areas. Both the captive and culture fisheries are quite common in the mangrove forests.

Avifauna

Mangrove forests provides good shelter, food and breeding ground for the resident and migratory birds About 177 species of birds are found in the mangrove forests of India (Mukharjee, 1975; Samant, 1986). Kingfishers, herons, storks, sea eagles, kites, etc. are the dominant and common birds observed. Mangrove region of the Gulf of Kuchchh harbours about 119 bird species. Extensive mudflats in the Gujarat coasts attract birds like pelicans. There are several bird sanctuaries in Sundarbans, Andaman and Nicobar Islands, and several other mangrove forests.

Mammals and Reptiles

A diversified mammalian and reptilian fauna is observed from mangroves. The Royal Bengal Tiger is one of the endangered species that lives in the Sundarbans area. This is the only locality in the world where the tiger shares aquatic and terrestrial food web. Some of the common animals found in mangrove swamps are the monitor lizard (*Varanus* sp.), estuarine crocodile (*Crocodylus porosus*), Pacific Ridley turtle *Lipidochalys olivacea*, various species of monkeys, otters, deers, foxes, wild pigs and fishing cats. Along the west coast, the crocodile (*Crocodilus palustris*) is found only in the Goa mangroves. Among the reptiles, 21 snake, 4 lizard, 5 turtles and 1 crocodile species are recorded (Deshmukh, 1994) from the Maharashtra coast.

Coral Ecosystem

Coral reefs are known to be the most diversified and productive ecosystem among all the marine ecosystems of tropical zone (Wells, 1988). Many corals are veryt beautiful, colourful and attractive to human being (Wafar, 1988). India has about 19,000 km^2 of major reef area including islands and coasts. Coral reefs are of direct economic importance due to their organic and inorganic resources. Corals are also source of income through tourism, and play an important role in protecting the shoreline. Coral reefs are often exploited for calcium carbonate - a raw material for many lime based industries such as lime, cement and calcium carbide. The fishery's resources of the reefs are extremely rich and diversified. The reefs are also exploited for their beautiful associated fauna such as molluses and gastropods *Trochus niloticus* and *Turbo marmoratus* are costly gastropods found in Andamans. Many species of cowries fished from this area are used in making gift articles such as lamp-shades, mirrors, dolls, etc. The giant clam *Tridacna* sp. is common in the Andaman-Nicobar and Lakshadweep.

Indian coral reefs consist of atolls, fringing reefs, patch reefs, elevated banks and submerged banks (Pillai, 1971). Table 4 presents the summary of Indian coral reefs, and the species distribution along the major reefs.

Coral Atolls

Lakshadweep archipelago consists of atolls with several low-lying islands in the east, a broad well-developed reef in the west, with a lagoon in between, connected to the open ocean by several channels. In addition, three more reefs and five submerged islands also harbour living corals. The number of coral species known is 103, belonging to 37 genera (Pillai and Jasmine, 1989). *Acropora* spp., *Pocillopora* spp., *Porites* spp. and massive encrusting faviids are common coral species of the Lakshadweep. *Psammocora* is common in the northern islands. Other common species are *Helipora coerulea* (blue coral) and *Millepora* spp. Genera like *Montipora* and *Echinopora* are recorded from the northern islands but are absent in Minicoy.

The Andaman-Nicobar Island: Coral reefs here are the fringing type surrounding the islands. There are about 500 islands, believed to be part of an emergent mountain chain. There are 516 villages with tribal inhabitants including Andamanis, Onges, Nicobaris, Jarawas and the

hostile Sentinels (Jain, 1984; Banerjee, 1985, Tikader and Das, 1985). The islands are covered with thick forests and mangroves are common trees. The complete biodiversity resources of this region is yet to be evaluated, due to non-accessibility to the region.

Pillai (1983) reported 135 species of Scleraticia, 110 species and 45 genera are hermatypic. Most of the reefs occur at depths of 5 to 7 m. Inshore waters are turbid with scarce coral growth < 100m from shore. Most dominant species in the reef flats are massive Porites and Faviidae. *Acropora, Pocillopora, Seriatopora, Stylophora,* etc. are the common arborescent genera commonly found. Major reef inhabitats include sand and shingle of the upper intertidal zone, dominated *by Donax, Hippa, Crassostrea, Nerita, Thais, Drupa* and *Cerithium* (Pillai 1983); subtidal dead shingle with *Arca, Tridacna* and many diversified species. The reef flats are dominated *by Drupa, Pyrene, Cerithium, Arca, Lithophaga, Pinactada* and variety of hard corals including a stinging coral *Millepora plathyphylla*. The stony corals include genera *Porites, Favia, Acropora, Pocillopora, Helipora, Tubipora* and *Montipora*.

Fringing Reefs

The coastal reefs of India, can broadly be divided into a) minor coastal coral reefs along the west coast and Visakhapatnam on the east coast and b) major coastal coral reefs along southeast India including Palk Bay and the Gulf of Mannar Corals, though rare in occurrence, are reported throughout the west coast. On the east coast, however, due to delta formation, heavy siltation takes place hindering coral growth.

Among the **Coastal Coral Reefs**, Gulf of Kuchchh region in Gujarat has the most luxuriant coral growth along the west coast of India. There are about 44 species of scleractinian corals and 12 soft coral species (Patel, 1988) The submerged reefs of this area harbour 18 stony coral species and has 45 percent coverage. The common genera are *Acropora, Porites, Pseudosiderastrea,* and *Favia* One soft coral *Juncella juncea* is also very common. Corals from this region are largely destroyed by limestone industries and siltation. Along the central west coast, Wafar (1986) reported two species (*Pseudosiderastrea tayami* and *Porites lichen*) of hard corals in patches from Mumbai. Recently, Untawale *et al.* (Pers Observation) cited large well-developed hard coral colonies at Colaba, near south Mumbai. The area under coral coverage is about 60 to 70 percent. One soft coral species is also found in this area. The fringing corals then extend up to Kerala. Malvan (discussed further) is considered to have the richest marine biodiversity along the central west coast. Parulekar (1981) reported *Porites*, a stony coral, as most common in Malvan waters. He reported nine species, including a rare red coral species, belonging to genera *Coscinarea, Favites, Goniastrea, Syneraraea* and *Pseudosiderastrea, Cyphastrea, Turbinaria*. All coral species reported are non-branching. Angria bank - a submerged reef situated off Ratnagiri has stony corals. Five coral species are reported from Gaveshani bank, off Malpe along Karnataka coast. *Pocillopora eydouxi* is recently reported from Visakhapatnam, on the east coast (Bakus, 1994).

The major coastal coral reefs, along the east coast is a series of fringing reefs Ninety-six species belonging to 36 genera of scleractinian corals and seven species of ahermatypic are reported from this region. The Gulf of Mannar is known to have more diversified and abundant coral species (Pillai, 1986). *Montipora* and *Acropora* represent 40 percent of the species (Pillai, 1971) in Palk Bay. Manauli and Krusadai islands near Mandapam, in the Gulf of Mannar, are known for their rich diversified fauna. Thirty species of stony corals were reported from Manauli reef of which the dominant corals were *Acropora, Porites, Goniastrea, Favia, Pocillopora* and *Montipora*. Krusadai Island demonstrates a well-developed coral reef. The "Mannar Barrier" consists of 20 small islands (Lal Mohan, 1986). Pillai (1977) reported 96 species belonging to 26 genera of hermatypic and 10 species of ahermatypic corals. *Acropora, Pocillopora, Poritidae* and *Favia* are the dominant corals from the north region. Due to natural calamities and over-exploitation by industries, students and local dwellers for ornamental value, many large colonies of coral species such as foliaceous forms *Montipora foliosa* and *Echinopora lamellosa* are about to become extinct

Associated Algae and Seagrasses

The coral ecosystem provides a good shelter for marine algal growth and diversified seaweed flora is often observed in coral areas. Some of the algae, though in minor scale, are responsible for reef building. There are certain algae that have calcium carbonate deposition and are known as coralline algae. The role of calcareous algae is however, less significant in the Indian Ocean than in the Pacific Ocean. Jagtap (1987) reported 20 m wide algal ridge on the seaward side of Kavaratti and Agathi Islands, of Lakshadweep.

The maximum marine algal biodiversity of more than 180 species and 99 genera is reported from Gulf of Mannar and Palk Bay (Umamaheshwara Rao, 1972). *Halimeda opuntia* contributed to 20 percent of total sampling. Altogether 82 marine algal species are recorded from the Lakshadweep lagoons with an estimated annual yield of 3645-7598 m tons of fresh weight per year (Subbaramaiah *et al* , 1979) Rhodophycean species were maximum in

numbers (39) followed by 33 green and 10 brown algal species. From Andaman and Nicobar Islands, 64 species and 40 genera were reported, including 27 Rhodophycean, 21 Chlorophycean and 15 Phaeophycean species (Gopinathan and Panigrahi, 1983; Jagtap, 1986). Kalimuthu *et al.* (1990) reported 77,000 wet tons of seaweed biomass for the Indian coast and approximately 19,345 tonnes from Lakshadweep groups of Islands.

Palk Bay and the Gulf of Mannar have extensive seagrass beds. Jagtap (1996) reported 12 species and seven genera of seagrasses from this area. Five species of seagrasses are reported from the Minicoy lagoon by Untawale and Jagtap (1984). The common genera were *Thallasia, Halophila* and *Cymodocea*. Kavaratti lagoon had luxuriant seagrass growth of *Thalassia* and *Cymodocea*.

Fisheries and Ornamental Fishes

The lagoons of the coral islands harboured about 600 marine fishes (Jones and Kumaran, 1980; Bakus, 1994) and the estimated fish production from the reef environments varies from 6 to 9 million tonnes per year (Munro 1982). Fin fishes are one of the major fish resources from Lakshadweep and the Andaman-Nicobar Islands. There are 9 fin fish species and 12 prawn species, which are exploited from the lagoons (Lal Mohan, 1983; Silas *et al.*, 1983). Alagarswamy (1983) reported abundance of sharks at >10 m depths of the Andaman-Nicobar Sea. Lakshadweep waters also harbour a good amount of sharks. Five species of Lobster *Panulirus* spp. are reported to occur from the innermost barrier reef to the outermost reef of the Indo-West Pacific coral reefs (George, 1974). Eight species of spiny lobster (Panulirus) and five species of slipper lobster (Scyllarids) occur along the Indian coast Eight species of edible crabs are reported from Andaman-Nicobar Islands (Kathirvel, 1983). Apart from this, snail species *Trochus niloticus*, and *Turbo* spp. were exploited for their commercial value. Four edible oyster species are also reported. The pearl oyster *Pinctada margaritifera* and few other species such as *Pteria pengion* occur on coralline reef flats at depths of 0 to 10 m (Alagarswamy, 1983). Seven species of holothurians along with sea urchin *Tripneustes gratilla* are known to be potential food species in the Andaman and Nicobar Islands (James, 1973). Some of the holothurian species from Lakshadweep are being over-exploited for export.

Ornamental Fish from the coral reef are in great demand as aquarium samples There is a vast resource available and fishes such as surgeon fish, parrot fish, damsel fish, soldier fish and cardinal fish are most popular. In Lakshadweep and the Andaman-Nicobar Islands, fishes of the group clupids and apogonids along with pomacentrids are captured. Gopakumar *et al.* (1994) located a large resource of *Spratelliodes delicatulus* in the marine park of Wandoor.

Five species of **Marine Turtles** are found all along the Indian coast and in Lakshadweep and the Andaman-Nicobar Islands (Rajgopalan, 1996). Hawksbill turtle *Ertmochelys imbricata Chelonia mydas* (green turtle), *Caretta caretta* (loggerhead) *Lepidochelys olivacea* and *Dermochelys coriacea* are the most common. Visit of the Gaharimatha coast along Orissa by millions of marine turtles is a matter of great interest There have been large scale mortalities also recently The population of the horse shoe crab are reported from the West Bengal coast There are two different species and they are of great economical - medicinal value.

Ocean Biodiversity

The oceans cover 71 % of the earth's surface and provide the major global environment for the evolution of life A variety of organisms inhabit different areas in the ocean, starting from the intertidal areas to the depths of the ocean. Biodiversity increases from the polar region towards the equator and reaches to the maximum in the tropical zone As compared to coastal biodiversity, the ocean shows the presence of lesser, but altogether different, forms of life There are also certain areas in the offshore region which are known as '*deserts*', where no life exists. The oceanic waters can be grouped into two categories, i. e. - surface and deep seas.

Surface

The ocean surface is a very dynamic zone where air-sea interaction, influence of radiation and heavy precipitation are seen Because of the presence of planktonic organisms, the surface waters normally show high biological productivity due to the qualitative and quantitative presence of phytoplankton and zooplankton.

Plankton - Phytoplankton and Zooplankton

Due to the availability of essential environmental conditions and nutrients, the planktonic species show the phenomenon of '*eutrophication*'. The best example of this is observed along the west coast, during pre-monsoon, in the blooms of *Trichodesmium erythraeum* - a blue green alga The euphotic zone of the 250 m water column shows the presence of several phytoplanktonic species which are unicellular in nature.

The zooplankton species responsible for the secondary production normally graze on the phytoplankton species. There are several species of zooplankton belonging to

different groups. These planktons migrate horizontally and vertically and are considered as an important food source for the tertiary animals.

Phytoplankton: There is sufficient information available on the productivity of phytoplankton in the Arabian Sea (Radhakrishna *et. al.*, 1978; Qasim, 1982; Bhattathiri, 1992). Goes *et al.* (1992) studied the distribution and production of phytoplanktons by using satellite imageries for chlorophyll images along the west coast of India. The intense cooling in the Gulf of Kuchchh, with high phytoplankton biomass, is an intersting phenomenon.

The most dominant phytoplankton group is diatoms (86%) followed by cyanobacteria (7%) and dinoflagellates (6%). Sawant and Madhupratap (1996) reported a total of 36 phytoplankton species. The most common were *Nitzschia* species such as *N. seriata, N. closterium* and *N. pungens* comprising 25% of the total population.. *Navicula* was common (22%) at only one station (15°N 64°E), followed by *Rhizosolenia* spp (10%) and *Chaetoceros* (9%). *Ceratium* sp. and *Peridinium* sp. were the dinoflagellates constituting 4% of the population.

There is no systematic list of phytoplankton species available and most of the work carried out is site-specific. It is necessary to document all available phytoplankton species systematically, along with the important environmental parameters.

Zooplankton: Zooplanktons are placed at the second lowest level of the trophic prism, feeding on the phytoplanktons. High zooplankton mass is observed when phytoplankton count is less and nutrition depletion is observed (Madhupratp *et al.*, 1992). Along the central and eastern Arabian sea, the composition of microzooplanktons in the upper 200 m was dominated by protozoans (ciliates - loricates and aloricates), flagellates and sarcodines, ranging from 55 % to 91 % (Gauns *et al.*, 1996). Tintinnids were represented by 30 genera, and 11 genera (*Tintinnopsis, Eutintinnus, Favella, Parundella, Amphoriddes, Codonella, Tintinnus* and *Xystonellopsis)* were present throughout the year. They further reported that among metazoans, nauplii and copepodite stages were common. The upper 100 m water column showed high microzooplankton abundance in all the seasons. The intermonsoon season showed the highest value of zooplankton, at 700 ml l^{-1}, followed by summer (300 ml l^{-1}) and winter (130 ml l^{-1}). Copepod fauna sampled from southeast and southwest coast of India was composed of Paraclanidae forming 27.6% to 76.7% of the total. In the upper stratum, Poecilostomatoids (Oncaeidae and Corycaeidae) along with cyclopod Oithonidae constituted 16.6% to 43.5% (Stephen, 1992). Among the twenty species of calanoids, *Pleromamma indica* was the most dominant species in 0-500 m water column. Based on zooplankton data collected from 1864 samples in the duration of 12 years (1976-1988), the zooplankton biomass values vary between 0.1 to 12 ml m^{-3}, 0.1 to 8.0 ml m^{-3}, 0.1 to 1.6 ml m^{-3}, and 0.02 to 0.37 ml m^{-3} in the Arabian Sea, the Bay of Bengal, Lakshadweep Sea and the Andaman Sea respectively (Goswami *et al.*, 1992). The numbers of zooplanktons species recorded from various parts of the Indian coastline are given in Table 5.

Fishery

India's marine capture fish production was 1.10 million tonnes in 1970. With the mechanization it reached 2.27 million tonnes in 1995-96 and has been showing signs of leveling off immediately thereafter, with the annual growth rates oscillating between ± 5%. The potential fishery yield estimate from India's EEZ is 3.9 million tonnes, with hopes of increasing production from the outer continental shelf. However, fish production is correlated to zooplankton production (Prasad *et al.*, 1970).

The shelf waters indicate a dense congregation of a number of coastal species. The neritic waters in the depth range of 150-398m were promising for deep sea forms like *Pseneopsis* spp., *Chlorophthalamus* spp., *Priacanthus* sp., etc. (Table 6).

Based on the FORV Sagar Sampada data, a check list of the fishes found in the exclusive economic zone (EEZ) of India was prepared by Balachandran and Nizar (1990). In all 87 families and 242 species including both conventional and non-conventional fish fauna, along with zoogeographical and vital biological information, have been collected to assess the stock potential and exploitation. Information on non-conventional resources of the pelagic, mesopelagic, bathy pelagic and benthic fishes of the outer shelf and beyond is essential to strengthen coastal fishery.

Deep Sea Life

Human interest in deep sea life has increased globally in the past few decades. Deep sea productivity is more chemosynthetic in nature (with the presence of hot springs and hydrothermal vents) than photosynthetic primary production (Grassle, 1986; Tunnicliffe, 1991).

Micro-Organisms

Microbes are of great importance in the deep sea due to their active role in the biogeochemical cycles (Chandramohan, 1992). Chandramohan *et al.* (1987) isolated bacteria attached to ferromanganese (polymetallic) nodules from the Indian Ocean. These nodules were collected at 5400 m depth in the Indian Ocean. Two types of psychrotrophic bacteria Mn (II) oxidizing and MnO_2 reducing were

reported. They belonged to members of *Vibro*, members of Enterobacteriaceae, *Bacillus*, *Micrococcus*, *Staphylococcus*, *Arthrobacter* and Coryneforms.

Deep sea fungi were isolated from the calcarious shells at 100 to 860 m depth in the Bay of Bengal. All the species isolated had terrestrial origin and *Aspergillus rusticus* was the most common species (Raghukumar *et al.*, 1992).

Benthic and Fishery Resources

Qualitative investigations on deep sea benthos of the Indian Ocean in the depth ranges of 1580 to 6000 m (latitude 21° N - 21° S and 51°- 94° E) revealed rich biota having relatively low species biodiversity (Parulekar *et al.*, 1992). Six meiofaunal and 12 macrofaunal taxa with neamatodes comprising 53.3 % of the total meiofaunal species were recorded (Table 7). Foraminifera (17.6%) and harpacticoids (16.8 %) were the other important taxa. Polychacta was the most dominant group among the macrofaunal taxa and accounted for 63.4%. Both macro and meiobenthos decreased in abundance with increasing water depths. In the <2000 m depth, the benthic biomass was uniformly high (0.11 - 12.75 g m^{-2}) and was lowest (0.12 g m^{-2}) at 7550 m depth.

Lack of adequate information on the availability and extent of commercially exploitable resources beyond the conventional fishing grounds has been a major constraint for the development of deep sea fishing in India. Deep sea fishing, being a capital intensive industry, depends largely on the exploitable varieties of resources that could earn foreign revenue. Crustaceans, mainly prawns, are much sought after due to their export value.

The exploitable stocks of crustaceans in the shelf water of India have been reported by George *et al.* (1963), Rao (1973), Sekharan *et al.* (1975) and Muthu *et al.* (1975). Occurrence of crustaceans in appreciable quantities beyond the continental shelf has also been reported (Kurian, 1965; Silas, 1969; Suseelan, 1974; 1985; and James, 1989) from the southwest coast and the Gulf of Mannar. On the west coast, the coastal prawns *Parapenaeopsis stylifera* (Karaikudi) has been encounterd in various densities, up to 53 m depth, during the south west monsoon almost as a continuous belt in the off shore waters between Quilon and Marmagoa. The upper continental slope provides an entirely different faunastic composition in which members of all deep sea penaeidean families (Solanoceridae, Aristeidae and Penaeidae) and Caridean prawns of family Pandalidae are represented. In a 200 - 300 m depth, the important species were *Plesionika spinipes* (60.5%), *Penaeopsis jerryi* (26.3%), *Solanocera hextie* (5.6%), *Metapenaeopsis andamanensis* (3.7%) and *Heterocarpus woodmasoni* and *H. gibbosus*.

The deep sea spiny lobster *Puerulus sewelli* is found in the appreciable quantities in the 200 to 400 m depths, mainly between Kanyakumari and Alleppey. The highest catch per haul was recorded at 200 to 300 m depth off Thiruvanthpuram. The size of these lobsters ranged from 71 to 200 mm in total length. This species is known to occur off Lakshadweep Islands between 660 and 840 m depth (Holthuis, 1984) An abundance of sand lobster *Thanus orientalis* at 40 to 70 m depth off Veraval to Dwarka and Kanyakumari to Alleppey has also been reported (Suseelan *et al.*, 1990). The swarming crab *Charybdis* (*Goniohellenus*) *smithii* ranging from 42 to 72 mm in carapace width is potentially an important constituent catch in the offshore waters. The highest catch was recorded at 200 to 400 m depths between Thiruvanthpuram and Alleppey

The neritic squids of the family Loliginidae and the oceanic squid of Omnastrephidae account for 70 % of the world's cephalopod catch. The purpleblack flying squid *Symplectoteuthis oualaniensis* (Lesson) belonging to Omnastrephidae family: comprises the economically important species of oceanic squid of the world. Other species that occur in stray quantities are *Onychoteuthis banksi* (Leach), *Thysanoteuthis rhombus* (Troschel) and members of the family Enoploteuthidae.

The literature review on the Indian Ocean shows that there are few efforts to study the deep sea biota. Therefore, there is much to be learnt about the biodiversity of this silent and dark zone of the deep sea.

Case Studies - Maharashtra Coast

A number of coastal areas along the Maharashtra coast are rich in marine biodiversity and have unique flora and fauna that needs to be preserved. These localities can serve as centers for ecotourism, recreation, education and research. The flora and fauna can be maintained as *'Germ plasm preservation centres'*. Efforts were made to identify the areas with high biodiversity and uniqueness of flora, fauna and other environment as *'Marine Protected Areas'* taking into consideration the ecological, biological and other environmental factors.

Detailed observations were carried out at each station on the flora, the fauna, the environment, etc. and information regarding local industries in that area was also collected. Changes in the marine biodiversity during the past 10 year were also determined by making comparisons with the earlier data, in order to indicate the trend. The intertidal zones along the open rocky coast were surveyed at low tide, for marine algae and benthic meiofauna. Marine algal samples were collected at random and the common species were recorded. Biomass of dominant algae was calculated by placing 0.25 m^2 quadrants randomly in 2-3

transacts. Species were preserved in the form of herbarium sheets and deposited at the National Institute of Oceanography, Goa. Benthic faunal samples were taken by placing a core size of 4 cm diameter randomly. Samples were immediately preserved in 5% formalin for further identification. In some cases, such as Colaba, Mumbai, the density of corals, and sea anemones was measured by photographing the area without disturbing the organisms.

The estuarine stations were surveyed for mangroves. The reproductive phenology was recorded and branches were collected to make herbariums. The density of mangrove trees was recorded by placing 10 m^2 quadrants at random. The core samples were taken for meiofauna Algal species were collected, whenever observed. Avifauna was recorded photographically and bird species were identified with the help of field guides (Ali and Ripley 1983a, 1983b). The availability and abundance of wild life was also recorded through discussions with the local people.

Marine Protected Areas

The Maharashtra coast lies between lat. 15° 43' to 20° N and long. 72° 49' to 77° 41' E. The coastline is 560 km long and is indented by numerous river mouths, creeks, small bays, headlands, promontories, cliffs, etc. There are about 18 major estuaries along the Maharashtra coast, harbouring many mangrove floral and faunal species in varying density.

The mangrove forests of Maharashtra comprise of 17 species along with 17 associated plant species. Among 37 stations visited, 25 stations harboured mangrove flora. Good patches were observed along Achra, Deogadh, Vijaydurg (Sindhudurg district), Purangadh, Ratnagiri (Ratnagiri district), Kundalika (Raigadh district) and Mumbra-Diva. *Avicennia marina* was the most common species. A high density of mangroves was observed at the above mentioned stations. Due to a good forest cover, these areas also give shelter to a variety of wild animals such as the fox, wild boar, snakes, etc. The mangrove forest is also known to be a sanctuary for various local and migratory birds.

Marine algae are more in number along rocky shores and prefer gradual slopes in the intertidal expanses. Altogether , 91 marine algal species were found along the Maharashtra coast. Malvan displayed a maximum number of marine algal species (73) followed by Colaba, Mumbai (64) and Ratnagiri (56). Species belonging to genera such as *Monostroma, Gelidium, Gracilaria, Sargassum*, etc. are economically important and hence exploited for their commercial value. Some species, e.g. *Acetabularia* sp. and *Caulerpa verticillata* are rare and require to be conserved by modern techniques such as germ plasm preservation, cryopreservation, and tissue culture.

The open sandy beaches generally have fine to medium sand and thus provide ideal pore space for the development of rich and diverse interstitial fauna. In general, the benthic macrofauna is dominated by polychaetes, both in term of density and diversity (till this date > 72 species are reported from the area). The mollusc group is represented by many important species of bivalves and gastropods such as *Perna virides, Crassostrea cucullata, Pinctada* sp., *Meretrix casta, M. meretrix, Paphia* sp., *Donax incarnatus, Solan* sp., *Gafrarium* sp., and *Bullia* sp. Crustacea is the other fauna group represented by mmany economically and ecologically important groups such as prawns, crabs, lobsters, isopods, amphipods. One of the ecologically important faunal group recorded at only a few locations (such as Vengurla-Rock Islands, Malvan, Ratnagiri, and Mumbai) is coral. From the above sites, corals are most abundant at Malvan. Nine species of corals are reported from Malvan waters (Qasim and Wafar, 1978; Parulekar, 1981) However, the highest density of corals have been recorded at Colaba.

The coastal zone plays an important role as a breeding and feeding ground for a large number of birds. However, avifaunal studies of the coastline are not many. Very scanty information regarding the birds of the coastal areas is available. A total of 121 bird species were recorded from mangroves and adjacent areas (Ali and Ripley, 1983a, 1983b; Samant, 1986). Out of these, 66 species are resident and local migrants, 24 true migrants, 28 resident with migratory populations and only 3 are vagrant or occasional strays.

The coasts of Maharashtra have marine turtles, porpoises, and dolphins. Occasionally, drifted and stranded whales are also reported from this region.

Selection of sites suitable as Marine Protected Areas (MPA) was mainly based upon the biodiversity of that particular area. In Table 8, merits of each area are described. Malvan was considered as one of the priority areas, as it has a naturally protected coast, and the Sindhudurg fort. The diversity of flora and fauna is also high. Due to the geomorphology of this area, subtidal biodiversity is also rich. Endangered species such as corals and gargoniuns are found in this area.

Altogether 37 stations were surveyed for the floral and faunal biodiversity and to identify the probable sites for Marine Protected Areas, taking into consideration their general environmental conditions.

After assessing the merits of each station, primarily 10 sites were selected for further detailed observation. In the last phase, out of these 10 sites, only 5 sites are recommended as Marine Protected Areas (Table 8). These areas are as follows:

Malvan is an open coast ecosystem, and is dominated by *rocky outcrops with intermittent sandy beaches.*

'Sindhudurg', a fort constructed by Maratha King Shivaji in the 16th century is on an island situated at a kilometer distance from the main land. The sea in between and around the fort has many submerged and exposed rocks that provide ideal substratum for marine biota and shelter many organisms. There is a gradual slope between main land and the fort, which is exposed during low tide (about 300 to 500 m). Towards northwest, cliffs are present with 10 to 20 m intertidal expanses. The recorded flora and fauna is highly diversified and present in large number The Government of Maharashtra has notified its intention to make this area into a National Park. In. general, the Malvan coast has sandy, rocky and muddy substratum. The rainfall is heavy and water transparency is quite good. Marine life, in comparison with other sites along the Maharashtra coast, is richer, both qualitatively and quantitatively.

Altogether 73 marine algal species are recorded from Malvan. Among these, 23 were Chlorophyceae, 17 Phaeophyceae and 33 Rhodophyceae members. The average biomass was 1.12 kg m^{-2}. The estimated standing algal crop of the Malvan coast varied from 450 to 600 tonnes annually. Brown algal species such as *Sargassum* spp. and the Dictyotales formed the major portion of the biomass.

Marine benthic fauna of the Malvan coast (sandy, rocky and marshy area) comprised of 208 species belonging to 172 genera (Parulekar, 1981). The faunal species displayed diversified composition of several groups including 9 corals, 2 sponges, 2 seapens, 18 sea anemones, 49 polychaete worms, 5 stomatopods, 5 isopods, 2 crab species, 5 prawns, 5 barnacles, 1 insect, 4 limpets, 10 top shell, 8 whelk, 11 spire shells, 3 sea hare, 3 mussels, 3 edible oyster, one pearl oyster, 11 clams, 3 echinoderms and 2 mud skipper species. There is also a chain of rocky islets towards the south extending up to Vengurla Rock Islands, which harbour a very good biota up to 15-20 m depth.

Achra - Devgad - Vijaydurg

Vaghotan, Deogad and Achra complex shows good mangrove formations and rich in biodiveristy.

Achra is an estuarine station with good mangrove patches. This region has an estimated area of 273 ha. Eleven mangrove species are distributed along the stretch of the estuary, viz. *Rhizophora mucronata, Avicennia officinalis, A. marina, Sonneratia alba, S. caseolaris, Exoecaria agallocha, Bruguiera gymnorhiza, Acanthus ilicifolius, Aegiceros corniculatum, Derris heterophylla* and *Clerodendron inerme*. *R. mucronata* and *A. officinalis* were found to occur in all parts of the estuary while the remaining species had a restricted distribution. *Sonneratia alba* and *S. caseolaris* were observed only in the midstream region of the estuary. *Exoecaria agallocha, A. corniculatum, C. inerme* and *D. heterophylla* were seen in the upper reaches of the estuary. Species like *B. gymnorhiza* and *A. marina* were noticed only in a few islands. The *Rhizophora* zone was dominated by *R. mucronata* with height ranging from 6 to 10 m approximately.

Achra mangroves are considered as 'sacred' since this land belongs to the local deity of Shri Rameshwar. Vijaydurg and Devgad have very good mangrove cover and these are also 'heritage' sites. Perhaps this tri-estuarine complex can be considered as a transition zone for the north and south west coast.

Two marine algal species i.e. *Monostroma oxyspermum* and *Enteromorpha clathrata* were dominant in the mangrove area. Other species such as *Gracilaria verrucosa, Colpomenia sinuosa, Padina tetrastromatica* were found in patches. Species of *Caloglossa* and *Catnella* were common on the pneumatophores and lower stem portion, that gets submerged during high tide.

Ratnagiri has a long sandy beach with rocky outcrop towards north. The average intertidal expanse in the open coast was around 30 m. The narrow expanse is due to the high cliffs. Barnacles, Oysters, *Ulva fasciata* and *Enteromorpha* spp. always cover the supralittoral zone. The mid-littoral zone is usually covered with Dictyotaceae members like *Dictyota, Padina, Stoechospermum, Spatoglossum* etc. and red algae like *Gracilaria* sp. and *Grateloupia* sp. The maximum seaweed growth was found in this zone The lower midlittoral zone is dominated by *Sargassum* spp. Sea anemones, zooanthus, hydroids, crustaceans, etc. represent the faunal group. Zooanthus is mostly associated with marine algae and occupies a large area

The Shirgao creek in Ratnagiri is quite long with healthy mangrove trees. Altogether, seven mangrove species and three associated species are found. In some areas, the Social Forestry Department had planted *S. alba* and *R. mucronata* during 1986 resulting in the dominance of these species. Other species were *Kandelia candel, A. officinalis, and A. ilicifolius*. The average density observed was 20-23 plants in 10 m^2 quadrant. The average height of *S. alba* was 6m and *R. mucronata* 4m. 117 bird species were recorded from Ratnagiri mangroves. This is also one of the rich fishing areas with luxurious intertidal fauna.

Colaba, a highly populated area of southern Mumbai, is a tip protruding into the Arabian Sea. This area, though within the city limits and despite the fact that the Mumbai coast is one of the most polluted coasts, exhibits a diversified and most luxuriant flora and fauna. The shoreline is a gradual slope with few immerging rocks. There are various tidal pools, with sandy bottom, providing an ideal environment for marine organisms.

A total of 64 marine algal species were recorded from here. The most dominant species were *Caulerpa* spp. Six

species belonging to genus *Caulerpa* , including one rare species *C. verticillata,* were recorded. Out of the 64 species found, majority (31) were red algae, followed by 19 green algae and 14 brown algal species. In supra-littoral zone, blue green alga, namely *Microcoleus* sp. was most dominant. Earlier workers (Untawale *et al.,* 1979; Khadilkar, 1988) did not record some species, such as *Gastroclonium, Champia,* etc. The flora here showed a marked similarity to that of the Gujarat (Kuchchh area) coast. The average biomass estimated was 0.25 m^2 quadrants. The average biomass estimated was 0.430 kg m^{-2}. The maximum biomass belonged to *Caulerpa* sp followed by *Hypnea valentiae.*

Fishing with gill net and rampon has been very common here. At many places, fisherfolk build stone walls to trap the fish during low tide. The local people collect oysters and clams. A large numbers of invertebrate species were observed in the intertidal region associated with marine algae. This area is dominated by the coral species *Goniopora stokesi.* There are two other coral species also growing in the intertidal zone. The corals seemed to have developed an ecological adaptation to survive in turbid as well as polluted conditions. Other common faunal species recorded were; sea anemone, sea cucumber, annelid worms, shrimps, amphipods, isopods, brittle stars, zooanthus colonies, etc.

Vikroli lies towards the western banks of the Thane creek. This area is important as a case for the conservation and management of mangrove forests in private ownership. Vikroli has about 1750 ha of mangrove vegetation owned and preserved by M/S Godrej Trust Pvt. Ltd. *Avicennia marina,* is one of the most dominant species along with *R. mucronata, S. apetala, A. corniculatum* and *A. illicifolius.* The average height ranges from 7 to 10 m. The other forms that enrich the biodiversity of Vikroli include 185 bird species, 8 prawn species, 15 crab species and 30 reptile species (Deshmukh, 1994; Kulkarni, Pers. Comm.).

The Godrej Trust has established an Interpretation centre to enhance the awareness about mangroves and the need to conserve them. A nursery has also been developed for providing saplings for afforestation. Two observation towers have been erected in this area. This is one of the best managed mangrove areas along the coast.

There are several islands present off Maharashtra coast such as Vengurla - rock islands, off Malvan, Kanderi-Underi, off Thal, etc. These islands support rich marine biodiversity as there is little pollution on these islands. Being remotely placed, less human interference has been observed. These islands are free from siltation occurring in the nearshore regions and have a less turbid and more transparent environment. All these conditions are ideal for the rich and healthy growth of intertidal and subtidal flora and fauna. These islands are also ideal for research, education and adventure tourism Some submerged banks with rich biota are also present along the Maharashtra coast.

Unique features were observed along the Mumbai coast. The Mumbra-Diva site had a good growth of mangrove species, *Sonneratia apetala.* The avergae height of the trees was 13m and the population was also highly dense. These need immediate protection.

Other Hot Spots Along the Indian Coast

Activities such as deforestation of mangrove forests, dredging of the coral reefs, and uncontrolled harvests of rare organisms by over-enthusiastic communities are the main reasons for degradation of the marine biodiversity (Dhargalkar and Untawale, 1991). Despite the over-exploitation and ever increasing pressures, some coastal areas have still retained their rich biodiversity. These sites are being identified and recommended for urgent preservation, conservation and sustainable utilization.

West Coast of India

Apart from the sites already described, Pirotan Island (Gulf of Kuchchh), is another priority coastal site.

The **Gulf of Kuchchh** lies between 22° 45' - 23° 55' N latitude an 70° 10' - 71° 58' E longitude. Apart from being a coral reserve, it is also known as the breeding ground for the Lesser Flamingo, a nesting place for Great Indian bustard, *Choriotis nigriceps* and a wintering area for waders, pellicans and ducks. The Pirotan Islands and submerged reefs display corals, giant sea anemones, sea cucumbers, gargoniuns, etc. The Gulf of Kuchchh is also very rich in marine algal biodiversity and biomass . There are several commercially important seaweed species such as *Sargassum* spp., *Gracilaria* spp. etc. Some of the rare and endangered genera such as *Acetabularia, Neomeris, Halimeda* have also been reported from this region. Table 9a describes the biodiversity values of the Gulf of Kuchchh.

In Tables 9b, 9c and 9d the biodiversity and socio-economical values of other horspots from west coast of India, namely Colab-Mumbra-Vikroli, Malvan-Achra-Deogad and Coondapur, are described.

East Coast of India

The east coast of India with the large delta formations supports large mangrove forests. The Gulf of Mannar is particularly known for its rich marine biota. Because of its high biodiversity value, the Indian National Man and Biosphere Reserves Committee declared Sundarbans and Gulf of Mannar as marine biosphere reserves in 1974 (Dhargalkar and Untawale, 1991).

Sunderbans is in the Ganga and Bramhputra Delta (21° 30' - 22° 45' N latitude and 88° 60' - 89° 5 E longitude), an area of 9630 km² with 4264 km² under mangroves. The mangrove forest of Sunderbans is a habitat for the tiger. This is the only place in the world where the tiger shares both an aquatic and a terrestrial food web. There are 64 mangrove species and they are home for many wild, endangered and globally threatened plant and animal species. The Royal Bengal tiger, estuarine crocodiles, monitor lizard and gray water monitor (*Varanus flubiscence*) are some of the wild animals found in this area. It is also a nesting place for marine turtles and marine mammals such as the Gangetic dolphin, the black finless porpoise, and the horse -shoe crab (a living fossil) are also found here.

Bhittarkanika is situated north of Mahanadi delta with mangrove forests covering the tidal islands. The largest living reptile - an estuarine crocodile *Crocodilus porosus*, which grown to be upto 5 m long, resides in this sanctuary. The most significant characteristic of this area is that Gaharimatha is a nesting site for the Pacific Ridley turtle *Lepidochelys olivacea*, which is the largest turtle in the world. This area is unique for its biodiversity values. (Dhargalkar and Untawale, 1991).

Gulf of Mannar is a shallow protected area between India and Sri Lanka (8°49' - 9° 15 N latitude and 78° 11' - 79° 15' E longitude) and is rich in marine biodiversity. About 106 coral species have been reported from this area, including branching corals *Acropora* spp. and *Montipora* spp., along with largely exploited molluscan species such as *Conus* and *Murex*. Economically important seaweed genera like *Gracilaria, Gelidiella, Sargassum* and *Turbinaria* are collected in large quantities for the phycocolloid extraction. The extensive seagrass beds are the feeding grounds for endangered species like the dugong and various turtles. The sandy beaches are nesting sites for the marine turtles.

Islands

Both the Lakshadweep archipelago and the Andaman-Nicobar group of islands are important marine areas. The **Lakshadweep** group of islands is formed of typical coral atolls and harbours a significant number of coral species, associated fauna and ornamental fishes. The rich biodiversity of this region includes 105 coral species, along with 78 seaweed species, 6 seagrasses, 91 sponges and 18 boring sponges (Bakus, 1994).

The Andaman and Nicobar Islands are considered to be one of the hot-spots of marine biota. These islands support both mangrove and coral ecosystems. The thick mangrove forests harbour 20 mangrove species and other rare and endangered animal species such as the estuarine crocodile, marine frog, and turtles. Other endangered species are Andaman wild Pig (*Sus scorfa andamanensis*), crabeating macaque (*Macaca fascicularis umbrosa*), and various species of birds. (Tikadar and Das, 1985). Most important areas are Vandoor and Narcondam.

There are about 2,900 marine animal species recorded from this group of islands (Subba Rao, 1984). Avifauna is composed of 50 species. Some of the species highlighting the rich biodiversity of the fringing corals of Andaman-Nicobar include 135 hard coral species, 251 species (22 endemic to Andaman-Nicobar) of echinoderms, 19 penaeid prawns, 4 crabs, and 6 lobster species. There are about 70 sponges, > 110 coelenterates, and 31 sea anemones (Bakus, 1994).

In Table 9e, 9f, 9g, 9h and 9I, the biodiversity and socioeconomic values of the hotspots of the east coast of India, namely Sunderbans, Bhitarkanika, Gulf of Mannar, Lakshadweep Island, and Andaman -Nicobar Islands, are described.

Conclusion and Recommendations

1. The coastal areas have greater variety of habitats than the open ocean and are subjected to greater developmental pressures and exploitation. Therefore, the conservation of the coastal habitats should have the highest priority.
2. The economic value of the coastal habitats is usually not taken into account while assessing their value. Coastal regions provides direct and indirect benefits to humankind. There are many ecological benefits, that coastal habitats provide, that need to be economically evaluated.
3. Diversity of the deep sea benthic communities and fishes in the water column is largely unknown. However, it is clear that they are a rich sources of genetic diversity.
4. It is necessary to maintain the population of various communities at an optimal level in order to sustain genetic exchange and ensure that the varieties of breeding populations are maintained to sustain natural genetic diversity.
5. In most of the developing countries the focus is on food production and on economic growth rather than on the conservation of biodiversity. Therefore, there is a need to explore the economic value and other practical benefits of conservation of biodiversity, so that policy decisions are made keeping in view the benefits biodiversity conservation offers.
6. Participation of the local people in the conservation of biodiversity is the need of the hour. It is essential to create awareness amongst coastal inhabitants about the need for the sustainable use of biodiversity.

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Table 1: Marine algal diversity of the Indian Coast

	Chlorophyta	*Pheophyta*	*Rhodophyta*	*Cyanophyta*	*Total*
Order	4	5	6	2	17
Families	15	12	31	6	64
Genera	45	39	120	11	215
Species	159	141	307	17	624

Table 2: Seaweed Resources available along the Indian Coast

No.	*Coastal States*	*Order*	*Family*	*Genera*	*Species*	*Production (Ton/year)*
01	Gujarat	15	42	105	202	100,000
02	Maharashtra	16	40	76	152	20,000
03	Goa	13	29	48	75	2,000
04	Karnataka	12	19	28	39	~100
05	Kerala	8	10	14	20	?
06	Lakshadweep Islands	13	29	51	82	70,000
07	Tamilnadu	15	45	428	302	90,000
08	Andra Pradesh	14	29	51	79	?
09	Orissa*	1	2	3	6	?
10	West Bengal	3	4	5	6	?
11	Andaman and Nicobar Islands	8	25	40	64	?

*Information available on Chilka Lake only.

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10	West Bengal	3	4	5	6	?
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*Information available on Chilka Lake only.

Table 3: Mangrove biodiversity of India

I	*FLORA*	*Genera*	*Species*
1	Algae	30	47
2	Fungi	40	50
3	Seagrasses	1	2
4	Mangrove flora	41	59
5	Lichens	8	14
II	*FAUNA*		
1.	Crustaceans	46	82
2.	Molluscs	57	88
3.	Wood borers	13	24
4.	Fishes	70	120
5.	Reptiles		
	— Snakes	18	21
	— Lizards	3	4
	— Turtles	5	5
	— Crocodiles	2	2
	— Amphibians	4	8
6.	Birds	53	119
7.	Mammals	29	34

Compiled from various published reports.

Table 4: Diversity of coral species along the Indian coast

Area	*Type*	*Hermatypes*		*Ahermatypes*	
		Gen	*Spp.*	*Gen*	*Spp.*
Palk Bay and Gulf of Mannar	Fringing	26	96	9	10
Gulf of Kuchchh	Fringing				
	Patchy	20	34	4	3
Andaman and Nicobar Is.	Fringing	47	100	12	35
Lakshadweep Is.	Atolls	27	69	4	9
Submerged Banks	Patchy	5	5	-	-
Central West Coast	Patchy	8	8	-	-
Indian Reefs	-	51	156	21	44

Total Genera : 71, Total Species : 200
Compiled from published reports.

Table 5: Zooplankton species distribution along the Indian coast

Locality	*Family*	*Genus*	*Species*
Shelf & slope waters of cochin	-	14	51
Goa estuaries	28	36	76
Godavari estuary	-	-	60
Vengurla & Karwar	23	33	90
Vengurla & Malpe	23	34	92
Goa (Coastal waters)	-	31	93
Lakshadweep	-	35	51
Bay of Bengal	-	19	28
Arabian sea	-	13	30

Compiled from published reports.

Table 6: Percentage composition of various groups of coastal and deep sea demersal fishery resources along west and east coasts of India

Area: *Effort (hrs/min):* *Composition*	*West coast* *212 hrs/15 min* *%*	*East coast* *118 hrs* *%*	*Andaman & Nicobar Archipelago* *12hrs/40 min* *%*
Shark	0.80	1.81	2.46
Skates	0.17	1.01	0.06
Rays	0.66	2.17	9.22
Carangids	2.89	8.39	17.20
Nemipterids	28.43	26.71	1.56
Saurida spp.	3.12	0.96	2.22
Upeneus spp.	0.97	1.97	1.88
Sphyraena spp.	1.28	8.85	0.68
Priacanthus spp.	6.98	7.55	0.39
Epinephelus spp.	0.73	2.25	3.24
Lethrinus spp.	0.78	1.44	7.21
Lutjanus spp.	1.25	0.28	5.90
Lutianus spp.	0.14	0.74	-
Other perches	0.45	0.66	-
Scieanids	0.84	1.26	-
Silverbellies	0.004	1.42	29.65

Contd. . . .

Area: *Effort (hrs/min):* *Composition*	*West coast* *212 hrs/15 min* *%*	*East coast* *118 hrs* *%*	*Andaman & Nicobar Archipelago* *12hrs/40 min* *%*
Mackerel	0.23	9.38	0.47
Cat fish	2.01	1.47	-
Flat fish	0.63	0.11	-
Trichiurus spp	6.17	0.53	1.01
T. auriga	1.56	1.00	-
Chlorophthalmus spp.	10.37	-	-
Cubiceps spp.	2.14	-	-
Neoepinnula spp.	1.29	-	-
Pseneopsis	10.89	0.46	-
Psenes indicus	0.21	4.96	3.04
Psenes spp.	0.12	-	-
Pipe fish	2.31	-	-
Deep sea fish	0.96	2.26	-
Other fishes	6.74	9.16	12.72
Crustaceans & cephalopods	4.39	4.25	1.08

Compiled from published data.

Table 7: Depth-wise Percentage Faunal Composition of Macro and Meiofauna

Faunal group	*1500-1999*	*2000-2499*	*2500-2999*	*3000-3499*	*3500-3999*	*4000-4499*	*4500-4999*	*5000-5499*	*5500-5999*
MACROFAUNA									
Polychaeta	57.2	68.6	56.2	62.2	71.0	62.5	92.2	43.4	82.2
Echiuroidea	-	1.8	-	5.4	-	10.8	-	-	-
Sipunculida	2.2	-	2.8	2.2	-	-	-	2.2	-
Cumacea	1.8	2.3	-	-	5.2	2.2	-	3.8	-
Amphipoda	12.3	8.2	6.6	10.6	9.6	6.5	-	-	6.4
Tanaidacea	8.6	4.9	2.8	-	-	4.4	-	6.4	-
Isopoda	4.9	5.2	4.3	16.4	3.2	6.5	5.2	18.6	4.4
Pelecypoda	9.4	6.2	12.5	3.2	5.2	-	-	-	-
Gastropoda	-	0.6	8.2	-	-	6.5	-	7.2	-
Ophiuroidea	1.6	2.2	4.3	-	3.2	-	-	18.1	2.6
Brachiopoda	2.0	-	2.3	-	2.6	0.6	2.6	-	4.4
Rhizopoda	-	*	-	*	*	-	*	*	-
MEIOFAUNA									
Nematoda	39.6	42.2	38.9	60.9	58.8	64.8	50.0	55.2	68.5
Harpacticoida	10.6	10.2	22.5	14.4	13.4	8.7	26.4	23.5	22.3
Ostracoda	8.3	12.5	3.6	2.0	16.7	8.7	-	12.8	-
Turbellaria	8.3	10.2	-	4.5	5.5	-	6.8	-	-
Kinorhyncha	-	4.5	3.6	-	-	-	4.2	-	-
Foraminifera	33.2	20.4	31.4	18.2	5.6	17.6	12.4	8.5	9.2

* gelatinous mass difficult to enumerate.
Parulekar *et al.* 1992.

Table 8: Biodiveristy Status of Feasible Sites for Marine Protected Areas

No.	*Name of site*	*Ecosystems*	*Merits of sites*
01	Malvan, Vengurla Rocks	Benthic, Island	• Naturally protected site (fort) • Total 73 marine algal species are found including some rare species • Rich algal biomass • Rich in marine fauna (Sea cucumber, sea urchin, brittle and star fish) • Rich in subtidal flora and fauna • Presence of corals and gargoniums • Turtle nesting behind the fort • Subtidal flora and fauna
02	Achra-Deogadh-Vijaydurg	Mangrove, Sand dune	• Well preserved sacred mangrove forests • Nursery for mangrove plantation already exists • Mangrove forests provides sanctuary for various terrestrial and avifaunal species • Sand dune vegetation
03	Ratnagiri (Along with Shirgaon creek)	Benthic and mangrove	• 56 marine algae are present • Diversified fauna • Well preserved mangrove forest • About 121 bird species are present around the mangrove area • Mangrove forests provides sanctuary for various terrestrial and avifaunal species
04	Mumbra-Diva, Vikroli*	Mangrove	• Well preserved mangrove forest of *S. apetala* • Mangrove forests provides sanctuary for various terrestrial and avifaunal species • Privately owned and conserved • Interpretation centre established • A nursery for afforestation programme
05	Colaba	Benthic	• Despite being in Megacity area, highly diversified flora and fauna • Total 64 marine algal species recorded including some rare species • Rich in biomass estimation • Fauna • Presence of corals in the intertidal zone

*Vikroli is mentioned as a special case for reference.

Table 9a: Evaluation of the Gulf of Kuchchh

Evaluation category	*Status*
Biogeography	• Fringing Corals • Only delta formation along west coast • Vast salt pans are present
Ecological status and Naturalness/ Uniqueness	• Largest area under mangrove along west coast of India • Extreme saline conditions in mangroves resulted into stunted growth and less species diversity • Fringing coral reef harbouring 40 coral species • Rich marine ecosystem • Highly diversified marine algal flora (>250 species) and biomass • Rare and endangered marine algae Acetabularia, Neomeries are found • Pirotan Island harbours various unique fauna including giant sea anemones, sea cucumbers, etc. • Breeding ground for Lesser flamingo and nesting for Great Indian Bustard • Wintering for various migratory birds
Socio-economical aspect	• Fisheries resources • Industrial development • Exploitation of corals for cement making • Eco-tourism by employing local communities
Scientific aspect	• Conservation and management plan • Uninterrupted scientific observations
National / International significance	• Pirotan Island is declared as a Marine park

Table 9b: Evaluation of Colaba-Mumbra-Vikroli site (Mumbai, Maharashtra)

Evaluation category	*Status*
Biogeography	• Corals reefs • Estuarine complex at Mumbra-Diva-Vikroli
Ecological status and Naturalness/ Uniqueness	• Rich marine biodiversity and highly densed coral population at Colaba • Dominant *Sonneratia apetala* forest at Mumbra-Diva • Mangrove forest provide sanctuary for many bird and wild animal species
Socio-economical aspect	• Mangrove forest is being utilized for firewood • Kharland / Aquaculture activities in the mangrove area • Fisheries • Development activities
Scientific aspect	• Interpretation centres • Conservation and management
National / International significance	• Marine protected areas • Unique coralline assemblage

Table 9c: Evaluation of Malvan-Achra-Deogad (Maharashtra)

Evaluation category	*Status*
Biogeography	• A 17th century 'Sindhudurg' fort is present providing natural protection to marine flora and fauna at Malvan • Mangrove forests at Achra and Deogad
Ecological status and Naturalness/ Uniqueness	• Rich in marine flora and fauna including 9 coral species at Malvan • Rich diversified marine algal flora • Sacred grove at Achra • Mangrove forests at Achra and Deogad sheltering many avifaunal species and wild animals • Nursery ground for prawn and fishes • Turtle nesting ground behind the fort at Malvan
Socio-economical aspect	• Local community depends upon the fishing activity in all the three areas • Mangrove forests provide nursery ground- aquaculture development • Tourism activity at Malvan • Development of eco-tourism
Scientific aspect	• Ideal site for seaweed cultivation experiments at Malvan • Uninterrupted scientific work • Conservation and management
National / International significance	• Marine park at Malvan • Marine protected area

Table 9d: Evaluation of Coondapur (Karnataka)

Evaluation category	*Status*
Biogeography	• Estuarine complex
Ecological status and	• Diversified mangrove flora (22 species)
Naturalness/ Uniqueness	• Nursery ground for prawns and fishes • Mangrove forests harbour many avifaunal and wild faunal species
Socio-economical aspect	• Human activities for development • Timber and honey collection • Aquaculture/ traditional fishing activities
Scientific aspect	• Ecological aspects should be investigated • Conservation and management activities
National / International significance	• Marine Protected Area status should be given • Marine protected area

Table 9e: Evaluation of Sundarbans (West Bengal)

Evaluation category	*Status*
Biogeography	• On the east coast, a triangular delta along the Ganga and Brahmaputra river • Covers about 9630 km^2 area with 4264 km^2 under mangrove cover
Ecological status and Naturalness/ Uniqueness	• Most diversified mangrove flora including some endangered species • Largest mangrove forest • Harbours many endangered species and economically important flora and fauna • Important site to preserve as gene bank • Abode of endangered animals such as salt water crocodile, olive Ridley turtle and Royal Bengal Tiger
Socio-economical aspect	• Supports coastal inhabitants • Produces 169000 m3 of timber • Honey collection as one of the major occupation • Fire wood and fodder • Supports local fisheries
Scientific aspect	• Biosphere reserve to conserve genetic diversity • Important site for biodiversity conservation
National / International significance	• Biosphere reserve • Unique site as tiger reserve • National Park

Table 9f: Evaluation of Bhitarkanika (Orissa)

Evaluation category	*Status*
Biogeography	• Delta of Brahmani and Baiterana river • Second largest mangrove formation
Ecological status and Naturalness/ Uniqueness	• Rich in biodiversity of flora and fauna • Mangrove forests covering the tidal islands • Provides shelter, feeding and breeding ground for various bird species • Nursery ground for fishes and prawns • Habitat of estuarine crocodile *Crocodilus porosus* and water monitor lizard • A living fossil 'Horse shoe Crab' is found in the mud flats • Variety of bird species are found
Socio-economical aspect	• Tribes sustain on fishes, crabs, etc. • Collection of honey and utilizing grass for basket making are the major occupations of tribes • Prawn farming is also being undertaken • Site provides scope for culture/education or ecotourism
Scientific aspect	• Conservation, management and sustainable use of the resources • Being a biosphere reserve, ideal for uninterrupted scientific research
National / International significance	• Wild life sanctuary • National park • Largest habitat for sea turtles and salt water crocodile

Table 9g: Evaluation of the Gulf of Mannar

Evaluation category	*Status*
Biogeography	• Chain of island formed of accumulated sand and coastal debris over dead coral core and surrounded by live fringing coral reef • Protected area between India and Srilanka
Ecological status and Naturalness/ Uniqueness	• Compact ecosystem with clayey and sandy substratum • Rich in marine biodiversity • Vast nursery for prawn, crab, shell fish, etc. • 106 coral species are reported • Rich in seaweed species and biomass • Seagrass beds as rich feeding ground for Dunongs and turtles • Ornamental fishes
Socio-economical aspect	• Rich in commercially important seaweed species that are being exploited for phycolloids extraction (5000- 7000 tonnes/annum) • Conus, Murex and shells are commercially exploited • Rich in fisheries resources, particularly shell fishery
Scientific aspect	• Conservation of corals and shell fishery is important to avoid extinction • Trade in ornamental shells to be regulated
National / International significance	• Marine biosphere reserve • Coral reef

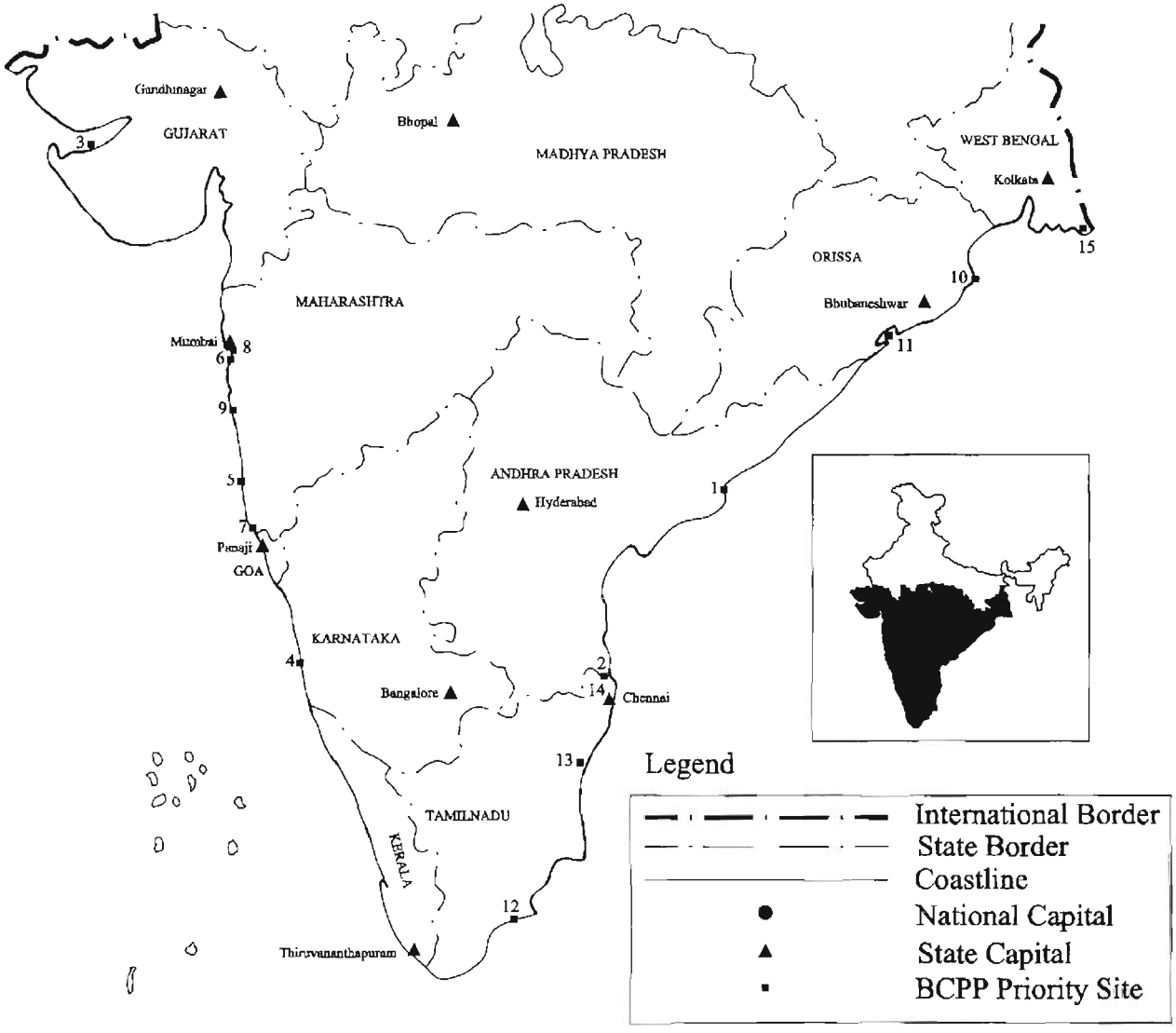
Table 9h: Evaluation of Lakshadweep Islands

Evaluation category	*Status*
Biogeography	• Archipelagos, group of islands forming atolls • Lagoon formations • Coral reefs
Ecological status and Naturalness/ Uniqueness	• Rich in marine biodiversity • 78 coral species, 91 sponges and 18 boring sponges • Diversified seaweed and seagrass flora with high biomass • Many coralline algae are found • Presence of Giant clam *Tridecna* sp. • Marine turtle nesting site
Socio-economical aspect	• Exploitation of corals for tourism and cement industries • Tuna fishery • Export of holothurians • Lobster fishery • Ornamental fish export
Scientific aspect	• Conservation and management • Ecotourism
National / International significance	• National marine park • Biosphere reserve

Table 9i: Evaluation of Andaman- Nicobar Islands

Evaluation category	*Status*
Biogeography	• Oceanic group of Islands • Coralline substrata with coral reef extending far away from shore line enclosing lagoons
Ecological status and Naturalness/ Uniqueness	• Rich mangrove flora (25,000 ha area under mangrove cover) harbouring several bird species and endangered wild animal species • Extensive coral reefs (135 species of hard corals) • Rich in fishery resource • 22 species of echinoderms are endemic to these islands • 50 species of avifauna • 4 turtle and one crocodile species are inhabiting • Feeding and breeding ground for many wild animals • Damage to the coral ecosystem due to oil pollution
Socio-economical aspect	• Inhabitants largerly depend on the marine resources for their livelihood • About 50,000 to 100,000 tonnes of fishes are annually harvested from this site • Timber and honey collection from the mangrove forest
Scientific aspect	• Detailed information on the biodiversity of flora and fauna required to be undertaken • Southern part of islands borders a major oil tanker route from Gulf countries to far East and Japan. Monitoring of oil pollution is a must to assess its effect on the flora and fauna
National / International significance	• Marine biosphere reserve of India

BCPP PRIORITY SITES ALONG THE COAST OF THE INDIAN MAINLAND



ANDHRA PRADESH
1 - Coringa Sanctuary
2 - Pulicat Lake Sanctuary

GUJARAT
3 - Gulf of Kachchh Marine National Park and Sanctuary

KARNATAKA
4 - Kundapur

MAHARASHTRA
5 - Achara, Deogad and Vijaydurg
6 - Colaba
7 - Malvan (Marine) Sanctuary
8 - Mumbra-Diva, Vikroli
9 - Ratnagiri

ORISSA
10 - Bhitarkanika Sanctuary
11 - Chilika Lake

TAMILNADU
12 - Gulf of Mannar Marine National Park
13 - Kaliveli Tank
14 - Pulicat Lake Sanctuary

WEST BENGAL
15 - Sundarban National Park

The sites shown in this map include sites prioritised by Dr. Untawale and Dr. Kanwinde

MAP PREPARED BY THE INDIAN INSTITUTE OF PUBLIC ADMINISTRATION

Assessing Indian Coastal Biodiversity

Hemal Kanvinde

Introduction

An increasing awareness of the loss of the world's biological diversity during the last two decades has stimulated international and national efforts towards conservation oriented programmes and policies. The task of prioritisation of geographical areas is an uneasy task since it may appear to the planners that areas with a low priority need not receive attention in conservation investments either by the government or by donor agencies.

In many developing countries, which more often than not possess high species diversity, the pressures of exploding populations has resulted in the felling of forests. Historically, the world over, the major centres of habitations have been coastal regions, not only because of their rich natural resources but also as centres of trade and commerce. India is endowed with a long and varied coastline of 7,500 km. in 10 maritime states and has a fairly active sea faring history. There are 53 coastal districts and six Union Territories, including islands of Andamans and Nicobar, and Lakshadweep. The number of people residing in these districts amounts to over 416 million, according to the 1991 census. This is nearly fifty percent of the country's total population (ADB 1994).

According to the Anthropological Survey of India, there are about 337 communities in India whose primary occupation is marine or inland fishing. Many of the traditional sea faring communities have taken to fishing using mechanised boats. Historically, these communities had a systematic method of fish harvesting that gave equal fishing opportunities to all families while at the same time safeguarding the fish seeds and fingerlings. Such systems are not utilised any more and over exploitation is the norm.

Considering the present situation in India, of extreme anthropogenic pressures on the depleting resources, a project was designed to establish priority areas for biodiversity conservation along the Indian coasts in order to highlight the areas rich in biodiversity that need immediate attention.

Objectives

The objectives of the project are:

1. To prioritise sites and stretches of coastal ecosystems on the basis of their biodiversity and socio-economic value
2. To prioritise strategies for conservation of priority and other coastal sites and stretches
3. To develop use and describe a participatory methodology for doing 1 and 2.

Process and Methodology

The Indian subcontinent has been studied by many workers and they have attempted to divide India into biogeographical divisions. The Indian coastal regions were described as separate provinces by Rogers and Panwar (1988). Similarly, recent attempts at the clasification of forests show a trend at giving increased importance to coastal forests. In the Champion and Seth (1968) classification of Indian forests, mangroves were a subtype of the Littoral forests and in the classification of Gadgil and Meher Homji (1990), mangroves form a distinct forest type. In the latest classification of Nayar (1996), mangroves and coastal zones are two separate biogeographical divisions. Hence, over the years, the uniqueness of the coastal area is being given its due recognition.

India has already done some prioritisation by protecting some coastal areas. Yet we have to recognise that these priorities will change in future as further information is available and communities become aware of the importance and limited nature of the resources under their care.

In the present study we divided the Indian mainland into the two coasts and further into the sub divisions of Rao and Meher Homji (1985). We have dealt with the coastal ecosystems at the level of bays, gulfs, large delta and small deltas, lagoons etc . rather than just as the east or west coast.

The Workshop I Participants selected some sites from an exhaustive list of 38 coastal sites mentioned in various literature for India (list enclosed). The selection of sites was somewhat subjective and dependent on the availability of information on all the sites that were listed. The relative merits of the different evaluation schemes were discussed and it was decided that a modification of the Kelleher et al (1995) evaluation criteria was the most appropriate for coastal regions of India. The workshop ended with a distribution of assignments to the participants. The

Coastal and Marine Protected Areas of the Indian Mainland

State	*Name*	*Year*	*Area in ha.*
Andhra Pradesh	Coringa Sanctuary	1978	23570.29
	Neelapattu Sanctuary		440
	Pulicat Sanctuary		50000
Gujarat	Gulf of Kutch Marine National Park	1989	16289
	Gulf of Kutch Marine Sanctuary	1982	29503
Maharashtra	Malvan Marine Sanctuary	?	2912
Orissa	Bhitarkanika Sanctuary	1975	65,000
Tamil Nadu	Gulf of Mannar Marine National Park	1989	623
	Pulicat Sanctuary		15367
	Point Calimere Sanctuary	1967	1728.76
West Bengal	Sunderban National Park*	1974	2,85,500
	Halliday Island Sanctuary*	1976	595
	Lothian Island Sanctuary *	1976	3800
	Sajnakahli Sanctuary *	1976	36240

Source: Kothari et at 1989 * Chaudhari and Chaudhury 1994.

The Process of Prioritising was done by a Working Group in three Workshops

	Workshop I	*Workshop II*	*Workshop III*
Date	18 November 1996	9 May 1997	14, 15 November 1997
No. of Participants	13	9	19
Objectives	Define criteria and select sites. Select working partners. Finalise information needs Finalise criteria for evaluation of the sites.	Mid phase evaluation of the information gathered and a trial on the prioritisation exercise.	Evaluation of each site and final prioritisation. Finalisation of the conservation recommendations for each site

working group included scientists, wildlife biologists, forest managers, and representatives of NGO's working in developmental aspects in the coastal areas.

Once the sites were selected, information gathering based on the evaluation criteria was taken up. It was seen that many of the selected areas of rich biodiversity were already protected areas and most of the biological listing of species was available. This was discussed in the next workshop. The Workshop II participants reviewed the progress of the project, some presentations were made and guidance was given on information sources that needed to be tapped. In this workshop, a trial of the prioritisation was carried out by the consensus method even though information was incomplete. This was done in order to gain some experience in the prioritisation exercise and to incorporate contributions from experts in different fields of coastline studies. The final workshop (III) was held on 14-15th November 1997 and defined the priority sites for conservation by devicing a scoring system for evaluating the sites for conservation by devicing a scoring system for evaluating the sites and finalised the conservation plans for all selected sites.

Wetlands of India have been brought together in many compilations and coastal wetlands of National importance, enumerated in these documents vary from 12 to 38 (list enclosed). The selection was necessary because of paucity of time to study all the coastal wetlands and the relative dilution of data if there were too many sites to consider. The selection of the sites were done taking into consideration the following points. (Criteria for Inclusion):

1. It is a good representative example of a wetland characteristic of that region.
2. It supports an appreciable assemblage of rare, vulnerable, endangered species or subspecies.
3. It is of special value as a habitat of plants and animals at a critical stage of their biological cycle.
4. It is a wetland of substantial socio economic and cultural value.

Table 1: Sites Defined in earlier Studies

S. No.	*Name*	*MoEF 1987*	*MoEF 1990*	*WWF 1993*	*IUCN 1995*	*MSSRF / ITTO*
	Gujarat					
1.	Great Rann of Kutch	-------	------	-------		
2.	Little Rann of Kutch	------			------	
3.	Gulf of Kutch	------		-------	------	
4.	Khijadia Lakes			------	------	
5.	Gulf of Khambat			------	------	
	Maharashtra					
6.	Ratnagiri	------		-------		
7.	Malvan	------		------		
	Goa					
8.	Chorao		------	-------	--------	-------
9.	Zuari Mandovi Complex	------		-------		
	Karnataka					
10.	Karnataka Estuaries			--------		
11.	Kundapur Mangroves	-------			-------	
12.	Karwar	------				
	Kerala					
13.	Kottampalli Swamp		------			
14.	Kadalundy			------		
15.	Kole Wetlands			------		
16.	Puduvppa			------		
	Tamil Nadu					
17.	Gulf of Mannar	------		------	------	
18.	Point Calimere	------		------	------	
19.	Vedaranyam Swamp		------	------		
20.	Pichavaram Mangrove	------		------	------	------
21.	Marrakanam	------				
22.	Muthupet	------				
23.	Kaliveli Tank			------	------	
24.	Adyar Estuary			------		
25.	Kovalam Lake		------			
26.	Pulicat Lake		------	------	------	
	Andhra Pradesh					
27.	Interu Swamp		------			
28.	Neelapattu Lake		------			
29.	Krishna Mangrove	------		------	------	
30.	Coringa Mangrove	------		------	------	
31.	Kondakarla Lake			------		
	Orissa					
32.	Chilka Lake		------	------	------	
33.	Mahanadi Delta	------		------	------	------
34.	Bhitarkanika Mangrove	------		------	------	------
	West Bengal					
35.	Sunderbans	------		------	------	
36.	Lothian Island		------			
37	Gosaba		------			
38.	Haliday Island		------			

- MoEF 1987 : Mangroves in India. A Status Report, GOI, Ministry of Environment and Forests, New Delhi
- MoEF 1990 : Wetlands of India. A Directory . GOI, Ministry of Environment and Forests, New Delhi
- WWF 1993 : Directory of Indian Wetlands. WWF-India
- IUCN 1995 : A Global representative system of Marine Protected Areas. Vol. III.

Table 2: The Sites that came up after the Initial Selection were:

Name	*Biogeographic Sub division*	*Criteria for inclusion*	*Ecosystem subtype*	*Important groups*
Gujarat				
Gulf of Kutch	Saharo Sindian	1,2,3,4	Mud flats and coral reefs	Sea grasses, marine algae, corals
Gulf of Khambat	Kathiawar	1,2,3,4	Mudflats	Mangroves
Maharashtra				
Malvan	Konkan	1,2,4	Estuary and rocky beaches	Mangroves, marine algae and corals
Karnataka				
Kundapur Mangroves	Malabar	1,2,4	Estuary	Mangroves
Kerala				
Kottampalli Swamps	Malabar		Lagoon	Sea grasses
Tamil Nadu				
Gulf of Mannar	Coromandel Circa	1,2,3,4	Coral reefs	Sponges, corals, Balanoss and Dugong
Kaliveli Tank	Coromandel Circa	1,3,4	Estuary and lagoon	Avifauna
Pulicat Lake	Coromandel Circa		Lagoon	Fisheries and Avifauna
Andhra Pradesh				
Coringa Mangroves	Coromandel Circa	1,3,4	Estuary	Mangroves
Orissa				
Chilka Lake	Utkal	1,2,3,4	Lagoon	Avifauna
Bhitarkanika Mangroves	Utkal	1,2,3,4	Estuary and Sandy beach	Mangroves, turtles, Avifauna and Salt water crocodile
West Bengal				
Sunderbans Sagar Islands	Bengal	1,2,3,4	Estuary and Mudflats	Mangroves, Avifauna and Salt water crocodile

The evaluation sheet decided in the first workshop is given below:
Biodiversity Conservation Prioritisation Project - Coastal Sites and Stretches

Table 3: Format for Grading Coastal Sites

Biogeographic and Geomorphology	Presence of rare biogeographic qualities or representative of "type" Unique or unusual geologic features
Ecological Importance	Species diversity Essential part of a process or life support system The degree to which the area by itself or in association with other protected areas encompasses a complete ecosystem The variety of habitat Habitat of rare and endangered species Nursery, juvenile areas, feeding, breeding or rest sites Rare or unique habitat for any species Genetic diversity and keystone species
Naturalness	Extent to which the area has not been subjected to human induced changes
Economic Importance	Existing contributions (Recreation, subsistence of traditional users, appreciation by Tourists, nursery area or a source of economically important Species) Potential contributions
Social Importance	Value to local and national communities for its heritage, historical, cultural, educational or recreational use
Scientific Importance	Value for research and monitoring
International/ National Significance	Potential as a world heritage site, biosphere reserve, Ramsar site, or is subject to an international or national conservation agreement
Practicality / Feasibility as a Protected Area	Degree of insulation from external destructive forces Social and political acceptability (community support) Compatibility with existing users Accessibility for education, tourism recreation Ease of management of compatibility with existing management regimes

This evaluation sheet was sent to forest departments, research institutions, NGOs and universities concerned with the particular site, for their inputs to the project.

Table 4: An example of the usage of the sheet is as :
Gulf of Kutch

Biogeographic / Geomorphology	Longitude - 68°20'- 70°40' East Latitude - 20°15'-23°40' North Area- 7350 Sq. km. Depth- 3-60 m 10A- West Coast Deeply indented coastline; very high tidal range; totally protected from southwest monsoon; strong currents (Tidal); wide tidal mud flats; active seismic zone
Ecological Importance	About 1300 identified species Yes- Breeding ground for fish, prawns and birds. Effective barrier to salt water ingress Largely self supporting Coral reefs, mud flats, mangroves, sandy coasts, benthic, salt marshes. Yes: Dugong, leather back 200 logical names turtle ?Green turtle, 9 plant species, 3 bird species, 10 fish species Yes Habitat for Amphioxes, Bonnelia, lkedosomo Pirotanesis, Sea Horse Yes : Bonnelia, Crabplover, Darter
Naturalness Importance	70 per cent + due to : Traditional fishing, Mangrove destruction, industries and salt pans
Economic Importance	21 per cent of state's fish catch : 3000 fishermen; 72300 tons of prawn; salt pans; pearl industry Tourism to Marine National park & Pilgrims Economically important species - Bombay duck, Pomfret, prawns, mullet, catfish, shark, golden anchovy etc. High potential for Jetties & Docks (largest harbour in the world)
Social Importance	Invaluable as national heritage, cultural, recreational and educationalScientific Importance Very high; under studied and researched, no monitoring
International / National Significance	Notified National Park; wintering ground for Eurasian Birds, Largest habitat for crab plovers & Breeding ground for Darters, Several heroneries; Great potential for Ramsar site because of its proximity to fresh water bodies.
Practicability / Feasibility as a Protected Area	At present low but has high Potential Very complex-Awareness among people is great Proper management can make it highly compatible Extremely high Very low (Less than 30 per cent)
Name & Address of Contributor :	Lavkumar Kachar and Diwakar Sharma

Table 5: Kundapur Mangroves

Biogeographic / Geomorphology	Estuarine Complex on a flat lateritic topography under tidal regime
Ecological Importance	22 Species- Biolife supporting system estuarine area and its vicinity constitute an eco-system as-a-whole
Naturalness Importance	The entire area is under anthropogenic pressures
Economic Importance	Subsistence in the form of fishing. Nursery area for fish breeding. Honey collection. Traditional minor forest products.
Social Importance	The area is valuable as a source of fishing and honey and Beeswax gathering by local people. A bun in the form of wora cutting
Scientific Importance	Integrated Ecological research as-a-whole is to be initiated
International / National Significance	The area needs protection should be declared as such
Practicability / Feasibility as a Protected Area	The area is under heavy pressure. Traditional exploitation has to be checked. The visiting management regime is in adequate
Name and Address of Contributor	Dr. T.A. Rao and Dr. Hemal S. Kanvinde

Finalising a scoring system to grade the sites was carried out under broad headings under which the scoring systems should function. This was taken up for discussion and a comprehensive system of scoring was developed in workshop III.

Table 6: Scoring System

Parameter	*Score*	*Reasoning*
I Habitat Value		In an ecosystem based approach, the variety of habitat increases the biological diversity of the site and hence we selected certain habitat that supported a variety of organisms. Deltas meant that creeks, channels, mudflats were present. Estuaries meant that intertidal areas flowing waters, and mudflats were present. Reefs were given a separate status since they are a habitat not just for coral polyps but also for fungi, algae, fish and invertebrates. Shores were classified into two since they support totally varied populations. Shallow waters was necessary to indicate a habitat for sea grasses, and the animals seen in lagoons Presence of each was given 1 point and absence 0. Summation of the section gave habitat value of the site.
Delta	1	
Estuary	1	
Coral Reefs	1	
Shores Rocky	1	
Shores Sandy	1	
Shallow waters	1	
II Biological Value		The Biological value of the site was divided into two. One gave weightage to the species diversity and another to being a habitat for animals and plants that are listed as endangered for our country and or the world. The number of species were divided into subsets and given scores, higher to higher no. of species. The no. of endangered species were also divided into subsets and then a score was assigned to every class.
Species diversity		
<200	1	
201-500	2	
501-1000	3	
1001-2000	4	
>2000	5	
Endangered Species	1	
1-5	2	
6-10	3	
11-20	4	
>20	5	

Contd. . .

Parameter	*Score*	*Reasoning*
III Social Value Population Density 0-100 101-250 251-500 >500	 5 4 3 2	The no. of people dependent on the resources of the site was one of the scoring criteria for social evaluation of the site. It was agreed that there will be approximation in this value since precise information was not available. yet we expect that dividing the populations into classes will reduce the level of approximation. Higher dependencies was given lower value since we feel that higher population pressure is a disincentive for resource protection.
Resource use Wood Grazing Fishing Mining NTFP	1 1 1 1 1 1	The types of resource use was another criteria and greater no of resources that a site provided to the people, the higher was its conservation value though each use was given equal weightage. Mining stands for mining of corals, seaweeds, shells, soil and ores.
Local Initiative	0,1	If the local population have taken joint initiatives to protect their site from destruction, then the site got increased weightage as a conservation site.
Historical, Religious, Archaeological	0,1	Presence of temples, mosques etc. give a site religious significance, else if it was a seat of princely power or a site of ancient civilisations gives a site higher value in conservation action.
IV Economic values Commercial Fisheries Tourism Navigation Ports and Harbours	 1 1 1 1	If the presence of a site along with its resources gave commercial benefits to the people of the area then there is a need to protect the area. Such commercial activities were grouped into four sections and given equal weightage.
V Threats Levels Current Potential	0,1,2	Commercial activities cause destruction of the biological diversity of the site and these were measured by scoring the level of threats as none : 0, small : 1, and large :2.
Total		

This system of scoring was tried on one site and it was found to be effective by all and thus this scoring pattern was used for all sites.

The Prioritisation Results

The ten sites under consideration were grouped under three headings.

Table 7

Deltas and estuaries	*Gulfs*	*Lagoons*
Bhitarkanika	Gulf of Kutch	Chilka Lake
Coringa	Gulf of Mannar	Pulicat Lake
Sunderbans		Kaliveli Tank
Kundapur		
Malvan		

These sites were scored for habitat, biodiversity, social and economic values in a plenary session so that even those who did not know of the site would be in a position to gain information. The scores are given below.

The scores ranged from 14 to 31 in the study and can be grouped into three sets

14-20	Kaliveli and Kundapur	Should be included in conservation action
21-26	Pulicat, Sunderbans, Coringa, Chilka, Bhitarkanika	Action Soon
27-31	Gulf of Mannar, Malvan and Gulf of Kutch	Immediate action

In an ecosystem based comparison priorities that have come up are:

Table 8

Priority	*Deltas and Estuaries*	*Gulfs*	*Lagoons*
1.	Malvan	Gulf of Kutch	Chilika
2.	Bhitarkanika	Gulf of Mannar	Pulicat
3.	Coringa	Kaliveli	
4.	Sunderbans		
5.	Kundapur		

6 There is a need for immediate attention to the following sites on the lines recommended.

- *Malvan:* It should be declared a marine Sanctuary without further delay.
- *Gulf of Mannar* It was noted that under a block B grant of GEF/UNDP, a detailed exercise is underway to strengthen the sustainable management of this biosphere reserve with the total involvement of the local Panchayats
- *Gulf of Kutch:* This needs urgent attention. A proposal for Block A grant from GEF/UNDP needs to be sent immediately

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Marine Biological Diversity of India's Oceanic Space: An Overview

Prabhas C. Sinha

Introduction

Marine Geography and Geomorphology

The Indian Ocean occupies an area of 28,400,000 mi² (75,000,000 km²) with mean depth of 3,928 m. Its eastern coast has a relatively narrow continental shelf. Its sediments are widely distributed. In addition to the pelagic sediments, it contains terrigenous sediments, coral reefs, biothermal facies and reefs associated with mid-oceanic plateaus. The Indian Ocean provides, therefore, a rich organic (plankton) feeding and fishing ground [Franknel 1995]. Its seasonally reversing monsoonal winds bring out marked changes in hydrology and biology of the area, which is around 7,000 km wide and represents a little over 20% of the total area of global oceans. The south-west monsoon with its characteristic low-level jet stream plays an important role in generating the intense coastal upwelling that occurs, in particular and very prominently off the coasts of Somali and the Arabian peninsula in the northern summer. The dominant physiographic feature of its seabed is the mid-ocean ridge in the shape of an inverted Y and the Ninety East Ridge straight from 10°N to 40°S.

The Indian Ocean has a negative water balance in general. However, the Bay of Bengal, due to high run off and precipitation, is an exception where a positive balance is created. The fact remains that nearly one third of the world's population lives on the islands and continents in and around the Indian Ocean, yet it remains one of the least studied parts of the global oceans [IOMAC 1991].

Marine Biogeography

Geographic barriers, climatic zones, thermal gradients, availability of food, predator-prey relationship, species assemblage, etc. have contributed to the zonation of the Indian Ocean into five biogeographic zones, such as,

(i) Bay of Bengal and Arabian Sea (Upto 10°N)
(ii) Equatorial Region (10°N to 10°S)
(iii) The Somali Current Region
(iv) The Agulhas Current Region
(v) Rest of Indian Ocean (Upto Subtropical Convergence) and Antarctic part of the Indian Ocean).

Hyden, et al (1984) combined the geophysical template based on variables such as salinity, surface currents, temperature and the zoogeographic realms and divided the Indian Ocean into 4 oceanic realms

(i) The Northern Indian Ocean: dominated by strong westward and equator ward currents.
(ii) The Northern Central Indian Ocean: dominated by trade winds, in particular, the westward currents.
(iii) The Southern Central Indian Ocean: dominated by weak and variable currents.
(iv) The Southern Indian Ocean: Zone dominated by variable eastward currents [Heywood 1995].

Sherman & Alexander (1986) identified five large marine ecosystems (LMEs) in the Indian Ocean, out of the global total of 49, namely: (i) the Agulhas Current, (ii) Somali Coastal Current, (iii) Arabian Sea, (iv) Red Sea and (v) Bay of Bengal. These relatively large regions, in order of 200,000 sq.km. or larger, are characterised by distinct bathymetry, hydrography, productivity and typically dependent population

Marine Biodiversity

Except for biological hot spots like coastal wetlands, mangroves and coral reefs, little is known about the diversity, abundance and distribution of marine organisms or the structure and function of marine ecosystems in its totality [USNRC 1992]. Previously unexplored, marine habitats, especially at deep sea and the ocean floor, may harbour millions of additional species, thus rivalling even the tropical forests.

Marine species live in a wide open system, the sea being continuous around the earth and have greater ranges and fecundity than terrestrial species. This confers on them a greater resilience to exploitation and environmental

change. Similarly, endemism is also rare. Also, many marine species, particularly fish and invertebrates, produce a large number of offsprings, with short lives and are known as 'r-strategists'. Recent species extinctions are almost unknown among marine organisms with a planktonic larval stage and among the many species of migratory, highly mobile, and widespread fishes [Clark 1996]. Species, that have large bodies are long-living, and slow breeding and produce few offspring, investment, known as 'k-strategists', are rarer in the sea. However these species are most vulnerable to exploitation.

Marine species facing the greatest risks for survival include oysters, octopus, porpoises, whales, sea fishes, sea turtles and dugong. The few known cases of marine extinction in historic times include Steller's Sea Cow, Caribbean Monk Seal, Sea Mink (all marine mammals) and Great Auk (a flightless marine bird).

Important Species

In one sense all species are equally important in their own terms. But certain species loom large in people's mental landscape due to their admirable traits, uniqueness, having survived aeons largely unchanged, for defying notions of what they should be, because they have some other ecological significance. The fact remains that whether the importance that people accord them is based in science, economics or human feelings of kinship, these species receive special attention in the current efforts at protecting and managing marine biodiversity [Norse 1993].

Marine mammals, the archetypal charismatic mega-fauna of the sea, form one such group. They can serve as 'strong "interactors" or keystone species in the marine ecosystem. Their diversity is noteworthy with more than 75 cetacean species (whale and dolphin), 35 pinniped species (seal, sea lion, walrus), many species of sirenians (manatees, dugongs), otters and the polar bears. Other important species include sea turtles, marine birds, reptiles etc.

Marine Biodiversity

	Number of Species
Mangrove	59 Species
Coral	342 Genera (793 Species for I.O.)
Marine Turtles	5 + 1 Species (With Unknown Nesting Ground)
(Mammal) Pelagic Marine	22 Species
(Mammal) Demersal Marine	2 Species
(Mammal) Near-shore Marine	2 Species
(Mammal) Lagoon Marine Inshore Cetacea	1 Species 3 Species
Pasture Forming Seagrass	10 Species
Marine Algae	625 Species
Edible Oysters	8 Species
Window-pane Oyster	1 Species
Lobsters	7 Species (Popular)
Crab	5 Species
Prawns	20-25 Species (Including Deep-sea)
Tuna	15 Species
Sharks	40 Species (Pelagic Ones)
Dolphins	6 Species (Smaller Ones)
Dugong	1 Species

However, one needs to reiterate that the integrity of the marine biosphere does depend far more on a planktonic species or benthic polychaete worms, than on the better known larger species These, thus, also deserve protection.

Important Areas

Like important species, some areas or ecosystems also merit special attention due to various subjective and objective reasons. They include areas which have become critical, marine hot-spots, areas where some species are in jeopardy, etc. The fact that marine ecologists have so little information on the importance of particular species and ecosystem services in each area, there will not always be a strong basis on which well informed choices could be made However, the consensus approach which is slowly evolving, reiterates that if high species diversity is used as a measure of importance, it should be used within but not among different biogeographic zones. Similarly, within a particular biogeographic zone, it should be used within ecosystem types but not among them [Norse 1993].

Moreover, some areas attain importance seasonally, because they become critical to key elements of marine biodiversity even if their own species diversity is low. Such areas include courtship or spawning areas, which serve as sources of recruits, nursery grounds, migration corridors, bottlenecks and stop-over points. Nonetheless, even areas of high marine endemism (areas having species with small geographic range with relatively narrow distributions) need to be identified, mapped and conserved. Also the fact that whether some kind of marine ecosystems are especially likely to have high endemism needs to be researched and established, so are the upwelling areas with high productivity.

Marine Ecosystems

1.	Upwelling Areas
2.	Regions of Divergence
3.	Intertidal Zone
4.	Coastal Wetlands and Lagoons
5.	Seagrass Bed Areas
6.	Deltas
7.	Turtle Nesting & Breeding Grounds
8.	Estuarine Areas
9.	Mangrove Forests
10.	Coral Reefs
11	Gulfs (Areas)
12.	Islands & Surrounding Waters

Marine Protected Areas

In India, over 570 areas covering about 4.5% of the national land territory, have been protected under various categories. Most of these are protected areas on land. The *in situ* conservation strategy for marine living resources remains restricted to 3 major protected areas notified by the Govt. of India. Degree of protection available to the marine protected areas has been provided in accordance with the provisions of Wildlife Protection Act, 1972 [Sec. 35 (1) and 35 (6)], Constitution of India [Art 48A and 51A(g)] and CRZ Notification, 1991 [CRZ I, 6(2) and CRZ IV].

(A) Wandoor Marine National Park (Mahatma Gandhi Marine National Park)
(B) Gulf of Mannar Marine National Park
(C) Gulf of Kutchh National Park
(D) Rani Jhansi Marine National Park
(E) Salt Water Crocodile Wildlife Sanctuary
(F) Khijadiya Sanctuary

Trophic Reationships in India's Oceanic Space

FAO has divided the global marine biomass into 15 regions. The fact remains that 85% of the global marine biomass

harvested belongs to demersal (bottom living) and shoaling pelagic (inshore free swimming) fish. Only 1% of marine biomass harvested is in the form of primary producers (the seaweeds).

Primary Producers (Phytoplanktons)

Fifty percent of India's ocean space has been covered with respect to research on phytoplanktons. In terms of highest phytoplankton productivity regions, southwest coastal and offshore areas lead, followed by the northern part of the Bay of Bengal, areas around the Andaman and Nicobar Islands and Lakshadweep. Major phytoplanktons found in the Indian waters belong to diatoms, dinoflagellates, coccolithophores, blue green algae (*Trichodesmium erythraeum and Oscillatoria erythereae* being the most prevalent) and green algae (abundant in tropical waters). In general terms, however, the Arabian Sea is more productive than the Bay of Bengal. The Indian Ocean, as such, is 75% more productive than the Pacific and 17% more than the Atlantic, as the value of organic carbon produced by the primary producers for the Pacific, Atlantic and the Indian Ocean are 46.4, 69.4 and 81 gms carbon per sq.meter per year, respectively [Seshappa 1991 & Qasim 1996].

Secondary Producers (Zooplanktons)

In terms of zooplankton productivity, south-west coastal and offshore waters have the lead with pockets of extreme productivity noticed off Bombay coast, Cochin coast and off the coast between Goa and Mangalore. On the eastern side, with lower productivity value, pockets of high secondary production are noticed between Vishakapatnam and Madras. High standing stock of zooplankton is observed in the western offshore region of Bay of Bengal [DOD 1997]. Fish eggs and larve are abundant off Ratnagiri, Konkan, Cochin and Quilon on the west coast and in the north-eastern areas of the Bay of Bengal. The total zooplankton biomass for the Indian Ocean has been estimated to be 5.19 $\times 10^8$ tonnes, the majority of this being sustained by the shelf areas, in particular during the southwest monsoon. In oceanic high seas realm, the zooplankton biomass increases during the pre-monsoon season [Qasim 1998].

Tertiary Producers

This is indicative of the marine standing crop or stock from which the "potential yield" or "annual sustainable yield" from the oceans could be determined. For the entire Indian Ocean, the tertiary production rate is of the order of 17m tons of carbon per year, this being the potential exploitable rate [Seshappa 1991]. The present Indian EEZ could provide an annual sustainable yield of 4-5 m tons [Nair & Pillai 1983]. The most reasonable and reliable estimate with respect to fish capture is to the tune of 3.9 m tons (which includes 2.21 m tons from within a 50 m depth zone and 1.69 m tons from 50 m depth to the outside limit of the Indian EEZ). The real potential available for deep sea fishing has been estimated to be not more than 1,64,000 tons per year [Qasim 1998].

Upwelling Areas

In general, the southwest coast of India experiences upwelling during the south-west monsoon, while the areas offshore along the east coast of India experience the upwelling during the south west monsoon [Qasim 1998]. Maximum upwelling occurs in the south west coast between Calicut in the South to Karwar in the north.

India's Marine Biological Wealth

Seaweed and Seagrass

Among the better known species of seaweeds, brown algae (about 1,500 species in number) are most abundant and are widely collected along the coasts of India [Norse 1993]. The intertidal zone in India alone has the potential of yielding 100,000 tons of seaweed per year, all of it, relatively rich in protein and carbohydrate.

About 625 species of marine algae are reported from Indian waters with maximum number of species i.e. 302 off the coast of Tamil Nadu, 202 species off the coast of Gujarat, 152 species off the coast of Maharashtra, 89 species off Lakshadweep, 79 species off Andhra Pradesh, 75 species off the Goa Coast, 39 species off the Karnataka coast and 34 species off Andaman and Nicobar Islands, 20 species off Kerala and 6 species off West Bengal. At present only 22,000 tons of seaweed (mostly red and brown algae) is being harvested from the Indian waters, whereas the total potential of the Indian Ocean is around 8,70,000 tons [Qasim 1996].

Submerged seagrass is often abundant in the shallow waters of temperate and tropical coastal zones of the world. Seagrass beds or meadows are highly productive and valuable resources. They enrich the sea and provide shelter and food for some of the most important and valued species of fish and shell fish, such as the ones found around Andaman and Nicobar Islands. Many Indian scientists have recently reported that a number of India's mangrove trees, seagrasses, and seaweeds exhibit antiviral activity [Premnath et al 1992].

Mangroves

59 species of mangrove are reported from the Indian waters, mainly from Sundarbans, Coringa, Mahanadi and Godawari Delta, Pichavarram, Gulf of Kutch and the Andaman and Nicobar Islands, totally covering an area of 3565 sq.km While 88% occur along the east coast, including the Andaman and Nicobar Islands, only 12% are found along the west coast [Qasim 1998].

Mangrove forests in India have reduced drastically from 14,00,000 ha to 7,00,000 ha by the late 1980s. Recently, the Forest Survey of India has come up with the figure of 3,54,000 ha, which is quite alarming Deforestation, conversion of land for aquaculture, and marine pollution are the major causes of destruction of this unique habitat. Use of mangrove foliage for grazing livestock has severely damaged mangrove forests in the northern coastal areas of India. so has logging for timber and wood chips [Norse 1993].

Coral Reefs

Extensive coral formations have been found in Palk Bay, Gulf of Mannar, Gulf of Kutch, Malvan, Lakshadweep and the offshore areas of Andaman and Nicobar Islands. These formations consist of atolls, fringing reefs, patch reefs, elevated banks and submerged banks. Coral reefs of oceanic types are found in Lakshadweep area and consist of mostly atolls and submerged banks The Andaman and Nicobar Islands, on the contrary, have 179 species of corals, with fringing reefs on the eastern side and barrier reefs with lagoons upto 40 m deep on the western side. Near-shore coral reefs, ranging about 96 species in number, are mostly reported from Southern India These fringing reefs are found in the Gulf of Mannar, Palk Bay, Pamban Pass, Mandapam, Manauli and Krusadai area. The Indian Ocean has 439 species of stony corals, 199 species of scarleratiman corals & 155 species of hermatypic corals [Qasim 1998]

Marine Fishes

Of the current marine fish production in India's EEZ, about 80% comes from within the 50 m depth, 19% from depth between 50 m to 200 m and only about 1% is being produced from the deep sea fishing sector beyond 200m. While the demersal species form 44% of the harvest, nearly 56% is contributed by the pelagic species. Similarly, west coast oceanic space contributes 70% of the total catch while the offshore areas off the east coast contribute only 30%. The four categories of deep sea fish stocks located through exploratory surveys in the Indian EEZ include:

(1) ***Coastal Residents:*** Oil Sardine. other Sardine, Anchovies, Bombay duck, Seer fish, Flat fish, Cat fish and Shrimps

(2) ***Shallow to Deep Water Migrants:*** lizard fish, Sciaenids, Silver bellies, Pomfrets, Mackerel and Cephalopods

(3) ***Deep Sea Residents:*** Bulls eye, Black ruff, Indian drift fish, Deep sea prawns, Deep sea lobsters, Oceanic tunas and Bill fishes.

(4) ***Deeper to Shallow Water Migrants:*** Elasmobranchs, Perches, Ribbon fish, Scads, Carangids, Tunnies juveniles.

Benthos (sub-tidal)

In the Indian Ocean, the northwest Arabian Sea and the northern Bay of Bengal have high benthic production. Wide variations have been noticed in the macro-benthos and meio-benthos quantitatively, in the EEZ of India. Macro-benthos biomass is higher in relatively shallower regions while the meio-benthos contribute significantly in the deeper regions Normally, meio-benthos (dominated by the nematodes. harpacticoids and tubellarians) out number the macro-benthos (dominated by polychaete worms, molluscs and crustaceans) in most habitats [Ansari et al 1996]. The subtidal zone, extending from the outer fringe of the infra-littoral zone to the open sea, represents the neritic coastal waters of the continental self (up to 200m depth) which are often quite productive.

The macrofaunal density and biomass abounds in the Arabian Sea, north-east, central-west and northern Bay of Bengal. Similarly, the meiofauna has highest values off the coast of Goa and the Andaman Sea [Ansari et at 1996]. High benthic faunal density has also been reported off the Konkan coast and the Karwar coast. High benthic biomass is found off the Karwar coast, Kakinada Bay and from the northwest continental shelf. The mud banks off the coast of Kerala are famous for their rich nutrients, benthic fauna and associated prawn fishery [Lathika et at 1991]

Benthic Standing Crop and Demersal Fishery

In general, benthic standing crop decreases with increasing depth and distance from the shore. However, there is an increase in the diversity of benthic organisms in deeper waters [Parulekar et at 1992].

Based on the amount of benthic standing crops present, the potential demersal fish and crustacean resources on the Indian continental shelf are estimated to be 102 m tons per year as against the present yield of 0.45 m tons per year [Parulekar 1982].

Geographically, the southern Arabian Sea (12°N to 7°N) and the northern Arabian Sea (24°N to 20°N) are most supportive of benthic productivity.

Other Marine Biological Resources

Marine Molluscs

In Indian EEZ, commercially important species are *Meretrix marmorata, K. opima, Vellorita cyprinoides and Gafrarium tumidum,* found in abundance off the Maharashtra coast, the Goa coast and in Kakinada Bay.

Edible oysters are represented by eight species in the Indian waters. Four of them are found in abundance including *Crassostrea gryphoides, C. madrasensis, C discoides, C. Calcutta* off the coast of Goa , Maharashtra and Tamil Nadu. A single species of windowpane oyster *Placenta placenta* is found in India, in the Gulf of Kutch and in the Kakinada Bay.

Pearl oysters, *Pinchada fucata,* are found in the Gulf of Kutch, Gulf of Mannar, and off the Kerala coast.

Mussels, popularly represented in the Indian waters by *Mytilus viridis,* are abundantly found off the southwest and southeast coasts.

Marine Crustaceans

Among the lobsters present in the Indian waters, the most popular is *Panulirus homorus*, followed by other species. Presence of a large member of deep sea lobsters, *Puerulus sewelli* and *Pollinustus mossambicus*, have been reported off the coast of Kerala and in the Gulf of Mannar, mostly along rocky coasts and coral reefs. The offshore area, from Colachel to Kanyakumari, is the most extensively fished area for lobsters.

Among the crabs fishery in India, five major species are found all along the Indian coast, representing families of swimming crab, mud crab and cancer crab

Others

About 305 species, of Marine sponges, have been recorded from the Indian waters They are found abundantly around Lakshadweep, Gulf of Mannar and Palk Bay, *Spongia officinalis var. ceylonensis* being the most abundant species.

The holothurian, *Holothuria scabra,* called Beche-de-mer when cured, is found in Indian waters, mostly along the south-east coast, in Palk Bay, Gulf of Mannar and Gulf of Kutch. Three other species are found in the coral reefs and lagoons of Lakshadweep and the Andamans.

The water monitor lizard, *Varanus salvator*, is found in wet, marshy or estuarine forests of India and are heavily poached for skins One estimate suggests the export of 20 million skins between 1940 and 1990, from Calcutta alone.

The Pelagic birds, represented popularly by the Andaman or oceanic teal, *Anagibberfrons albogularis*, inhabits the mangrove creeks and swamps of the Andaman Sea. From tens of thousands their number is reduced to bare 250.

Box tortoise, *Batagur baska*, are herbivores and are generally found along the coast of West Bengal near Calcutta. They are now severely depleted.

Marine crocodiles are represented by the salt water crocodile, *Crocodylus porosus,* the carnivore inhabiting mangrove swamps of eastern India and the Andaman Sea. They are fast approaching extinction. FAO and UNEP are helping India since 1975 to restore their population.

Special Case Studies

Prawns and Shrimps

Of the many species of prawns and shrimps, some 20 contribute in a major way to Indian marine fishery, although to varying extent.

The commercial prawns and shrimps of India belong to three major families, namely Panaeidae, Palaemonidae and Sergestidae. Among the 28 valid species in the genus Panaeus itself, eight are represented in Indian waters and are commercially important [Sampath 1998]. Similarly, out of the 24 species of genus Metapenaeus, 10 have been recorded in Indian waters. Some species of deep sea prawns have been discovered recently in Indian waters, off the southwest coast, such as *Aristitus semidentatus* and *Parapandalus spinipes*

Annual prawn production in India is about 80,000 metric tons, 75% of which comes from the coastal areas of Maharashtra and Kerala. The all India average of landing of deep sea prawns have declined to 9 tons in 1991 from 25-35 tons prior to 1985. [Seshappa 1991].

Tuna

Some 20% of the global production of tuna and tuna like fishery comes from the Indian Ocean i.e. 0.87 m tons. Of the total national tuna production, 79% are oceanic tuna, 17% neritic tuna and 4% bill fishes. Among the oceanic tuna, yellow fin tuna form 50.7% and skipjack 36 3%. The rest is formed by bigeye tuna, albacore and southern bluefin. Neritic tuna in Indian waters is represented by 5 species, however major production comes from only two, the kawakawa (36.4%) and longtail tuna (22.3%) [Somavanshi 1998]. Bill fishes in Indian waters are represented by 5 species.

In general, the western Indian ocean contributes about 6 times more oceanic tuna catch (i.e 590.3 metric tons) than the eastern Indian Ocean (i e 100 metric tons).

Sharks

In total, there are about 350 species of shark. Sharks generally live by feeding on other animals of the sea,

especially the fish. Elaborate research on Indian sharks is absent. There are about 40 species of pelagic sharks, belonging to five families. Although 75% of the shark species in Indian waters belong to the family Carcharhinidae (reqiem sharks) [Sivasubramanian 1992]. Since sharks generally grow slowly, mature late, have a small number of young, and live for many years, it implies that shark stocks are very much vulnerable to overfishing [Hanfee 1997].

Marine Turtles

Out of the global total of eight species, seven are endangered world wide. Five species of marine turtles inhabit and nest in the Indian Seas. A sixth species, the flatback turtle (*Chelonia dipressa*) is ocassionally recorded in eastern Indian waters but has not been found to nest around the Indian Ocean [IOMAC 1996].

The herbivorous green sea turtle *(Cheolonia mydas)* is migratory and is left globally with 12 large nesting populations The entire west coast of India has scattered nesting, with a concentration of 200 females north of Bombay. A similar number of nests are found on the east coast just south of Calcutta. Gulf of Mannar (between Pamban and Kanyakumari) and Palk Bay (between Rameshwaram and Mimisal) are places where green turtles are regularly caught. Their population is also dwindling in the Andaman Sea

The primarily carnivorous hawksbill or tortoise shell turtle *(Eretmochelys imbricata)* nests exculusively on island beaches. Its population is seriously depleted throughout its island habitats, including the Andaman and Nicobar Islands.

The mostly carnivorous leatherback turtle *(Dermochelys coriacea)*, the largest of all turtles, are found around Great Nicobar Island and Little Andaman Island. In 1979, there were only 150 of them left in the Indian waters.

The omnivorous Olive Ridley turtles *(Lepidochelys olivacea)* nest in Bhitarkanika and Gahirmata (Orissa). These sites are two of only four in the world where groups of 1,50,000 turtles nest synchronously.

The loggerhead turtle *(Caretta caretta)* is also found in the Indian waters.

Marine Mammals

Marine mammals in India are diverse to a considerable extent i.e. they range from plankton feeders to squid and fish feeders. Similarly they are bottom dwellers, oceanic and pelagic. In the Indian waters they are represented by seven families.

(i) *Whales:* Indian Ocean has been an important habitat for all representatives of great and small whales. Once very rich, the Indian Ocean great whale population was completely devastated by the commercial whaling in the 19th century.

(ii) *Dolphins:* India's offshore waters have various forms of piscivorous dolphins and four species of cephalopods. Smaller species of dolphins, 6 in number, feed on pelagic column and bottom layers through echolocation or biosonar. Of course, *Delphinus delphis*, is the most commonly found dolphin in India's oceanic space and often preys on shoals of small fishes such as mackerel and oil sardine.

(iii) *Dugongs (Seacow or Manatees):* This largest of vegetarian marine mammals, *Dugong dugon*, inhabits shallow tropical seas around the Indian Ocean and feeds on seagrass. These voracious eaters consume about 25 kg of seagrass at one time. Found usually adjacent to coral reefs, the species neither lives long nor breeds in captivity Even in the wild, a single calf is born at most only once every two years. Males and females reach maturity not earlier than 10 years of age, more usually between 15 to 17 years This combination of late maturation and low reproduction makes this species highly vulnerable to extinction.

Conclusions

Managing Marine Biodiversity of India's EEZ and adjoining High Seas Area:

Traditionally, all marine resources, both living and non-living, lying outside the territorial sea (upto 12 n miles) were considered "open access" resources, i.e. free for all. Law of the Sea allowed coastal nations resource rights in the EEZ (upto to 200 n miles) i.e. an area of 2.02 m sq.km. for India. Recently, UN has asked for delineation of nation's continental margin within 10 years and may extend the resource rights up to a maximum of 350 n miles i.e. probably adding 1.3 m sq.km. more to the Indian EEZ. It will have to strengthen and implement not only its Coastal Regulation Zones (CRZs), but will have to come up with Ocean Regulation Zones (ORZs) and Deepsea Regulation Zones (DRZs).

Today, more emphasis is being placed on the biodiversity found within a "Large Marine Ecosystem" (LME) as a measure of the condition of any region's living marine resources [Thorne-Miller & Catena 1991]. Improving the economic and environmental valuation of India's marine resources could be one major step towards integrated coastal and marine area management.

The fact that our knowledge of marine biodiversity within our EEZ is yet highly insufficient to inform our actions fully, a cautious approach may be followed such as, creation of marine refugia or reserves. Ideally, these marine protected area networks should be established around

known breeding grounds, nesting areas, upwelling areas and other habitats vital to the perpetuation and proliferation of target species [Jeffreys 1995]

Marine Hot Spots of India

Although there has not been any serious attempt to demarcate the marine hotspots, based on available information and data, the following areas could well find a place in any formal listing of marine hot-spots in India's oceanic space

(1) Estuarine area (2) Mangrove forests on shores and islands (3) Coral reefs, (4) Upwelling areas (5) Coastal wetlands and lagoons (6) Seagrass bed areas (7) Deltas (8) Turtle nesting and breeding grounds (9) Gulf of Kutch (10) Gulf of Mannar (11) Palk Bay (12) Andaman Sea and (13) Lakshadweep Sea

Marine Hotspots

(a)	**Phytoplankton:** SW Coast, N Bay of Bengal, Andaman & Nicobar Islands, Lakshadweep.
(b)	**Zooplankton:** SW Coast (Bombay, Cochin & Goa to Mangalore), E Coast (Vishakapatnam to Madras), W Bay of Bengal, and off Ratnagiri, Konkan, Qilon, NE Bay of Bengal.
(c)	**Seaweed & Seagrass:** Off Tamil Nadu, Gujarat, Maharashtra, Lakshadeep, Andaman and Nicobar Islands.
(d)	**Mangroves:** East Coast, Sunderbans, Koringa, Mahanadi, Godavari delta, Pichavaram, Gulf of Kutch, Andaman and Nicobar Islands.
(e)	**Coral Reefs:** Palk Bay, Gulf of Mannar, Gulf of Kutch, Malvan, Lakshadweep, Andaman and Nicobar Islands.
(f)	**Marine Fishes:** West Coast
(g)	**Benthos (Sub-tidal):** NW Arabian Sea, N Bay of Bengal (i) **Macrofauna:** NE & CW Arabian Sea, N Bay of Bengal (ii) **Meiofauna:** Off Goa & Andaman Sea
(h)	**Marine Molluscs:** Off Maharashtra Coast, Goa, Kakinada Bay, Tamil Nadu, Gulf of Kutch, Gulf of Mannar, Kerala, SW & SE Coasts
(i)	**Marine Crustaceans:** Kerala, Gulf of Mannar, Colachel to Kanyakumari
(j)	**Marine Sponges:** Off Lakshadweep, Gulf of Mannar, Palk Bay
(k)	**Holothurians:** SE Coast, Palk Bay, Gulf of Mannar, Gulf of Kutch, Lakshadweep, Andaman and Nicobar Islands
(l)	**Marine Birds:** Andaman Sea
(m)	**Marine Crocodiles:** E Coast, Andaman Sea
(n)	**Prawns and Shrimps:** SW Coast off Maharashtra & Kerala, Lakshadweep
(o)	**Tuna:** N & S Arabian Sea, Lakshadweep
(p)	**Sharks:** E Coast
(q)	**Marine Turtles:** S Calcutta, Gulf of Mannar, Palk Bay, Andaman Sea, Orissa Coast (Bhitarkanika & Gahirmata)
(r)	**Whales:** S Indian Ocean
(s)	**Dolphins:** Cochin, Quilon, Bombay, Calicut-Vizhinjam zone of Kerala Coast, Mangalore-Calicut Area
(t)	**Dugongs:** Lakshadweep, Andaman & Nicobar Islands

Data Availability, Gaps in Knowledge and Limitations in Understanding

The study of the benthos marine community of India's oceanic space has progressively developed in the last two decades. Most of the information, however, pertains to regional studies and these are largely of short duration The nonavailability of baseline data on the quantitative estimates of benthos of the EEZ is felt particularly while assessing the potential marine living resources [Parulekar 1982]. That is why, until recently, estimates of the potential demersal fishery resources are projected on the assumptions derived from fish catch data, and consequently, there exists a wide gap between the harvested quantity and the potential yields

No doubt, some marine ecosystems, such as coral reefs and mangroves, have high species diversity, but despite increasing pollution and destruction of coastal habitats, there is little evidence to suggest an imminent major loss of species diversity. This may be partly due to the lack of knowledge, but the more important fact is the typical nature of marine life history of different organisms, which is yet to be understood reasonably [Clark 1996]

Review of existing data with respect to the marine biodiversity of India's oceanic space does not reflect, in any way, the full status of scientific knowledge with regard to specific taxa, geographic areas, ecosystems or habitats, and only touches on genetic level diversity and the virtually important relationships between ecosystem dynamics and ecosystem diversity

Risk Assessment and Sustainable Management

Efforts are underway to place a greater emphasis on the linkage between scientific and societal needs and the utility of long-term broad-scale coastal and ocean space assessment and monitoring aimed at improving the sustainability of marine biological resources. A scientific framework is now emerging to understand the pressures on coastal and oceanic ecosystems caused by toxic effluents, habitat degradation, nutrient loadings, harmful algal bloom, aerosol contaminants and over-exploitation. This has been facilitated by a series of regional efforts aimed at the integration of research, monitoring and assessments. Assessing such risks and forecasting future ones, and identifying where the maximum ecosystem and yield damages would be done, should be taken up as a priority. Simultaneously, risk assessment of the mitigation methods also, needs to be completed before enforcing regulations or suggesting action plans.

Recommendations in Light of the Jakarta Mandate

The Jakarta mandate is a program for applying the "Convention on Biological Diversity" (CBD) to coastal and marine areas. The Jakarta mandate singles out coastal management, marine protected areas, fisheries, mariculture and introduction of alien species for special attention. Implementation of the Jakarta Mandate will require national action and regional and international co-operation. This means sharing information, co-operative research, financial and technical assistance, and development and implementation of supportive laws and policies in areas ranging from trade to pollution control.

Prioritizing India's Oceanic Space. Conceptual and Methodological Issues

The importance of marine biodiversity is proportionate to the vastness of the oceans themselves. Factors that should be considerd for prioritizing marine conservation sites in the realms of India need to be understood. For example, prioritization could be based on the following values:

Commodity Values

(i) dependence for sea food increasing
(ii) coastal megacities increasing
(iii) species of commercial importance lie within EEZ
(iv) medicinal use, as food additives and processing agents, manufacture goods, bioactive substances etc.
(v) growing aquaculture and mariculture to meet present and future food demand

Cyclic Significance

(i) as determinants of structure and function of ecosystem e.g. crucial role of marine phytoplankton in atmospheric dynamics
(ii) Knowledge of interaction among marine biota, earth's geochemical cycles and global climate change as crucial feedback for maintaining the global biospheric conditions
(iii) Critical to environmental dynamics at all levels, local, national, regional and global

Uniqueness

(i) Limited adverse environmental impacts of anthropogenic disturbances as oceans provide relatively stable, extensive, open, and well buffered habitats.

Conservation Feasibility

(i) preventing habitat destruction – especially in coastal, estuarine, wetland, mangroves and coral reef systems
(ii) preventing coastal and marine pollution – including suspended sediments, nutrients and toxics
(iii) restricting over-exploitation of harvestable species-including fish, shelfish, turtles, marine mammals
(iv) slowing the specter of global climate change with all its attendant marine impacts
(v) Level of threat is difficult to be determined as so little is known about marine biota and rate of extinction
(vi) Inventories and ecological studies are needed for all oceans, with special emphasis on those habitats most immediately threatened such as coral reefs and coastal zones.

To prioritise from among marine biological diversity requires not only more data but new kinds of data and new ways of synthesizing what we know.

The fact remains that the bottom of the ocean is still largely unexplored, more so for its biological diversity. Assessing and understanding its biodiversity and related interactive systems will require resources equivalent to those committed for exploring the moon. Because such research depends on costly and specialized equipment, including funds for ships

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Some Aspects of Biodiversity and its Conservation in the River Islands of Brahmaputra

Abani Kumar Bhagabati and Anil Kumar Goswami

The Brahmaputra riverine tract stretching for a length of 720 Km within Assam, is ecologically an important zone of North East. Characterised by new and fresh alluvial formations, presence of a large number of wetlands and river islands and frequent geomorphological changes, the tract is a part of one of the note hot-spots of global biodiversity. The Brahmaputra which is identified as the fourth largest river in the world in terms of water discharge, forms the axis of this elongated tract. Being highly braided, the river provides favourable conditions for the formation of numerous sandbars and islands, locally called *chars* Interestingly, more than 1,000 *chars* are found to be spacious and more or less permanent containing within them wetlands of varying sizes. As a matter of fact, almost all the wetlands within the islands get coalesced with the rising water of the Brahmaputra during summer. But in winter, the islands including the wetlands remain surrounded by the subsided river water constituting thereby an ecological system quite distinct from other terrestrial systems. The islands, especially the spacious ones, favour luxuriant growth of a variety of grasses, bushes, riverine trees and a wide variety of aquatic plants and animals which collectively form habitats not only for resident birds, mammals, reptiles and amphibians, but also attract a large number of migratory birds. The present study, which attempts to map a select group of islands (Majuli, Burhachapari and Kalarchar-Bhangnamari) from the perspectives of biodiversity and to identify the threats and pressures on them, is based on data and information collected through a rapid ground survey carried out during January-March, 1998.

The study has been carried out in two stages: (1) As a part of the pre-field activities maps and relevant information were collected from various sources like Survey of India, Brahmaputra Board, Assam Remote Sensing Application Centre, State Char Area Development Authority and Revenue Circle Offices of the concerned areas. (2) Ground surveys were carried out to study the status of biodiversity and feasibility of its conservation in the three selected islands. The survey team consisting of biologists, geographers and fluvial geomorphologist was assisted by members of the concerned branches of Assam Science Society and local people interested in the field. Brief socio-economic survey and interview were also conducted to understand the minds and conditions of the people living in the islands, especially in the fringe villages of the Burhachapari sanctuary.

In the case of Majuli, the biggest river island of the world, the study listed as many as 97 resident and migratory birds observed at six wetlands, two extensive *chaparies*, roadsides and the area around Kamalabari. Rare birds observed include greater adjutant stork, lesser adjutant stork, spottedbilled pelican, white necked stork, common crane, falcated teal, pallas's fishing eagle, brahminy kite, osprey, darter, etc Among the mammals, the important one is the wild buffalo. A small group of water buffaloes are there in Banaria *Chapari*. It is interesting to note that their habitat is isolated from the rest of the Brahmaputra Valley by the river Brahmaputra itself on the south and the Kherkatia Luit on the north. Occasional presence of tigers is also reported by the graziers living in the *Chars*. Moreover, commonly found amphibians and reptiles including turtles, and 43 species of fish available in the island have been listed. Dominant trees, grasses and aquatic plants found in the island have been identified Major threats and pressures on the island ecosystem have been discussed.

In the case of Burhachapari, which has been recently declared a wildlife sanctuary, brief accounts on the existing important mammals like the Indian one-horned rhinoceros, Asian elephant, wild buffalo and tiger along with their future prospects have been presented. As many as 77 birds observed at two wetlands, Brahmaputra riverside and in the forests and grasslands of the island are listed. Among them, black stork, blacknecked stork, swamp partridge and the lesser adjutant stork are important. Presence of Bengal florican in the grasslands dominated by *Imperata cylindrica* is also reported by the forest officials. Site for habitat conservation for this rare bird is tentatively delineated. Floral diversity in terms of forest, grasses and

wetland vegetation is discussed. The sanctuary has been under great pressure and threat from both natural and human factors. Bank erosion, overgrazing and illegal fishing are identified to be significant among these.

The intensively populated island complex, Kalarchar-Bhangnamari, has also been studied. Once very richly endowed with grasslands, this island currently suffers from their scarcity. The geo-environmental conditions of the island, however, are suitable for diverse species of trees and grasses. The destruction of forests and grasslands has now made the island relatively less significant from the biodiversity point of view During the field survey, 43 species of birds were observed here. Grasslands were found to be either highly degraded or transformed into agricultural land.

At the end, fourteen recommendations for further in-depth study of Biodiversity and its conservation, in the Brahmaputra riverine tract in general and the islands in particular, have been put forth. The overall broad suggestion considered to be of immediate concern is to prepare a master plan to ensure biodiversity conservation in the riverine tract.

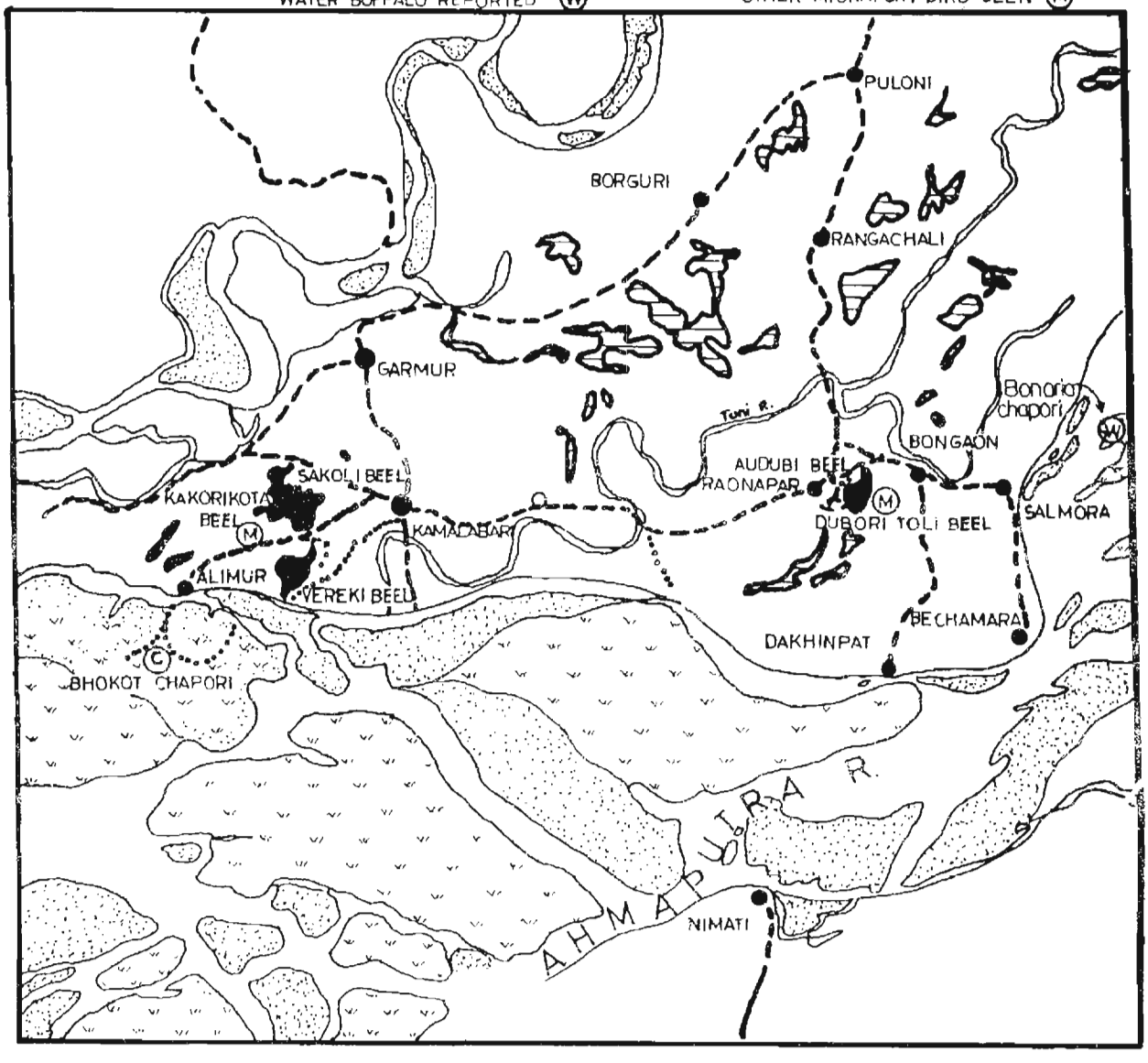
MAJULI CENTRAL

AREA SURVEYED

2 0 2
KM

INDEX

RIVER/STREAM
TRANSECT ROUTE
WET LAND:
SURVEYED
OTHERS
CRANE SEEN (C)
OTHER MIGRATORY BIRD SEEN (M)
WATER BUFFALO REPORTED (W)



Prioritisation of Biological Conservation Sites in Indian Wetlands

Jay S. Samant

Preamble

Wetlands are the areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine waters, the depth of which does not exceed six meters at low tide (Ramsar Convention, 1971). However, the scope of the present project is restricted to inland wetlands.

India's wealth of inland wetlands includes both natural as well as human-made wetlands. In fact, the proportion of the country's land area under human-made wetlands (n=65,252) is about 1.8 times higher than its area under natural wetlands (n=2167). In addition and according to one estimate, the major rivers and their tributaries have a network of more than 17,500 kms. According to MOEF(1990), the area of human-made wetlands was around 25,89,266 ha and that of natural wetlands was 14,50,871 ha. Since 1990, there has been a significant increase in the number and extent of human-made wetlands. It is interesting to note that the country's land area under human-made wetlands is increasing primarily due to various irrigation and hydro-electric activities. On the contrary, the country's land area under natural wetlands may go on reducing due to several natural and anthropogenic forces. Though natural wetlands are endowed with greater diversity of micro-habitats and thus have a higher biodiversity value, the value of a large number of shallow human-made wetlands as waterfowl and fish habitats should not be under-estimated.

Rivers, streams, springs, flood plains, a variety of lakes (including *chaurs, jheels, beels, sarovars* etc.), ponds and marshes are the more common natural wetlands of India. Whereas rice fields, tanks, reservoirs and canals are the common types of human-made wetlands.

Hussain *et.al.* (1993) have identified the following predominant inland wetlands in India's different geographical zones.

1. Tanks, reservoirs and other water bodies of the Deccan Peninsula.
2. Saline expanses of Rajasthan and Gujarat (mainly Rann of Kachchh)
3. Fresh water lakes and reservoirs from Gujarat eastwards to Rajasthan and M.P.
4. Marshes, *Jheels*, Terai swamps and *Chaurs* lands of the Indo-Gangetic plains
5. Flood plains of the Bhramaputra and marshes and swamps in the hills of North-Eastern India.
6. Lakes and rivers of the mountains (primarily the palaearctic region) of Kashmir and Ladakh.

Each of these categories have varying degrees of biodiversity and socio-economic value, and share some common ecological aspects. Each of them, nevertheless, has some unique biodiversity value, from the viewpoints of species richness, representativness, endemism, rarity or threat. Therefore, it is of prime importance to give legal protection to these wetlands. However, many sensitive wetlands are still outside the extensive PA system of the country. Such wetlands are neglected or used as wastelands and are under serious threat (Samant, 1993). The Biodiversity of these wetlands has been facing serious threats because of pollution, siltation, invasion of exotic species, eutrophication, encroachment and over exploitation of its natural resources.

Studies on the flora and fauna of wetlands in the country have been scanty and fragmentary in nature. Moreover, due to the dynamic nature of the wetland ecosystems and anthropogenic impacts on them, the status of wetland biodiversity has changed drastically in the recent past. The common plant species associated with lotic and lentic wetlands have been summarised by Brij Gopal & Krishnamurthy (1993). The information on the fauna of inland wetlands is scarce. However, avifauna of the wetlands has been studied in detail, particularly due to the pioneering efforts of Dr. Salim Ali and his students. To a somewhat lesser extent than avifauna, fish inventories have been made of the wetland systems.

In countries like India, wetlands are not only important from the biodiversity viewpoint, but they are also important from the socio-economic aspect. A large number of people

living around wetlands, depend heavily on their resources for subsistence and carry out traditional activities like fishing, grazing, farming, gathering of biomass, etc. Besides, wetlands provide food to millions of poor people in the country

Background

This project sought to prioritise, for biodiversity conservation, from among the wetlands of India It also sought to develop and test a participatory method for prioritisation.

The specific objectives of the project were

1. To collate available information on wetland biodiversity in India and to develop and update inventory of natural and human-made wetlands
2. To develop criteria for indicator parameters to select representative ecosystems for prioritisation on their biodiversity potential and socio-economic values.
3. To evolve strategies for the identified wetlands by developing an appropriate methodology for biodiversity conservation and sustainable use with community participation.
4. To identify major factors responsible for degradation of wetlands in general and sensitive ecosystems in particular and to suggest priorities to restore degraded wetlands and rehabilitate the associated communities
5. To prepare a detailed report with the help of maps on the findings of the investigations

Process and Methodology

Process

The project was implemented in the following phases:

(i) Identifying the prioritisation criteria, evolving a quantitative methodology of prioritisation and preparation of a methodology manual (with prioritisation matrices)

(ii) (a) Collection of published and unpublished literature pertaining to inland wetlands. The collected literature included wetland directories, research papers, theses, books, reports manuals, articles, proceedings and different types of maps (including maps prepared using satellite data).

Over a hundred publications/unpublished material were collected, encompassing about 900 inland wetlands. For an easy access of secondary data during prioritisation of over 150 wetlands, the entire bulk of secondary information was catagorised into 16 themes. These are, wetland ecosystem (fundamentals), wetland ecosystems in India (profiles), wetland valuation, wetland biodiversity (general account), biodiversity in/around Indian wetlands, plants in/around Indian wetlands, macro-invertebrates, fish, amphibians, reptiles, birds, mammals, threats to wetland biodiversity, wetland laws and policies in India, wetland management and conservation, and wetland mapping.

(b) Preparing inland wetland inventory through state maps and other literature.

(c) Developing a model questionnaire to get information on inland wetlands with emphasis on their ecological potential and socio-economic value

(iii) Modification of prioritisation methodology based on experts' views, actual data availability and field visits

(iv) Data analysis for prioritisation of over 150 wetlands. The analysis comprised calculation of ecological-cum-socioeconomic criteria score (referred to as "Average Criteria Score" or ACS), in order to determine priority levels of inland wetlands. A computer was utilised to determine criteria score and to determine the priority levels of different wetlands.

Methodology of Prioritisation

Prioritisation has been done for inland wetlands of the country, for which secondary information became available during the course of the project. Such wetlands fall both within and outside protected areas.

Prioritisation was carried out basically by converting subjective (qualitative) information available for different wetlands into quantitative scores, referred to as ACS. Thus the present prioritisation has been a quantitative exercise, though there has also been a use of ecological judgments and logical assumptions to decide the priority levels of a wetland.

In order to develop the methodology, various approaches to prioritisation were critically reviewed. These included the species oriented approach, ecosystem oriented approach, and integrative (ecosystem cum socio-economic) approach (Johnson, 1995) Considering the significance of anthropogenic pressures in India on wetlands and their biodiversity, the Integrative Approach was selected As stated earlier, it takes into account both the ecological and the socio-economic criteria in order to prioritise sites for biodiversity conservation.

After studying the various prioritisation methodo-

logies, the following ecological and socio-economic criteria were identified

Ecological Criteria

(a) Richness, (b) Distinctiveness, (c) Rarity, (d) Representativeness, (e) Keystone function, (f) Threat.

Socio-economic Criteria

(a) Economic Utility (viz. food, fodder, medicines etc.)
(b) Other (non-economic) Utility (viz. subsistence, religious, recreation, educational, scientific)
(c) Conservation feasibility (viz. economic, legislative, administrative, institutional, community participation)

Each of the criterion was assigned a weightage value to indicate its importance with respect to each other. Definitions, brief explanations, weightage value assignment and score calculation for each criterion has been explained in the manual prepared for the prioritisation methodology.

The ecological and socio-economic criterion were applied to both biotic (living) and abiotic (non living) attributes of the wetland ecosystems, through matrices of prioritisation. These attributes are listed below

Biotic attributes

(a) Microphytes, (b) Macrophytes,
(c) Zooplankton, (d) Macroinvertebrates,
(e) Fish, (f) Amphibians,
(g) Reptiles, (h) Birds,
(i) Mammals

Abiotic attributes

(a) Water quality, (b) Hydrology,
(c) Nutrient status, (d) Ecosystem processes,
(e) Habitat diversity

Based on the number of attributes and sub-attributes (i.e. "ecological/ taxonomic groups" and "species" respectively) fulfilling different criterion elements, " Total Ecological Criterion Elements Score (TECES) and Total Socio-Economic Criterion Elements Score (TSCES) were calculated, through prioritisation matrices. The average of these two scores has led to the determination of an " Average Criteria Score" (ACS). The higher the ACS for a wetland, the higher the priority for its conservation

After determining the ACS for all the wetlands for which secondary information had become available, the maximum ACS (referred to as 'Yardstick ACS') were determined and "Priority Levels" for over 150 wetlands were decided.

To determine the priority levels, ACS of five internationally important inland wetlands of India were used as "standard ACS values", with which the ACS of all other wetlands were compared. The standard ACS have been 7%, 31%, 46%, 54%, 59% and 100% of the yardstick ACS, consequently, five basic priority levels were decided as follows

LEVEL V:	Wetlands whose ACS is 7% - 31% Yardstick ACS.
LEVEL IV:	Wetlands whose ACS is 31% - 46% of Yardstick ACS.
LEVEL II.	Wetlands whose ACS is 46% - 54% of Yardstick ACS.
LEVEL II:	Wetlands whose ACS is 54% - 59% of Yardstick ACS.
LEVEL I:	Wetlands whose ACS is 59% - 100% of Yardstick ACS.

Wetlands having ACS falling in level V are those with high ecological and socio-economic potential but having poorer data availability

Major Findings

Inventory of about 900 inland wetlands has been made using different types of literature. The inventory includes both lentic (standing water) wetlands and lotic (running water) wetlands.

Of the total number of wetlands inventoried, about 150 wetlands have been analysed for deciding their priority levels. Others could not be analysed for prioritisation mainly because of the non-availability of suitable data for them. Thus, wetlands other than those which have been analysed to decide their priority levels have been considered as 'Wetlands of Unknown Value'. There are over 700 such wetlands. It must be noted that all of them are not necessarily insignificant from ecological and socio-economic view points. Rather, many of them may come out as 'High Priority Wetlands' when sufficient databases could be built up for them in the future. The prioritisation matrices and the model questionnaire developed under the present prioritisation project could be used to determine their priority levels in future

It may further be noted that about 118 wetlands (i.e. 74.7% of all the wetlands prioritised) have fractional ACS values, which are higher than zero but lower than *'cut-off'* ACS (i.e. 1). These wetlands are considered as 'Low Priority Wetlands' for the present prioritisation exercise. During futuristic prioritisation exercises many of these wetlands too can also be promoted as 'High Priority' wetlands if they are found to have high biodiversity,

ecological and socio-economic potential through databases likely to be built up for them in future.

Wetlands whose ACS range between 1 and 14 have been identified with certainty as High Priority wetlands (Priority Levels I to V or Grades 'A', 'B' and 'C'), even at the present stage of prioritisation. There are 40 such wetlands, which make 25% of all the wetlands analysed for prioritisation (158). The priority level wise number of such 'High Priority Wetlands' is shown in Table 1. Whereas biogeographic region- wise numbers of such wetlands has been shown in Table 2. It is found from Table 1 that the state of Rajasthan has the highest number (n= 6) of 'High Priority Wetlands'. Hence, it can be considered as the 'Most Important State' for the conservation of inland wetlands. On the contrary the table shows that states/U.T. like Delhi, Orissa, and Sikkim do not have High Priority wetlands.

Further, the states of U.P., Gujarat, Manipur, Madhya Pradesh & J&K also have a comparatively large number of High Priority Wetlands (n= 4, 4, 5, 4 and 4 respectively) and thus they can also be considered as 'Important States' for the conservation of inland wetlands.

It is interesting to find that Nal Sarovar (ACS=6.85) and Great Rann of Kachchh (ACS= 6.3) of Gujarat fall in the priority levels equivalent to some of the of Ramsar sites (Level III & IV or Grade 'B'). Thus they can be seriously considered to be wetlands having equal importance to that of the internationally important wetlands of India.

Table 2 has revealed that the semi-arid biogeographic region zone has the highest number (n= 11) of 'High Priority' wetlands. Hence it can be considered as the 'Important Biogeographic Region' for the conservation of inland wetlands of the country.

The biogeographic regions of North East India, Gangetic Plain, & Deccan Peninsula also have a considerable number of High Priority wetlands (n = 7, 5 and 7 respectively). Hence they should also be considered as 'Important Biogeographic Regions' for the conservation of inland wetlands in India.

It must be noted that the 33 High Priority wetlands, from different states, falling in Level V (or Grade 'C') are those that are in urgent need of detailed research and data collection. They appear to be the wetlands with high ecological and/ or socio-economic potential but lacking adequate data to allow prioritization. In fact, all the high priority wetlands (Level I to V) are in need of urgent and effective implementation of conservation and management measures.

The final report makes recommendations, based on the findings of the project, for undertaking studies on identified and lesser known wetlands of biodiversity potential by involvement of regional research institutions, universities/ local colleges, NGO's and volunteers. This would also help evolve strategies and policies for wetland conservation at local level.

Table 1: Statewise Summary of Prioritised Inland Wetlands

State	*High Priority Wetlands*					*Low Priority Wetlands*	*Total Wetlands analysed for Prioriti-sation*
	Grade - A		*Grade - B*		*Grade-C*		
	**Level I*	**Level II*	**Level III*	**Level IV*	**Level V*		
(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
Andhra Pradesh	00	00	00	00	01	07	08
J & K	00	00	00	01	03	17	21
Gujarat	00	00	01	01	02	16	20
U.P.	00	00	00	00	04	12	16
Assam	00	00	00	00	02	07	09
Karnataka	00	00	00	00	00	07	07
Tamil Nadu	00	00	00	00	02	21	23
M.P.	00	00	00	00	04	05	09
Goa	00	00	00	00	01	01	02
Bihar	00	00	00	00	01	03	04
West Bengal	01	00	00	00	01	04	05
Rajasthan	00	01	00	00	04	03	09
Punjab	01	00	01	00	00	01	02
Manipur	00	00	00	00	04	00	05
Orissa	00	00	00	00	00	02	02
Delhi	00	00	00	00	00	01	01
Maharashtra	00	00	00	00	02	04	06
Kerala	00	00	00	00	00	03	03
Arunachal Pradesh	00	00	00	00	01	02	03
Haryana	00	00	00	00	00	01	01
Pondicherry	00	00	00	00	01	00	01
Sikkim	00	00	00	00	00	01	01
Total	02	01	02	02	33	118	158

Level I : ACS 14.0 but > 8.3 = Grade 'A' High priority wetlands = 3
Level II : ACS < 8.3 but > 7.5 (two in Rajasthan and one in Manipur)
Level III : ACS < 7.5 but > 6.5 = Grade 'B' High priority wetlands = 4
Level IV : ACS < 6.5 but > 4.3 (one in J&K, two in Gujarat, one in Punjab)
Level V : ACS < 4.3 but > 1.0 = Grade 'C' High priority wetlands = 33
Low priority wetlands : ACS > 0 but < 1.0 = 118
Wetlands with unknown value : ACS = 0 are excluded.

Table 2: Biogeographic Regionwise Summary of Prioritised Inland Wetlands

Biogeographic Region	*High Priority Wetlands*					*Low Priority Wetlands*	*Total Wetlands analysed for Prioriti-sation*
	Grade - A		*Grade - B*		*Grade-C*		
	**Level I*	**Level II*	**Level III*	**Level IV*	**Level V*		
(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
Trans Himalayan	00	00	00	00	00	07	07
Himalayan	00	00	00	01	04	14	19
Desert	00	00	00	01	03	02	06
Semi Arid	01	01	02	00	07	20	31
Western Ghats	00	00	00	00	01	04	05
Deccan Peninsula	00	00	00	00	07	46	53
Gangetic Plain	00	00	00	00	05	16	21
NE India	01	00	00	00	06	09	16
Total	02	01	02	02	33	118	158

Level I : ACS 14.0 but > 8.3 = Grade 'A' High priority wetlands = 3
Level II : ACS < 8.3 but > 7.5 (two in Semi Arid and one in NE India)
Level III : ACS < 7.5 but > 6.5 = Grade 'B' High priority wetlands = 4
Level IV : ACS < 6.5 but > 4.3 (one in Himalayan, one in Desert and two in Semi Arid)
Level V : ACS < 4.3 but > 1.0 = Grade 'C' High priority wetlands = 33
Low priority wetlands : ACS > 0 but < 1.0 = 118
Wetlands with unknown value : ACS = 0 are excluded.

Annex 1: Bio-Geographic Region and State wise Summary of Inland Wetlands Inventory (With Unidentified Values)

States	*Bio-Geographic Regions*								
	I	*II*	*III*	*IV*	*V*	*VI*	*VII*	*VIII*	*Total*
Andhra Pradesh	00	00	00	00	00	66	00	00	66
Arunachal Pradesh	00	02	00	00	00	00	00	00	02
Assam	00	00	00	00	00	00	00	12	12
Bihar	00	00	00	00	00	07	21	00	28
Goa	00	00	00	00	02	00	00	00	02
Gujarat	00	00	15	27	00	00	00	00	42
Himachal Pradesh	00	03	00	00	00	00	00	00	03
Haryana	00	00	00	09	00	00	00	00	09
Karnataka	00	00	00	00	18	30	00	00	48
Kerala	00	00	00	00	23	01	00	00	24
Madhya Pradesh	00	00	00	04	00	74	00	00	78
Maharashtra	00	00	00	00	27	161	00	00	188
Meghalaya	00	00	00	00	00	00	00	02	02
Manipur	00	00	00	00	00	00	00	01	01
Orissa	00	00	00	00	00	28	01	00	29
Punjab	00	00	00	10	00	00	00	00	10
Rajasthan	00	00	18	86	00	00	00	00	104
Tamil Nadu	00	00	00	00	00	94	00	00	94
Tripura	00	00	00	00	00	00	00	04	04
Uttar Pradesh	00	10	00	00	00	09	81	00	100
West Bengal	00	00	00	00	00	00	37	00	37
Total	00	15	33	136	70	470	140	19	883

Bio-Geographic Regions

(I) Trans-Himalayan
(II) Himalayan
(III) Desert
(IV) Semi-Arid
(V) Western Ghats
(VI) Deccan Peninsula
(VII) Gangetic Plains
(VIII) North East

Annex 2: Biogeographic Region and State Wise Inventory of Priotrised Inland Wetlands

Sr No.	*Name of Wetland*	*Latitude / Longitude (00° 00 N 00° 00 E)*	*Type*	*Bio-Geographic Region*	*Acs*	*Priority Level*
1	*2*	*3*	*4*	*5*	*6*	*7*
	Andhra Pradesh					
1	Hussain Sagar Lake	17 20 - 78 30	Lentic	Deccan Peninsula	0.23	LPW
2	Indravati N.P	19 00 29 30 - 81 00 82 00	Lotic	Deccan Peninsula	0.32	LPW
3	Jeedimetal Lake	17 32 - 78 28	Lentic	Deccan Peninsula	0.24	LPW
4	Kolleru Lake	16 30 16 45 - 81 05 81 20	Lentic	Deccan Peninsula	1.42	V
5	Kondarkal Lake	17 36 - 83 00	Lentic	Deccan Peninsula	0.05	LPW
6	Neelapattu Lake	13 50 - 79 59	Lentic	Deccan Peninsula	0.25	LPW
7	Pakhal Lake	17 57 - 80 00	Lentic	Deccan Peninsula	0.26	LPW
8	Pochram Reservior	18 08 - 77 57	Lentic	Deccan Peninsula	0.17	LPW
	Arunachal Pradesh					
9	Mehao Sanctuary	28 05 29 15 - 95 40 96 03	Lotic	Himalayan	0.32	LPW
10	Lali Sanctuary	27 53 28 10 - 95 23 95 30	Lotic	Himalayan	0.18	LPW
11	Namdapha Sanctuary	27 23 27 29 - 96 15 96 18	Lotic	Himalayan	2.35	V
	Assam					
12	Beels of Assam		Lentic	North East India	0.06	
13	Dibru Flood Plain	27 30 28 00 -94 55 95 40	Lotic	North East India	0.75	LPW
14	Dipore Flood Plain	26 05 26 09 91 36 95 45	Lotic	North East India	1.20	V
15	Manas National Park	26 37 26 50 - 90 15 91 15	Lotic	North East India	1.45	V
16	Sareawar Beel	26 20 - 90 05	Lentic	North East India	0.13	LPW
17	Wetlands in Sonai Rupai Sanctuary	26 15 26 40 42 10 - 92 92 45	Lotic	North East India	0.44	LPW
18	Wetlands in Kaziranga National Park	26 35 26 45 - 93 05 93 40	Lotic	North East India	0.90	LPW
19	Wetlands in Laokahowa Sanctuary	26 15 26 40 - 92 10 - 92 45	Lotic	North East India	0..44	LPW
20	Wetlands in Orang Sanctuary	26 15 26 40 42 10 - 92 92 45	Lotic	North East India	0.44	LPW
	Bihar					
21	Chaurs of North Bihar	25 15 27 00 - 84 10 88 10	Lentic	North East India	2.37	V
22	Chota Nagpur Plateau	22 00 25 03 - 85 47 87 50	Lentic	Deccan Peninsula	0.14	LPW
23	Kabartal Lake	25 35 - 86 10	Lentic	Gangetic Plain	0.14	LPW

Contd. . . .

1	*2*	*3*	*4*	*5*	*6*	*7*
24	Vikramshila Gangetic Dolphin Sanctuary	UN	Lotic	Deccan Peninsula	2.37	LPW
	Delhi					
25	Jamuna River near New Delhi	28 50 28 46 - 77 22 77 13	Lotic	Gangetic Plain	0.20	LPW
	Goa					
26	Caramboloim Lake	15 23 - 73 50	Lentic	Western Ghats	1.03	V
27	Santa Monica Lake	UN	Lentic	Western Ghats	0.25	LPW
	Gujarat					
28	Ajwa Lake	22 24 - 73 24	Lentic	Semi-Arid	0.16	LPW
29	Banas Kanta Wetlands	71 20 - 73 20	Lentic	Semi-Arid	0.07	LPW
30	Chhari Dhand	UN	Lentic	Desert	0.37	LPW
31	Dharoi Wetland	UN	Lentic	Semi-Arid	0.49	LPW
32	Fadval Tank	UN	Lentic	Semi-Arid	0.11	LPW
33	Falzar Reservior	21 91 - 70 16	Lentic	Semi-Arid	0.34	LPW
34	Great Rann of Kachchh	23 25 24 25 - 8 07 71 15	Both	Desert	6.30	IV
35	Hamirsar Tank	23 15 - 69 40	Lentic	Semi-Arid	0.22	LPW
36	Harni Wetland	UN	Lentic	Semi-Arid	0.66	LPW
37	Kaneval Reservior	22 33 - 72 58	Lentic	Semi-Arid	0.29	LPW
38	Little Rann of Kachchh	23 10 23 45 - 70 45 71 45	Lentic	Desert	3.01	V
39	Nal Sarovar	22 30 23 12 - 71 25 75 05	Lentic	Semi-Arid	6.85	III
40	Panriej Reservior	22 33 - 72 58	Lentic	Semi-Arid	0.29	LPW
41	Pavgadh Lake	22 29 - 73 22	Lentic	Semi-arid	0.16	LPW
42	Sabarkanta Wetlands	23 21 23 59 - 71 20 73 20	Lentic	Semi-Arid	0.07	LPW
43	Sapad Dam	21 00 21 23 - 70 10 70 13	Lentic	Semi-Arid	0.85	LPW
44	Thol Lake	UN	Lentic	Semi-Arid	1.96	V
45	Vadhwana Lake	22 11 -73 29	Lentic	Semi-Arid	0.16	LPW
46	Wetlands of Eastern Saurashtra	21 00 22 30 - 70 30 70 10	Both	Semi-Arid	0.45	LPW
47	Wetlands of Kachchh	22 45 23 45 - 68 40 71 00	Both	Desert	0.29	LPW
	Haryana					
48	Lav Kush Tirarth	29 55 - 76 00	Lentic	Semi-Arid	0.02	LPW
	Jammu & Kashmir					
49	Ahansar	34 18 - 17 39	Lentic	Himalayan	0.15	LPW
50	Anchar Lake	34 20 - 74 82	Lentic	Himalayan	0..55	LPW
51	Chushul Marshes	33 35 - 78 45	Lentic	Trans-Himalayan	0.15	LPW
52	Dal Lake	34 06 - 74 52	Lotic	Himalayan	1.83	V
53	Gilsar Lake	UN	Lentic	Himalayan	0.23	LPW
54	Haigam Rakh	34 15 - 74 03	Lentic	Himalayan	3.24	V
55	Hanle River Marsh	32 55 - 78 55	Lotic	Trans-Himalayan	0.35	LPW
56	Hokarsar Lake	34 05 - 74 45	Lentic	Himalayan	1.35	V
57	Indus River Strech	34 10 - 77 80	Lotic	Trans-Himalayan	0.37	LPW
58	Khushal Sar Lake	UN	Lentic	Himalayan	0.23	LPW
59	Mansar Lake	32 45 - 75 23	Lentic	Himalayan	0.57	LPW
60	Mirgund Lake	34 08 - 74 38	Lentic	Himalayan	0.98	LPW
61	Naranbagh Lkae	34 12 - 74 41	Lentic	Himalayan	0.18	LPW

Contd. . . .

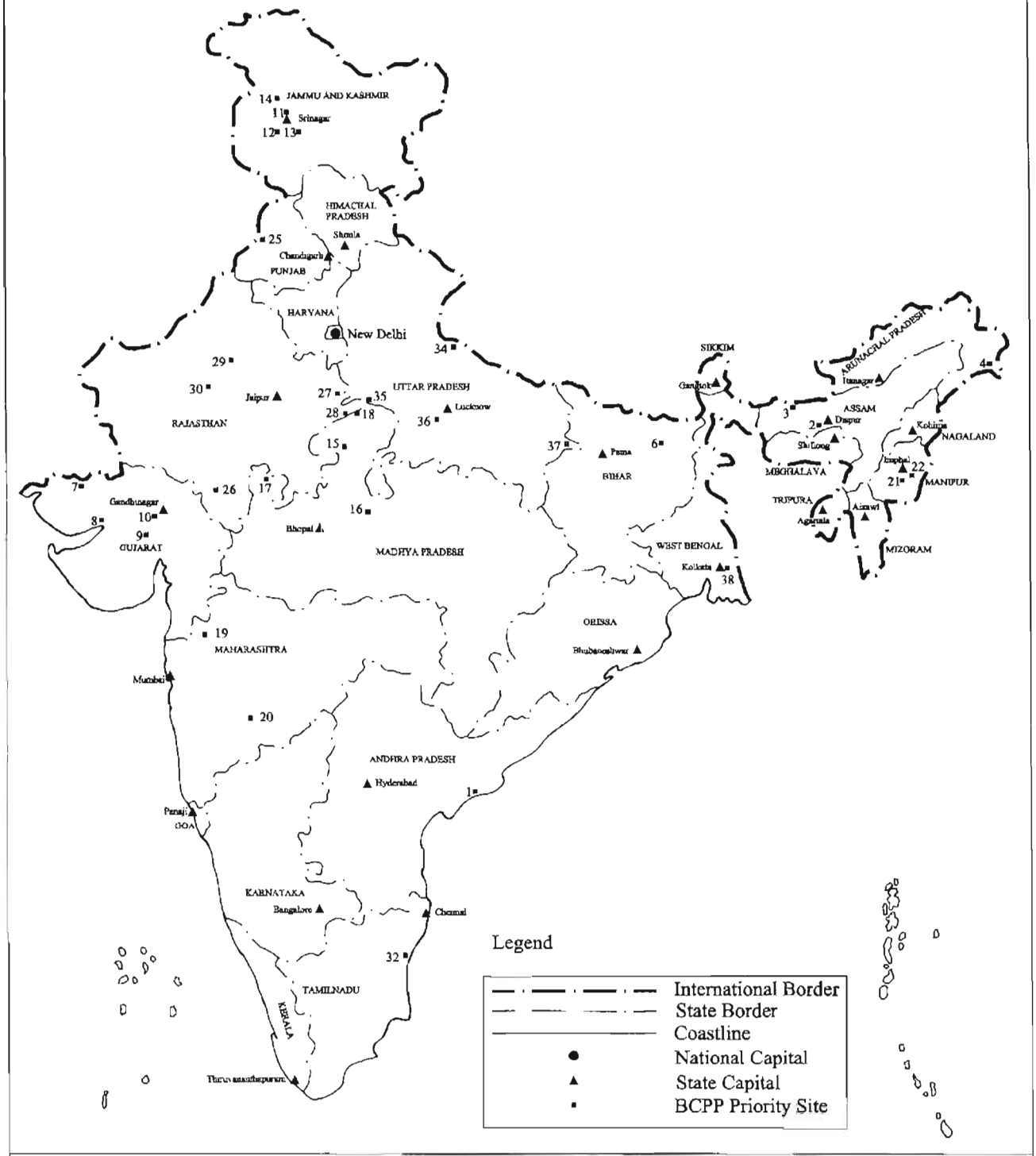
1	*2*	*3*	*4*	*5*	*6*	*7*
62	Pangong Tso	33 50 - 78 35	Both	Trans-Himalayan	0.35	LPW
63	Hallabagh Lakes & Marshes	43 10 - 75 41	Lentic	Trans-Himalayan	0.86	LPW
64	Shey Marshes	34 10 - 77 10	Lentic	Trans-Himalayan	0.09	LPW
65	Surinsar Lake	32 46 - 72 02	Lentic	Himalayan	0.47	LPW
66	Tso Kar Basin	33 05 - 78 00	Both	Trans-Himalayan	0.15	LPW
67	Tso Murari	33 18 - 78 10	Both	Himalayan	0.27	LPW
68	Waskursar Lake	32 07 32 50 - 78 03 78 20	Lentic	Himalayan	0.15	LPW
69	Wular Lake	34 26 - 74 42	Lentic	Himalayan	4.30	IV
	Karnataka					
70	Belikere Lake	UN	Lentic	Deccan Peninsula	0.13	LPW
71	Gudavi Bird Sancturay	14 26 - 75 01	Lentic	Deccan Peninsula	0.76	LPW
72	Kakkare Bellur (Village) Wetland	UN	Lentic	Deccan Peninsula	0.02	LPW
73	Kukkarhali Lake (In Mysore University)	UN	Lentic	Deccan Peninsula	0.06	LPW
74	Ranganthitto Wild Life Sanctuary	12 25 - 76 45	Lotic	Deccan Peninsula	0.92	LPW
75	Tuganbadhara River	16 21 - 77 21	Lotic	Deccan Peninsula	0.15	LPW
76	Wetlands of Bangalore	UN	Lentic	Deccan Peninsula	0.86	LPW
	Kerala					
77	Peechi Dam Reservior	10 30 10 24 - 6 15 76 27	Lentic	Western Ghats	0.65	LPW
78	Peppara Dam Reservior		Lentic	Western Ghats	0.14	LPW
79	Periyar Lake		Lentic	Western Ghats	0.40	LPW
	Madhya Pradesh					
80	Bhamragadh Pamed & Udanti Sanctuary	UN	Lentic	Deccan Peninsula	0.05	LPW
81	Chandapata Lake	25 26 - 77 42	Lentic	Semi-Arid	1.74	V
83	Chicklod Lake	23 07 - 77 42	Lentic	Deccan Peninsula	0.45	LPW
84	Dihaila Jheel	23 35 - 78 05	Lentic	Semi-Arid	1.31	V
85	Gandhi Sagar		Lentic	Semi-Arid	1.85	V
86	Indravati N.P	19 00 29 30 - 81 00 82 00	Lentic	Deccan Peninsula	0.32	LPW
86	Manjira Barrage	17 38 - 78 05	Lotic	Deccan Peninsula	0.43	LPW
87	National Chambal Sanctuary	25 00 26 30 - 79 15 75 40	Lotic	Semi-Arid	2.93	V
88	Upper Lake of Bhopal	23 16 - 77 25	Lentic	Semi-Arid	0.09	LPW
	Maharashtra					
89	Jayakawadi Reservior	19 30 - 75 20	Lentic	Deccan Peninsula	0.27	LPW
90	Katraj Pond	UN	Lentic	Deccan Peninsula	0.12	LPW
91	Mula Mutha River	UN	Lotic	Deccan Peninsula	0.54	LPW
92	Nandur Madhameshwar	20 01 - 74 07	Lentic	Deccan Peninsula	1.74	V
93	Pashan Tank	UN	Lentic	Deccan Peninsula	0.09	LPW
94	Ujanee Reservior	18 10 - 75 05	Lentic	Deccan Peninsula	2.08	V
	Manipur					
95	Ikop Lake	24 15 25 30 - 94 00 94 15	Lentic	North-East India	1.11	V
96	Keibul Lumjao National Park	24 10 - 93 57	Lentic	North-East India	2.23	V
97	Kharung Lake	24 15 25 30 - 94 00 94 15	Lentic	North-East India	1.11	V
98	Loktak Lake	24 35 - 93 50	Lentic	North-East India	8.30	I
99	Phumlen Lake	24 15 25 30 - 94 00 4 15	Lentic	North-East India	1.11	V

1	*2*	*3*	*4*	*5*	*6*	*7*
	Orissa					
100	Indravati N.P	19 00 29 30 - 81 00 82 00	Lotic	Deccan Peninsula	0.32	LPW
101	Satkosia Gorge Sanctuary	20 33 - 84 50	Lotic	Deccan Peninsula	0.05	LPW
	Pondicherry					
102	Ousteri Pond	15 57 - 79 45	Lentic	Deccan Peninsula	209	V
	Punjab					
103	Harike	31 13 - 75 12	Lentic	Semi-Arid	6.50	III
104	Ropar Wetland	30 55 30 58 - 76 26 76 28	Lentic	Semi-Arid	0.25	LPW
	Rajasthan					
105	Fatheh Sagar Lake	UN	Lentic	Semi-Arid	0.45	LPW
106	Gwadia Lake	UN	Lentic	Deccan Peninsula	0.27	LPW
107	Jai Samand Wild Life Sanctuary	27 42 - 75 33	Lentic	Semi-Arid	3.48	V
108	Keoladeo National Park	27 07 27 12 - 79 29 79 33	Lentic	Semi-Arid	14.00	I
109	National Chambal Sanctuary	25 00 26 30 - 79 15 75 40	Lotic	Semi-Arid	2.93	V
110	Pichola Lake	UN	Lentic	Semi-Arid	0.43	LPW
111	Sambhar Lake	27 00 - 75	Lentic	Semi-Arid?	7.50	II
112	Sardar Samand Reservior	25 09 - 73 05	Lentic	Desert	1.49	V
113	Thar Desert Wetland	UN	Lentic	Desert	2.35	V
	Sikkim					
114	Wetlands of Sikkim	UN	Lentic	Himalayan	0.01	LPW
	Tamil Nadu					
115	Bhavani Sagar Reservior	11 28 - 77 06	Lentic	Deccan Peninsula	0.34	LPW
116	Chembakaram Tank	UN	Lentic	Deccan Peninsula	0.18	LPW
117	Chitarangudi Tank	09 20 - 78 30	Lentic	Deccan Peninsula	0.06	LPW
118	Kaliveli Tank	12 05 12 15 - 79 47 79 59	Lentic	Deccan Peninsula	1.16	V
119	Kanjirangulam Tank	09 20 - 78 30	Lentic	Deccan Peninsula	0.06	LPW
120	Kankavati	13 33 - 77 54	Lentic	Deccan Peninsula	0.85	LPW
121	Kanya Kumari Wetlands	UN	Both	Deccan Peninsula	0.64	LPW
122	Karakailli Tank	12 32 - 79 52	Lentic	Deccan Peninsula	0.24	LPW
123	Karungulam	09 21 - 78 32	Lentic	Deccan Peninsula	0.82	LPW
124	Koonthakulam Tank	8 28 - 77 44	Lentic	Deccan Peninsula	0.07	LPW
125	Kullur Sandai Tank	9 32 - 77 58	Lentic	Deccan Peninsula	0.01	LPW
126	Madhavaram Jheel	13 15 - 80 00	Lentic	Deccan Peninsula	0.03	LPW
127	Ousteri Tank	15 57 - 79 45	Lentic	Deccan Peninsula	2.09	V
128	Parangipetapi, Mandap, Perumallak	UN	Lentic	Deccan Peninsula	0.01	LPW
129	Santhanur Reserviou	12 20 - 78 54	Lentic	Deccan Peninsula	0.52	LPW
130	Sengulam Tank	08 38 - 77 51	Lentic	Deccan Peninsula	0.08	LPW
131	Simon Estate Wetland	UN	Lentic	Deccan Peninsula	0.02	LPW
132	Sirathavam Tank	13 00 - 80 10	Lentic	Deccan Peninsula	0.28	LPW
133	Vedanthangal	12 32 - 79 52	Lentic	Deccan Peninsula	0.29	LPW
134	Vembakottam Tank	09 20 - 77 46	Lentic	Deccan Peninsula	0.01	LPW
135	Vettakudikarvati Reservior	10 30 - 78 30	Lentic	Deccan Peninsula	0.37	LPW
136	Wetlands in Madhuari Agricultural Research Institute	09 54 - 78 54	Lentic	Deccan Peninsula	0.70	LPW
137	Wetlands in Nilgiri District	11 18 25 - 76 35 76 40	Lentic	Deccan Peninsula	0.72	LPW

Contd. . . .

1	*2*	*3*	*4*	*5*	*6*	*7*
	Uttar Pradesh					
138	Asan Reservior Doon Valley	UN	Lentic	Himalayan	0.25	LPW
139	Azhinjilam Jheel	UN	Lentic	Himalayan	0.11	LPW
140	Corbett National Park	29 25 29 40 - 8 45 79 05	Both	Gangetic-Plain	0.96	LPW
141	Dahar Jheel	26 55 27 25 -79 10 80 15	Lentic	Gangetic-Plain	0.95	LPW
142	Dudhwa National Park	28 21 28 41 - 80 30 80 55	Lentic	Gangetic-Plain	1.30	V
143	Eastern U.P. Wetlands	25 10 26 20 - 81 00 84 45	Lentic	Gangetic-Plain	0.26	LPW
144	Jheels in vicinity of Haidergah	26 35 - 81 15	Lentic	Gangetic-Plain	0.13	LPW
145	Katerniaghat Pashu Vihar Sanctuary	28 07 28 40 - 81 03 81 20	Lentic	Gangetic-Plain	0.78	LPW
146	Kishanpur Pashu Vihar Sanctuary	28 21 28 40 - 80 20 80 24	Lentic	Gangetic-Plain	0.32	LPW
147	Manjheera Impoundement	28 18 - 81 04	Lentic	Gangetic-Plain	0.20	LPW
148	National Chambal Sancturay	25 00 26 30 - 79 15 75 40	Lotic	Gangetic-Plain	2.93	V
149	Nawabganj Priyardarshani Bird Sanctuary	26 50 - 81 10	Lentic	Gangetic-Plain	1.39	V
155	Pyagpur Jheel	27 25 - 81 48	Lentic	Gangetic-Plain	0.27	LPW
151	Sitwadar Jheel	27 25 - 81 48	Lentic	Gangetic-Plain	0.27	LPW
152	Soj Jheel	26 55 27 25 -79 10 80 15	Lentic	Gangetic-Plain	0.95	LPW
153	Suraha Tal	25 48 25 52 - 84 8 85 13	Lentic	Gangetic-Plain	2.89?	V
	West Bengal					
154	Brace Bridge Wetlands	22 31 22 33 88 17 88 18	Lentic	Gangetic-Plain	0.14	LPW
155	Chaurs of West Bengal	25 15 27 00 - 84 10 88 10	Both	North -East India	0.47	LPW
156	Durgapur Barrage	23 28 - 87 18	Lentic	Gangetic-Plain	0.50	LPW
157	Jaldapara Wildlife Sanctuary	26 45 - 89 45	Lentic	Gangetic-Plain	0.40	LPW
158	Salt Lake Swamp	22 25 22 40 - 88 20 88 35	Lentic	Gangetic-Plain	1.42	V

BCPP PRIORITY SITES IN THE INDIAN MAINLAND (WETLANDS)



ANDHRA PRADESH
1 - Kollern Sanctuary
ASSAM
2 - Dipor Beel
3 - Manas National Park
ARUNACHAL PRADESH
4 - Namdapha National Park
5 - Deepam (not plotted since its location is not known)
BIHAR
6 - Chaurs of North Bihar

GUJARAT
7 - Great Rann of Kachchh
8 - Little Rann of Kachchh
9 - Nal Sarovar Sanctuary
10 - Thol Sanctuary
JAMMU AND KASHMIR
11 - Dal Lake
12 - Hsigam Lake
13 - Hokarsar Lake
14 - Wular Lake

MADHYA PRADESH
15 - Chandpata Lake (Madhav N.P.)
16 - Dihaila Jheel
17 - Gandhi Sagar Sanctuary
18 - National Chambal Sanctuary
MAHARASHTRA
19 - Nandur Madhmeshwar
20 - Ujanee Reservoir

MANIPUR
21 - Loktak Lake (Keibul Lamjao N.P.)
22 - Phumlen Lake
23 - Ikop Lake (not plotted since its location is not known)
24 - Kharung Lake (not plotted since its location is not known)
PUNJAB
25 - Harike Lake

RAJASTHAN
26 - Jaisamand Lake
27 - Keoladeo Ghana N P.
28 - National Chambal Sanctuary
29 - Sambhar Lake
30 - Sardar Samand Lake
31 - Thar Desert Wetland (not plotted since its location is not known)
TAMILNADU
32 - Kaliveli Tank
33 - Ousteri Tank (not plotted since its location is not known)

UTTAR PRADESH
34 - Dudhwa National Park
35 - National Chambal Sanctuary
36 - Nawabganj Sanctuary
37 - Surahs Tal Sanctuary
WEST BENGAL
38 - Salt Lake Swarop

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Prioritization of the Indian Grasslands for Conservation of Biodiversity

Asad R. Rahmani and M. Zafar-ul Islam

Introduction

The purpose of this study was to prioritise from among grasslands in India in order to focus conservation action especially on those priority grasslands which were unprotected or inadequately protected.

The specific objectives were

1. To prioritise sites and stretches of grassland ecosystems on the basis of their biodiversity and socio-economic value
2. To prioritise strategies for conservation of priority and other grassland sites and stretches.

Indian Grasslands

Grasslands are formed in regions where climatic and edaphic factors prohibit the growth of trees. A grassland has been defined as the land in which grasses (graminoids) are the dominant plants but some legumes, herbs and shrubs are also present. In India, grasslands are mainly found in Gujarat (Saurahstra), Rajasthan (Thar desert), Maharashtra (Deccan), Western Madhya Pradesh (Malwa plateau), Uttar Pradesh (*terai*) and the Brahmaputra Valley. Montane grasslands are found in Western Himalayas, Sikkim and the Western Ghats. This report deals only with the grasslands of the Indian plains.

Grasslands Protected Areas

There is no pure dry grassland sanctuary or park in India where viable populations of all the represented faunal elements of that ecosystems can be seen. The Great Indian Bustard Sanctuary (also called Jawahar Lal Bustard Sanctuary), although covering more than 8,000 sq km, has less than 400 sq km under the control of the forest department and therefore effectively protected. Even in these 400 sq km, probably less than half is under grass cover.

In Saurashtra, the once-famous grasslands or *vidis*, are under tremendous pressure of grazing and land use changes. Only Rampura Grassland near Dahod and Velavador National Park in Bhavnagar are well protected. However, in Madhya Pradesh, the Sailana Florican Sanctuary and nearby grasslands have come under intense agricultural pressure. During the last ten years, more than half of Sailana grasslands have disappeared.

In the south, most of the grasslands have already disappeared. Rollapadu grasslands especially protected in the 1980s for the conservation of the Great Indian Bustard are indirectly under threat by angry farmers due to crop depredation by an increasing number of Blackbuck. Presently, there is hardly any scope to increase the area of the sanctuary.

The humid grasslands of the Himalayan *terai* and the Brahmaputra valley, which contain some of the most spectacular and endangered animals of India, have been severely fragmented and survive only in some PAs such as Dudwa, Kaziranga, Manas, Orang, Kishanpur, Pobitora and D'Ering sanctuaries.

In 1988, W.A. Rodgers and H. S. Panwar of the Wildlife Institute of India published a document entitled "Planning a Wildlife Protected Areas Network in India". The main aim of this document was to prioritise more areas for biodiversity protection, so that a whole gamut of habitats, ecosystems and species, across the country are protected. They also identified gaps in our protected area network and gave recommendations accordingly attempting to ensure that each ecosystem type is represented. Grassland protection, which till then had received low priority, was given greater importance and a number of gaps were identified in the coverage of grasslands by the PA network. Some of these gaps are also discussed here.

Methodology

Literature consultation: For each grassland type and for each area, extensive literature consultation was done. More than 300 research papers and reports were read.

Consultation with experts: Grassland experts, field biologists, forest officials and social scientists were consulted in person or through correspondence.

Interview with grassland users: More than 800 grassland users were interviewed in Rajasthan, Uttar Pradesh, Madhya Pardesh, Gujarat, Assam and Maharashtra to collect socio-economic information Owing to various reasons we could not interview people in the *shola* and alpine areas.

Ranking of grasslands: As there is no single methodology to rank or prioritise a habitat, various methods were used to find out which are the most important grasslands in India, needing urgent conservation measures. We ranked the grasslands according to.

(a) Biological values
(b) Socio-economic values
(c) Administrative importance
(d) Geographical representation
(e) Habitat representation
(f) Cultural and social values

Each of these is described in detail

(a) Biological values: In order to compare the biological values of different grasslands, larger mammals, birds, plants and in some cases butterflies, amphibians and reptiles were studied We could not get information on insects, spiders, termites, worms, and even smaller mammals which may be of prime importance for the ecology of the grasslands.

Diversity value of each grassland was also calculated by the number of species of each taxon i.e. mammal, bird, plant, buttelly, etc.

In certain cases where a critical or endangered species is confined to a certain grassland habitat only, presence/absence and abundance of such a species was chosen as an important criteria for ranking For instance, the Nilgiri Tahr is a highly endangered, endemic species of the *shola* grasslands Any shola grassland where this animal is found is important for conservation. Within these Tahr-occupied grasslands, further ranking was done on the basis of abundance of the Tahr. For instance, a grassland with more than 200 Tahrs is more important than a grassland with only 10 Tahrs. Similarly, the Lesser Florican is a purely grassland species. A grassland with a viable breeding population of Lesser Florican is certainly more important than a similar grassland with no or very few Floricans. For the Terai grasslands, presence of Bengal Florican, Swamp Deer, Hispid Hare, Rhinoceros, Pygmy Hog, etc were considered, while for the arid grasslands of Rajasthan, presence/absence and abundance of the Great Indian Bustard played a major role in determining the worth the of grassland

(b) Socio-economic values: A detailed questionnaire was designed after consultation with various people. First, a preliminary sample survey was done, in Bharatpur to test the proforma, and the results were discussed with Prof Kanchan Chopra of the Institute of Economic Growth, Delhi. She suggested some modifications in the questionnaire and the methodology. After incorporating the suggestions, detailed surveys were conducted in the grasslands of the Terai, Thar desert and Kutch, the wet grasslands of Assam, and the semi-arid grasslands of northwest and south India. Data on the following parameters were collected:

Site: State, District, Village, Type of Road, Date, Population of village,

Family Information: Name of head, # of individual, adults, minors, working members, caste, religion, # of literates, qualification, occupation

Income: Land holding and income from that, employment (full, partial, nil) and income from that

Dependency: On Agriculture, Grassland, Industry, other

Crops: Name of crops

Grassland type: Species of grass, area, storing, shortage.

Livestock

Fuel: Source, how much used, shortage

Schools

Employment avenues

(c) Administrative importance: While ranking the grasslands, administrative importance given to the grasslands or the possibility of protecting the grassland was also considered. Each grassland was ranked as follows:

Already well-protected	1.0
Protected (Govt or private)	0.9 to 0.8
Protected but chances of destruction very high	0.7 to 0.6
Can be protected	0.5
Unprotected but light biotic pressures	0.4
Unprotected but heavy biotic pressures	0.3
Unprotected with no chance of recovery	0.2
Already too late	0.1

(d) Geographical representation: Each grassland was also ranked according to its geographical importance i.e. whether others of its kind are present in the state, or region, or elsewhere. As usual, ranking was done at the decreasing importance from 1 to 0.1. Unique grassland in the state or a region was given one mark while the common grasslands found all over the country were given 0.3 to 0.1 marks

(e) Habitat representation: While ranking a grassland, importance was also given to whether it is represented in the Protected Areas (PA) system or not

Unique grassland not represented in PA system	1.0
Unique grassland under-represented in PA system	0.9 to 0.7
Grassland well represented in PA system	0.6 to 0.4
Grassland over-represented in PA system	0.3 to 0.1

Results

The final prioritisation of grasslands was based on biological values, habitat representation and state representation. Care was taken to select the grasslands in such a way that they represented all the habitat types, from the arid grasslands of the Thar desert and *Shola* grasslands of the Western Ghats, to the tall, wet, grasslands of the Brahmaputra flood plains. Consideration was also given to regional or state boundaries. For example, *Shola* grasslands were selected from all the states (Kerala, Tamil Nadu and Karnataka) which have such types of grasslands. Similarly, arid grasslands were selected from Rajasthan and Kutch.

State-wise Prioritisation of Grasslands

Uttar Pradesh

Priority Number One	**Dudwa, Kishanpur, Katerniaghat**
Priority Number Two	**Lagga-Bagga** (Mustufabad Range) **Pilibhet forests** (Mahauf Range)
Priority Number Three	**Sohagi Barwa** (Matholta, Nichlaul) **Suhelwa** (Katkunya beat) **North Gonda** (Bhabar Range, Bhagwanpur)

Rajasthan

Priority Number One	**Desert National Park**: fragmented grasslands **Sultana & Ramgarh** grasslands in Jaisalmer
Priority Number Two	**Taal Chhaper** in Churu **Diyatra-Khetolai** in Bikaner **Bap** in Jodhpur
Priority Number Three	**Keoladhar** in Bharatpur

Madhya Pradesh

Priority Number One	**Maidans** of Kanha National Park **Sailana** in Ratlam **Gunnar** in Panna
Priority Number Two	**Ghatigaon** in Gwalior **Pohri** in Shivpuri **Rewas ka Magra** in Mandsaur **Panpura** in Dhar
Priority Number Three	**Naulakha** in Mandsaur **Jhalwa, Ambha** & **Dhamnod** in Ratlam **Udanti and Sitanadi** in Raipur

Gujarat

Priority Number One	**Banni** in Kutch **Velavador** in Bhavnagar **Lala area** in Naliya taluka in Kutch
Priority Number Two	**Rampura** grassland in Dahod **Rampara** in Wankaner **Gaga** in Jamnagar
Priority Number Three	**Ranigoda/Hipavali** in Bhavnagar **Mithiala** in Bhavnagar **Kengarpur** in Jamnagar **Pipala** in Bhavnagar

Maharashtra

Priority Number One	**Nanaj, Karmala, Madha, Mohol** grasslands in Solapur district **Gnanganga** in Buldana
Priority Number Two	**Chapedgaon** (Ahmednagar), **Virgaon** in Ahmednagar
Priority Number Three	**Khadrapur** (Kolhapur), **Boramani** (Solapur) **Lalling** (Dhulia), **Wadali** (Amraoti)

Andhra Pradesh

Priority Number One	**Rollapadu** grasslands in Kurnool
Priority Number Two	**Siruvella** near Nandyal **Vikarabad** and **Shamsabad** in Rangareddy **Nellibanda** in Kurnool
Priority Number Three	**Hanimireddypalli** in Anantapur

Karnataka

Priority Number One	**Shola grasslands** of Kudremukh
Priority Number Two	**Rannibennur** in Dharwad
Priority Number Three	**Bilgi** and **Chincholi**

Tamil Nadu & Kerala

Priority Number One	**Eravikulam** in Kerala **Grass Hills** & **Anamalai** in Tamil Nadu
Priority Number Two	**Anamudi** in Kerala **Parambikulam** in Kerala
Priority Number Three	**Pacchapal Malai** in Kerala **Kuchi Malai** in Kerala

Assam

Priority Number One	**Kaziranga, Manas, Orang, Pabitora, Bornadi Dibru-Saikhowa**
Priority Number Two	**Lowkhowa Burachapori Sadiya plains** in Tinsukia
Priority Number Three	**Jamjing** in Dhemaji **Bordalani** in Dhemaji and Lakhimpur **Kochmora** in Sonitpur **Pani-Dihang** in Sibsagar **Nameri** in Sonitpur

Arunachal Pradesh

Priority Number One	**D'Ering Wildlife Sanctuary** in East Siang
Priority Number Two	**Dibang** in Dibang Valley
Priority Number Three	**Namdapha** in Changlang **Deopani & Kerim** in Dibang Valley **Chapories** of Lohit river **Grasslands** between Sesseri and Sibia rivers

West Bengal

Priority Number One	**Jaldapara & Gorumara** in Jalpaiguri
Priority Number Two	**Sahabad-Sayedabad** near Bagdogra
Priority Number Three	**Buxa Tiger Reserve** in Jalpaiguri **Flood plains** of Teesta River

Brief Discussion

All the grasslands from the arid Banni to the alpine meadows of Sikkim are under tremendous pressure from grazing and change in the land use pattern. India has a large number of livestock (430 million heads), and the number is still growing. Except in the arid grasslands of Jaisalmer, in all other areas there is a tremendous difference between the demand and the availability of fodder. Most of this demand is met from forest resources. Though less in national parks such as Dudwa, Kaziranga, Manas, Eravikulam, Kanha, Velavador etc., most of the other protected areas are subjected to legal or illegal grazing. A finding of the study was that most of the areas with high biological values were those which were protected from human exploitation (i.e. they had low socio-economic value because local communities were not allowed to use the resources). In other words, wherever over-exploitation of resources was prevented, biodiversity values increased. This contradiction can be resolved by judicious exploitation of resources. For example, in Dudwa, Kaziranga, Manas etc. at present annual burning of course grass is practiced to increase habitat suitability for endangered species. This grass can be given to surrounding villagers for thatch, fodder and other purposes, thus decreasing the conflict between the PA and local communities. As the Terai grasslands are at a successional stage, the annual grass cutting and burning may be the most economical way to maintained them. It must be emphasised here that under no circumstances should grass be commercially exploited from PAs because once this is allowed, all controls and checks to ensure regulated exploitation become ineffective.

However, under certain circumstances, commercial exploitation of grass may actually become a motivation for better management of grasslands, as shown in studies at Dahod where lakhs of kilogram of grass is harvested annually. Our studies have shown that there is no conflict between grassland protection and conservation of grassland birds, because most of the birds breed during the monsoon when grasslands have to be protected for hay production. By the time the grass is tall enough for harvesting, most of the birds have already completed their breeding cycle. Actually, protection of the Lesser Florican, the Great Indian Bustard, the Rain Quail, the Button Quail, etc can complement hay production. Even in the Desert National Park, we strongly recommend that every three or four years, grass should be harvested from the core areas and given to villagers, as periodic grass removal makes the habitat more suitable for the Great Indian Bustard.

Considering all the factors, we found that among all five major grassland types of our country, the *terai* grassland ranks highest in terms of habitat for rare, endangered, endemic and glamorous species (e.g. Rhino, Elephant, Wild Buffalo, Swamp Deer, Hispid Hare, Pygmy Hog, Bengal Florican). The alpine grasslands have low priority mainly because they are present in many countries (Nepal, Pakistan, China, Bhutan) and human population pressures are comparatively low. Although, there are some spectacular species such as the Blacknecked Crane, The Kiang, The Snow Leopard, the Tibetan Antelope and the Tibetan Gazelle, none of them is endemic to India. Moreover, they range in such a huge area that it is difficult to identify certain areas for intensive conservation, except perhaps the breeding sites of the Blacknecked Crane.

Our studies prove that although some grasslands may have low endemicity, they may be absolutely essential for certain species. For instance, shola grasslands of Western Ghats do not have many species but they are important for the survival of the Nilgiri Tahr, which does not occur any where else in the world. That is why we have given the highest biological ranking to these grasslands. Similarly, the grass *bheeds* of Malwa plateau and Saurashtra are

essentail for the survival of the critically endangered Lesser Florican. Therefore, they also rank very high in our order.

Selection of the ten most important grasslands for biodiversity conservation is not easy. However, we have made an attempt in this direction, taking into consideration all the values: biodiversity, socio-economic, administrative geograpahical and habitat representation. The following grasslands/protected areas ranked the highests: Kaziranga, Manas, Dudwa, Kanha, Velavador, Dahod, Rollapadu, Banni, Desert National Park and Eravikulam.

Table 1: Major Existing Grasslands of Indian Plains

State	*District*	*Name*	*Size* (sq km)*	*Grassland Type*	*Status*	*Main threats*
Gujarat	Kutch	Banni	840	Dry, Saline	UP	Spread of *Prosopis*, Over-grazing
		Naliya	>100	Dry, coastal	UP	Introduction of *Prosopis*, Over- grazing
	Panchmahal	Dahod	20	Semi-arid	P	None
	Bhavnagar	Velavador	30	Semi-arid,	P	Spread of *Prosopis* Saline
	Rajkot	Rampara	10	Semi-arid	P	Grazing
Rajasthan	Jaisalmer	Ramgarh	--	Arid	UP	Indira Gandhi Nahar Project (IGNP)
	Jaisalmer	Sultana	--	Arid	P	IGNP
	Churu	Talchappar	7	Arid	P	Grazing
	Bikaner	Fragmented	—	Arid	UP	IGNP, Grazing patches
Madhya Pradesh	Ratlam	Sailana	2.5	Semi-arid	P	Spread of agriculture
	Ratlam, Dhar, Mandsaur	Fragmented private grasslands	--	Semi-arid	P	Spread of agriculture
	Mandla	Kanha	—	Semi-arid	P	None
Uttar Pradesh	Lakhimpur-Kheri	Dudwa	100	Wet	P	None
	-do-	Kishanpur	—	Wet	P	None
	Pilibhet	Reserved	—	Wet	P	Afforestation
	Bahraich	Katerniaghat	—	Wet	P	Grazing, Afforestation
	Maharajganj	Sohagi Barwa	—	Wet	P	-do-
Bihar	Champaran	Valmikinagar	—	Wet	P	-do-
West Bengal	Jalpaiguri	Jaldapara	118	Wet	P	None
	Jalpaiguri	Gorumara	8	Wet	P	None
Assam	Barpeta, Nalbari, Kokrajhar	Manas	100	Wet	P	Tribal insurgency

* Grassland size. P = Protected, UP = Unprotected

Contd. . . .

State	*District*	*Name*	*Size* (sq km)*	*Grassland Type*	*Status*	*Main threats*
	Darrang Sonitpur	Orang	50	Wet	P	None
	Nagaon	Pabitara	16	Wet	P	None
Arunachal	East Siang	D'Ering	—	Wet	P	Not known
Maharashtra	Solapur, Ahmednagar	Jawaharlal - Nehru Bustard Sanctuary	8,496	Semi-arid	P human	General disturbance
Andhra	Kurnool	Rollapadu	6	Semi-arid	P	Occasional illegal grazing

* Grassland size.
P = Protected, UP = Unprotected

Table 2: Ranking of Grasslands based on the following Evaluations

Name	*Biological*	*Socio-economic*	*Administrative*	*Geographical*	*Habitat*
Dudwa	1.0	-	1.0	0.1	0.8
Kishanpur	1.0	-	1.0	-	0.8
Katerniaghat	1.0	-	0.8	-	0.8
Lagga-Bagga	0.8	-	0.5	-	0.8
Pilibhet	0.8	-	0.8	-	0.8
Sohagi-Barwa	0.8	-	0.7	-	0.8
Suhelwa	0.6	-	0.7	-	0.7
North Gonda	0.5	-	0.6	-	0.7
Desert NP	1.0	-	0.7	1.0	1.0
Sultana	0.8	1.0	0.5	1.0	1.0
Ramgarh	0.7	1.0	0.5	1.0	1.0
Taal Chhaper	0.5	0.5	1.0	0.6	0.8
Bap	0.8	1.0	0.5	0.6	0.7
Keoladhar	0.5	1.0	1.0	0.6	0.8
Diyatra	0.8	1.0	0.5	0.5	0.7
Khetolai	0.8	1.0	0.5	0.5	0.7
Bajju	0.5	0.8	0.3	0.4	0.7
Khinya	0.8	1.0	0.5	0.5	0.7
Miyajlar	0.6	0.5	0.7	0.5	0.7
Kanha	1.0	0.5	1.0	1.0	0.7
Sailana	1.0	1.0	0.7	0.7	1.0
Naulakaha	1.0	1.0	0.7	0.7	1.0
Jhalwa	1.0	1.0	0.6	0.7	0.9
Ambha	1.0	1.0	0.6	0.7	0.9

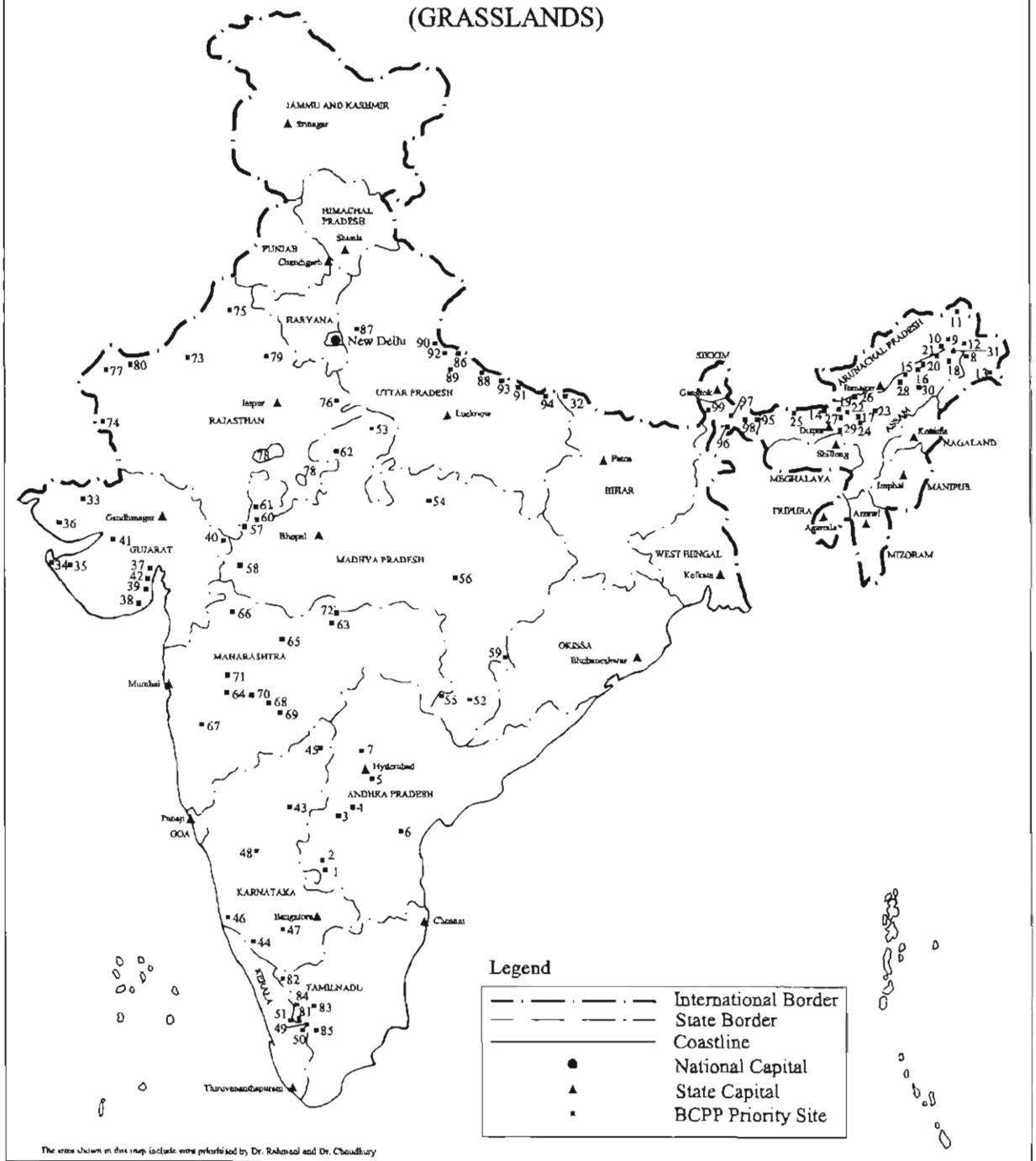
Contd. . . .

Name	*Biological*	*Socio-economic*	*Administrative*	*Geographical*	*Habitat*
Dhamnod	1.0	1.0	0.6	0.7	0.9
Piploda	1.0	1.0	0.6	0.7	0.9
Panpura	1.0	1.0	0.7	0.7	0.9
Rewas	0.7	1.0	0.5	0.7	0.7
Ghatigaon	1.0	0.5	0.6	0.4	0.6
Udanti	0.9	?	0.6	1.0	0.8
Sitanadi	0.9	?	0.6	1.0	0.8
Velavadar	1.0	0.5	1.0	1.0	1.0
Banni	1.0	1.0	0.5	1.0	1.0
Gaga	1.0	0.8	0.7	0.5	0.6
Rampura	1.0	1.0	1.0	0.6	0.6
Lala	1.0	1.0	0.6	0.7	0.7
Ranigoda	0.7	1.0	0.6	0.6	0.7
Pipala	0.7	1.0	0.6	0.6	0.7
Kengarpur	0.7	1.0	0.6	0.6	0.7
Rampara	0.8	?	0.8	0.6	0.7
Mithilia	0.7	?	0.6	0.6	0.7
Nannaj	1.0	1.0	1.0	0.9	0.9
Karmala	1.0	1.0	1.0	0.9	0.9
Madha	1.0	1.0	1.0	0.9	0.8
Virgaon	0.7	1.0	0.7	0.6	0.7
Chapedgaon	0.8	1.0	0.6	0.6	0.7
Mohol	1.0	1.0	1.0	0.9	0.8
Boramani	0.6	1.0	0.7	0.6	0.7
Virgaon	0.6	1.0	0.6	0.6	0.7
Lalling	0.6	1.0	0.7	0.6	0.7
Wadali	0.4	0.7	0.7	0.6	0.7
Khadrapur	0.5	0.7	0.6	0.6	0.7
Rollapadu	1.0	0.5	1.0	1.0	1.0
Vikarabad	0.5	0.7	0.3	0.8	0.7
Shamshabad	0.5	0.7	0.3	0.8	0.7
Siruvella	1.0	0.5	0.4	0.8	0.7
Nellibanda	1.0	0.5	0.4	0.8	0.7
Hanimiredypali	0.5	0.5	0.2	0.5	0.1
Rannibennur	1.0	0.5	1.0	0.3	0.6
Bilgi	0.5	?	0.7	0.3	0.6
Chincholi	0.5	?	0.4	0.3	0.6
Kudremukh	0.8	?	0.8	0.8	0.8
Eravikulam	1.0	0.0	1.0	1.0	0.9

Contd. . . .

Name	*Biological*	*Socio-economic*	*Administrative*	*Geographical*	*Habitat*
Grass Hills	0.9	?	1.0	1.0	0.9
Anamalai	1.0	?	1.0	1.0	0.9
Anamudi	0.8	?	0.8	0.7	0.7
Parambikulam	1.0	?	1.0	0.7	0.6
Pacchapal	0.7	?	0.7	0.7	0.6
Kuchi Malai	0.6	?	0.6	0.7	0.6
Orang	1.0	1.0	1.0	0.8	0.8
Kaziranga	1.0	1.0	1.0	1.0	1.0
Manas	1.0	1.0	1.0	1.0	1.0
Pabitora	1.0	1.0	1.0	0.8	0.8
Bornadi	1.0	1.0	1.0	0.8	0.8
DibruSaikhowa	0.8	1.0	0.9	0.8	0.7
Lowkhowa	0.8	1.0	0.8	0.8	0.7
Burachopori	0.8	1.0	0.6	0.7	0.7
Sadiya	0.7	1.0	0.5	0.7	0.7
Bordalani	0.7	1.0	0.5	0.7	0.6
Kochmora	0.7	1.0	0.5	0.7	0.6
Pani-Dihang	0.7	1.0	0.5	0.7	0.6
Jamjing	0.7	1.0	0.5	0.7	0.6
Nameri	1.0	0.7	0.9	0.8	0.7
Dibang	0.9	1.0	0.8	0.7	0.7
D”Ering	1.0	1.0	0.8	1.0	0.9
Namdapha	1.0	0.7	0.9	0.7	0.6
Chapories	0.7	1.0	0.5	0.6	0.6
Sesseri/Sibia	0.7	1.0	0.5	0.6	0.5
Deopani/Kerim	0.6	1.0	0.5	0.6	0.5
Jaldapara	1.0	0.6	1.0	1.0	1.0
Sahabad	0.6	1.0	0.1	1.0	0.7
Buxa	1.0	0.5	1.0	0.8	0.7
Teesta plains	0.4	1.0	0.2	0.6	0.7

BCPP PRIORITY SITES IN THE INDIAN MAINLAND (GRASSLANDS)



The areas shown in this map include areas prioritised by Dr. Rahmani and Dr. Choudhury

ANDHRA PRADESH
1 - Ramareddypalli
2 - Medinapalli
3 - Nellibanda
4 - Rollapadu Sanctuary
5 - Shamshad
6 - Sirivella
7 - Vikarabad

ARUNACHAL PRADESH
8 - Chaporites of Lohit River
9 - Scattered grasslands between Sesseri and Sibia Rivers
10 - D'Ering (Lohit) Sanctuary
11 - Debang Sanctuary
12 - Kamla
13 - Namdapha National Park

ASSAM
14 - Barnadi Sanctuary
15 - Borachapori
16 - Bordoloni
17 - Burhachapori Sanctuary
18 - Dihru-Saikhowa Sanctuary
19 - Hugrajuli
20 - Jamjing and Senggajan
21 - Kobo Chapori
22 - Kochmara
23 - Kaziranga National Park
24 - Laokhowa Sanctuary
25 - Manas National Park
26 - Nameri National Park
27 - Orang Sanctuary
28 - Pabitra
29 - Pabitora Sanctuary
30 - Panj-Dihing Sanctuary
31 - Ataspur, Sibia Chapori, Kaziya Plains (Dhemaihapori, Kuwaji Kaliya R.F. and Ambikapur)

BIHAR
32 - Valmiki Tiger Reserve

GUJARAT
33 - Banni
34 - Gaga Grass Indian Bustard Sanctuary
35 - Kanjarpur to Kachchh
36 - Lala Area
37 - Mithiala
38 - Pipala
39 - Ramgoda/Hipavali
40 - Ranapura in Dahod
41 - Ranipura in Wankaner
42 - Velavadar National Park

KARNATAKA
43 - Bilige
44 - Brahmagiri Sanctuary
45 - Chamaloti
46 - Kudremukh National Park
47 - Malkoot Temple Sanctuary
48 - Ranebennur Sanctuary

KERALA
49 - Amarmuh
50 - Brevikulam National Park
51 - Parambikulam Sanctuary

MADHYA PRADESH
52 - Bhanvargarh Wild Buffalo Sanctuary
53 - Ghatigaon Great Indian Bustard Sanctuary
54 - Gunnor
55 - Indravati National Park
56 - Maudara of Kanha National Park
57 - Sailana Sanctuary
58 - Sardarpur Sanctuary
59 - Udanti Sanctuary
60 - Pratwa, Ambha and Dhamnod
61 - Neelakha and Rewas Magra
62 - Palni

MAHARASHTRA
63 - Akola Grassland
64 - Chapedgaon
65 - Gyanganga
66 - Lalbag
67 - Kandepar
68 - Madha
69 - Mahol
70 - Nasej, Kamala and Borsamna (all within the Great Indian Bustard Sanctuary)
71 - Virgaon
72 - Wadali

RAJASTHAN
73 - Jap
74 - Desert National Park
75 - Dyaara-Khetolai
76 - Keoladeo Ghana National Park
77 - Ramgarh
78 - Scattered grasslands of Eastern Rajasthan
79 - Tal Chapper Sanctuary
80 - Salasna

TAMILNADU
81 - Anamalai Sanctuary (including Orias Hills)
82 - Vedanthangal Bird
83 - Point Calimere Sanctuary
84 - Karan Malai
85 - Palani Hills

UTTAR PRADESH
86 - Dudhwa National Park
87 - Hastinapur Sanctuary
88 - Katarniaghat Sanctuary
89 - Kishanpur Sanctuary
90 - Lagga-Bhaga
91 - North Gonda
92 - Pilibhit Forests
93 - Sohelwa Sanctuary
94 - Sohagi Barwa Sanctuary

WEST BENGAL
95 - Buxa Tiger Reserve
96 - Flood Plains of the Teesta River
97 - Gorumara National Park
98 - Jaldapara Sanctuary
99 - Sahabad-Sayachabad Grasslands

MAP PREPARED BY THE INDIAN INSTITUTE OF PUBLIC ADMINISTRATION

Survey of Grasslands in some Parts of Central and Southern Assam

Anwaruddin Choudhury

North-eastern India is considered a bio-diversity **hot-spot** as well as an important area for **endemic birds**. Some of the last remaining wet savannah grasslands in India are found here. Despite their importance and significance from the biodiversity point of view, the grasslands of this region are rather poorly studied. The present project had central and southern Assam as the study area (24°08`-26°35`N, 92°09`-93°28`E). The districts or parts thereof covered included Nagaon, Sonitpur (part), Karbi Anglong (Part-only Hamren Sub-division), NC Hills (North Cachar Hills), and the Barak Valley districts of Cachar, Hailakandi and Karimganj.

The main objectives of the study were to survey the grasslands for biodiversity value and, socio-economic value, and to select representative sites of different grassland types for long-term conservation (through prioritisation on the basis of biological and socio-economic values). Physiographically, the bulk of Nagaon and Barak Valley are plains. The NC Hills, Hamren, and parts of Barak Valley and Nagaon are hilly. The Brahmaputra River flows along the northern periphery of the study area. The area enjoys a tropical monsoon climate with a hot and wet summer and a cool and usually dry winter. The annual average rainfall ranges from less than 1000 to more than 5000mm.

The Methodology included collection of data from both secondary and primary sources. The **Secondary sources** consulted included books, research papers, popular articles, newspaper reports and articles, census data and unpublished materials; Data were also collected through discussion with the local NGOs, forest staff, staff of other government departments, and with other knowledgeable persons, including some local villagers. **Primary** data on biodiversity were collected through field surveys in the main grasslands (mostly by foot-transect and vehicle-transect method), and through the administeral of questionnaires in some select fringe villages, for the collection of socio-economic data. The help of local NGO's was taken while conducting the socio-economic surveys. Preparation of herbarium sheets of grass specimen (identified at the Botanical Survey of India, Shillong) and contacts with the officials of Government departments, local NGOs and other knowledgeable person, including fishermen and graziers, were made for both field surveys and secondary data collection. Socio-economic surveys were conducted by visiting the select villages and interacting with the villagers. Questionnaire were completed in the field itself and preserved specimens of skins, skulls, antlers, horns, and feathers were also examined, wherever available.

The main grasslands (area: 10 km^2 or more) were found in **Bagori** and **Burhapahar-Deochur** areas of Kaziranga National Park (NP), in **Laokhowa** Sanctuary (WS), **Burhachapori** Sanctuary and **Kochmora** Reserved Forest (RF). In the Barak Valley districts, most of the grasslands were cleared long back for cultivation. In the hilly areas of NC Hills district and in Hamren sub-division of Karbi Anglong district, most of the grasslands are abandoned *jhums* which do not remain grassland for long, due to succession by scrub and shrubs or due to repeated *jhumming*. The main grass species identified in the major grasslands of the study area included **Arundo donax** *Nal*, **Erianthus ravennae** *Ikora, Ikor*, **Imperata cylindrica** *Ulu kher*, **Phragmites karka** *Khagori, Khag*, **Saccharum arundinaceum** *Meghela, Bhutang*, **S. procerum** *Meghela, Bhutang*, **S. spontaneum** *Kohua, kash*, **Themeda arundinacea** *Kher, Bota Kher, Son*, **Thysanolaena maxima** *Ful-jaru, Rema* and **Vetiveria zizanioides** *Birina, Binna*. The major grassland type of the region is tropical wet savannah comprising tall elephant grasses which often reach a height of up to **5 m**.

During this study, the presence of 33 species of mammals could be confirmed while the total number of mammal species likely would be above 50 as many smaller rodents were overlooked. The **Indian rhinoceros** *Rhinoceros unicornis*, **Asian elephant** *Elephas maximus*, **Wild water buffalo** *Bubalus arnee*, **Swamp deer** *Cervus duvauceli* and **Tiger** *Panthera tigris* are some of the globally threatened species found in the grasslands. The Wild buffalo has become extinct in the Barak Valley districts. Though its presence there had not been reported earlier, during this survey three preserved specimens were

examined and photographed. The Swamp deer is also almost certainly extinct in Barak Valley. The only viable population of this rare deer in the entire eastern India is now found in the grasslands of Kaziranga NP. A plastercast of tiger pugmark obtained from a small patch of grassland was examined by the P.I. in Hailakandi district which measured 19cm in width and seemed to be an unusually huge specimen (the soil type might have lead to exaggeration but nevertheless it was a big animal). The record was significant as the last 'Tiger census' did not show presence of any tigers in the entire area.

The **Spotted-billed Pelican** *Pelecanus philippensis*, **Great white-bellied Heron** *Ardea insignis*, **Greater Adjutant Stork** *Leptoptilos dubius*, **Greater Spotted Eagle** *Aquila clanga*, **Pallid harrier** *Circus macrourus*, **Swamp partridge** or Swamp francolin Francolinus gularis, **Bengal Florican** *Houbaropsis bengalensis*, **Black-breasted Parrotbill** *Paradoxornis flavirostris* and **Jerdon's Bushchat** *Saxicola jerdoni* to list a few are some of the globally threatened/near-threatened species recorded in the grasslands or waterbodies inside the grasslands of the area. The total number of bird species found in the grasslands of the study area is above 150 which includes many which are basically not grassland birds but use the grasslands off and on.

Among the reptiles, there were the threatened species such as the **Tricarinate turtle** *Melanochelys tricarinata*, **Elongated tortoise** *Indotestudo elongata*, **Keeled box turtle** *Pyxidea mouhotii* and **Rock python** *Python molurus*. A total number of 19 species of reptiles could be identified including some endangered species. A large number of snakes and smaller lizards were seen but could not be identified (as no specimens were collected)

For the **socio-economic survey**, sampling of 16 villages were carried out near the protected areas (sample size was 22.3% or a fifth of the total families of the villages). The economy of the sampled villages was dominated by agriculture (primary) in the fringe of Kaziranga NP and Laokhowa WS, while it was dairy farming in Burhachapori WS. Except for two villages near Laokhowa WS and one near Kaziranga NP, the production of paddy was not enough to sustain them for the whole year. This was mainly because of the poor yields, primitive methods, of cultivation usually raising only one crop a year (only the Immigrant Moslems raise more than one crop at places), and depredation by wild animals. The overall income was less than the expenditure in all but one village. Most of the families surveyed were found to be poor, some even below poverty line, the average annual income per family being only Rs. 20,000/- (Rs. 1670/- per month).

The attitude of the villagers towards the conservation of grasslands was interestingly varied. The villagers (all Nepalis), near Burhachapori, responded favourably. In Laokhowa, a bulk of the Immigrant Moslems, who are known for their agricultural skills and are very hardy, were by and large against conservation measures. Of the six sampled villages near Kaziranga NP, two were against protecting the area, while one responding positively.

The **prioritization** of sites has become essential as resources (financial, institutional and human) available for conservation are limited and needs to be used wisely. In the study area, only five sites were found to be large enough for some conservation attention. Since prioritization is a relative term, priority ratings have been made here on all-Assam basis which also shows how high the five sites of the present study (two forming part of Kaziranga NP) rate in the tables. Grasslands having less than 10 sq. km area have not been considered as these are sparsely distributed, many of these are temporary in nature and are of little ecological value for long-term conservation. Two types of ratings have been used. One to show the richness of biodiversity including present status of conservation as a protected area, while the other to identify the most threatened sites for immediate conservation attention (Tables 2 and 3).

According to the first system, to identify the richest biodiversity sites, Kaziranga has the highest score of 49 followed by Manas and Dibru-Saikhowa with scores of 43 and 39 respectively. Other sites of the study area which are in the list have scored 32 (Burhachapori), 30 (Laokhowa) and 20 (Kochmora). Of the 20 sites of Assam, the major sites of the study area ranked 1st, 4th, 7th and 16th respectively showing the importance of this study area for grassland conservation. In the second system, which focuses on the most threatened sites, Manas has the highest score of 72 followed by Laokhowa, Kobo *Chapori*, Dibru-Saikhowa and Kaziranga with scores of 62,61,60 and 59 respectively and all are in need of priority conservation attention. Other sites of the study area which are in the list have scored 53 (Kochmora) and 46 (Burhachapori). Of the 20 sites of Assam, the major sites of study area ranked 2nd, 5th, 10th and 15th respectively showing the importance of the study area for grassland conservation. However, considering the extent of grassland area left in this study area (less than 2.0% of the total geographical area), all the areas should be given conservation attention.

The rating system used for identifying fringe villages which heavily depend upon the protected areas shows that Paschim Singimari near Laokhowa WS has the highest score of 26 followed by Leteripar Lalung, also near Laokhowa and Sishuati near Burhachapori WS with scores of 22 and 16 respectively (Table 1). All these areas are in need of urgent attention for ecodevelopment, motivation and awareness. The dependency on the protected areas includes collection of grass, grazing by domestic stock, encroachment including cultivation and habitation by the Forest Villagers, collection of grass and wood for fuel,

fishing and commercial logging. Except in the protected areas, the grassland habitat is vanishing. Hundreds of hectares of elephant-grass jungles are cleared every year for cultivation of crops such as rice and mustard.

Poverty, illiteracy (only 28%, range: 0-61%, in the fringe villages), high birth rate, unemployment (58-68% non-workers in the fringe villages), lack of awareness about conservation, lack of motivation and relatively less development are the main reasons for high level of dependence and illegal activities in the protected areas.

The presence of a large number of domestic livestock, with the possibility of transmission of disease like rinderpest to the wild bovines, and plantation of trees are also problems for the grasslands. Moreover, in the protected areas, especially in Kaziranga, the grassland is burnt annually, from December to March, as part of the management practices. Late burning (February and March) has been found to be harmful for breeding of some of the endangered species such as the Swamp Partridge and the Bengal Florican. About 89% of the grasslands listed in tables are under different protected areas. However, only about 59% are adequately protected, all in Kaziranga NP (Bagori and Burhapahar-Deochur areas).

This study revealed that no natural grassland of significance, i.e., worth conservation effort, exists in Hamren subdivision of Karbi Anglong district, NC Hills district and in the Barak Valley districts. This is also the first ever survey to ascertain the status of the grasslands in these areas. This study, however, revealed that rich elephant grass jungle once existed in the floodplains of the Barak Valley.

The **recommendations** included protected area status to Kochmora RF, effective management in Laokhowa and Burhachapori, massive eco-development programme in the fringe villages, prevention of further encroachment (recent encroachments be evicted), control of grazing, regular inoculation with the help of NGOs of domestic stock to prevent possible spread of disease among wild ungulates, burning of grassland within January and in patches (also by rotation of two or three years' cycle) and a complete halt to plantation of trees in the grasslands.

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Table 1. Human use and Dependency on the Grasslands of the Protected Areas of the Villages covered by Socio-economic Survey

Name of the Village		*TC*	*GR*	*En*	*Fuel*	*F & L*	*Att.*	*Total Rating*
Near Burhachapori WS								
Sishuati		3	4	2	3	2	2	16
Dhania		3	4	2	3	1	2	15
Jhawani		3	4	2	3	1	2	15
	@	3	4	2	3	1.3	2	15.3
Near Laokhowa WS								
Paschim Singimari		4	3	6	4	3	6	26
Leteripar Lalung		4	1	4	4	3	6	22
Bongaon FV		3	2	4	3	1	2	15
Kaliadinga Lalung		4	1	2	3	1	2	13
Pub Amrakanda		2	1	0	4	2	4	13
Andherapara		1	1	0	1	1	4	8
Nij Laokhowa		1	1	0	1	0	2	5
	@	2.7	1.4	2.3	2.9	1.6	3.7	14.6
Near Kaziranga NP								
Harmoti - II		1	1	0	1	1	6	10
Bandordubi		1	1	0	1	1	6	8
Kabin Rangphargaon		0	0	0	0	0	4	8
Madu Beygaon		0	1	0	1	0	4	6
Harmoti - I		0	0	0	0	1	4	5
Najan Nabasti		0	0	0	0	1	2	3
	@	0.3	0.5	0	0.5	0.7	4.3	6.7
Average Total Dependence		2.0	1.96	1.4	2.1	1.2		

TC = Thatch/Grass collection for local building material and commercial use: 0 - negligible, 1 - very low, 2 - low, 3 - medium, 4 - high;
GR = grazing: 0 - negligible, 1 - low, 2 - medium, 3 - high 4 - very high;
En = Encroachment (including legal use of land for cultivation & habitation): 0- negligible, 2:< 1sq km, 4: 1-5; 6:> 5;
Fuel = Grass & wood collection for fuel: 0-negligible, 1-very low, 2-low, 3- medium, 4- high, 5- very high;
F & L = Fishing & Logging: 0 - negligible, 1 - low, 2 - medium, 3 - high;
Att. = General attitude of the Villagers towards grassland of the protected area: 2 - favourable, 4 - indifferent, 6 - against.

Table 2: Priority Rating for the Grasslands of Assam on the basis of various Biodiversity & Socio-economic Values

Name	*Size*	*Rare wildlife found*	*Sizeable population of rare species*	*Disturb-ances*	*Contiguity with other grasslands*	*Conservation status*	*Total rating*
1. Kaziranga	5	16	12	4	3	5+4	49
2. Manas	5	16	11	2	1	5+3	43
3. Dibru-Saikhowa	3	14	9	2	4	4+3	39
4. Burhachapori	2	12	6	2	3	4+3	32
5. Kobo chapori	3	12	8	1	4	2+1	31
6. Orang	2	11	4	4	1	4+4	30
7. Laokhowa	2	12	5	1	3	4+3	30
8. Nameri	1	8	6	4	1	5+4	29
9. Amarpur, Sibia chapori	3	13	4	1	5	1+1	28
10. Jamijing	2	12	7	1	1	3+1	27
11. Bornadi	2	8	5	3	1	4+3	26
12. Pabitora	2	8	3	3	1	4+4	25
13. Sadiya (Bhimchapori, Kundil Kaliya RF and Ambikapur)	2	9	5	1	3	3+1	25
14. Pani-Dihing	1	10	3	1	1	4+2	22
15. Borchapori	2	9	5	1	1	1+1	20
16. Kochmora	1	11	0	1	3	3+1	20
17. Sengajan	1	9	2	1	2	3+1	19
18. Bordalani	2	9	3	1	1	1+1	18
19. Pabho	2	10	0	1	1	3+1	18
20. Hugrajuli	1	5	0	2	1	3+1	13

Size: 1 = < 15sq km; 2= 15-50 sq km; 3= 51-100 sq km; 4= 101-200 sq km; 5=> 200 sq km.

Rare wildlife: total number of species among the 20 selected.

Sizeable population of rare species of wildlife: total number of species among the 20 selected.

Degree of disturbances: 1 = heavily disturbed; 2 = disturbance moderate; 3 = disturbance to a lesser extent; 4 = disturbance negligible.

Contiguity with other grassland (size): 1 =< 15 sq km; 2 = 15-50 sq km; 3 =51-100 sq km; 4 = 101-200 sq km; 5=> 200 sq km.

Conservation status: (a) 1= other areas; 2= Proposed Reserved Forest; 3= Reserved Forest; 4= Wildlife Sanctuary; 5= National Park.

(b) 1= no protection; 2= very inadequately protected; 3= inadequately protected; 4= adequately protected.

Table 3: Priority rating for the Grasslands of Assam on the basis of Degree of Threat

Name	*Size*	*Rare wildlife found*	*Sizeable population of rare spp.*	*Protection status*	*Level of threats*							*Total value*
					P	*En*	*Gr*	*Gc*	*F*	*In*	*Att*	
1. Manas	18	16	11	1+2	5	3	3	2	3	4	4	72
2. Laokhowa	10	12	5	2+2	5	5	4	4	5	2	6	62
3. Kobo Chapori	10	12	8	4+4	4	4	3	4	2	0	6	61
4. Dibru-Saikhowa	10	14	9	2+2	2	3	4	4	4	2	4	60
5. Kaziranga	18	16	12	1+1	4	1	1	2	1	0	4	60
6. Jamjing	6	12	7	3+4	4	3	4	4	5	0	6	58
7. Amarpur, Sibia chapori	10	13	4	5+4	3	4	4	4	3	0	4	58
8. Borchapori	6	9	5	5+5	3	5	4	4	3	2	4	55
9. Bordalani	6	3	9	5+4	3	5	4	3	4	2	6	54
10. Kochmora	6	11	0	3+4	4	5	5	5	4	0	6	53
11. Orang	10	11	4	2+1	4	2	3	3	2	2	6	50
12. Sadiya	6	9	5	3+4	3	3	2	2	5	2	4	48
13. Sengajan	2	9	2	3+4	4	3	4	4	5	0	6	46
14. Pabho	6	10	0	3+4	3	4	4	4	4	0	4	46
15. Burhachapori	6	12	6	2+2	2	3	4	3	4	0	2	46
16. Bomadi	6	8	5	2+2	3	2	2	2	3	4	4	43
17. Pabitora	6	8	3	2+1	4	2	4	3	3	0	6	42
18. Pani-Dihing	2	10	3	2+3	3	3	4	4	4	0	4	42
19. Hugrajuli	2	5	0	3+4	2	5	3	3	2	3	6	38
20. Nameri	2	8	6	1+1	1	1	2	1	2	2	4	31

Size: 2=< 15 sq km; 6= 15-39 sq km; 10= 40-100 sq km; 14= 101-200 sq km; 18=> 200sq km.

Rare wildlife: total number of species among the 20 selected.

Sizeable population of rare species of wildlife: total number of species among the 20 selected.

Protection status: (a) 1= National Park; 2 = inadequately protected; 3= very inadequately protected; 4= Proposed Reserved Forest; 5= other areas.

(b) 1= adequately protected; 2= inadequately protected; 3= very inadequately protected; 4= no protection.

Level of threats: (a) Poaching- 1= insignificant; 2= low; 3=moderate; 4= high; 5= very high.

(b) Encroachment (including legal use of land for cultivation & habitation, eg., Forest Villages)- 1= insignificant; 2= low; 3= medium; 4= high; 5= very high.

(c) Grazing- 1= insignificant; 2= low; 3= medium; 4= high; 5= very high.

(d) Grass collection- 1= insignificant; 2= low; 3= medium; 4= high; 5= very high.

(e) Fishing, logging, fuelwood collection- 1= insignificant; 2= low; 3= medium, 4= high; 5= very high.

(f) Insurgent-related threats- 2=low; 3= medium; 4= high.

(g) General attitude of the villagers- 2= favourable; 4= indifferent; 6= against

Biodiversity Conservation Prioritisation in the Thar Desert

S. M. Mohnot

Introduction

Deserts are one of the six natural life supporting regions of the earth. Human beings have been living in these deserts since time immemorial. Basically the desert is an environment where moisture is either absent or inadequate for biological life. The presence or absence of moisture is dependant on precipitation and evaporation in the region. When evaporation exceeds precipitation, it results in aridity. Deserts occupy roughly a seventh of the land surface of the globe. A perusal of the world map shows that deserts are not scattered randomly over the globe but, to a large extent, confined to two belts - one around the Tropic of Cancer and the other around the Tropic of Capricorn. These belts are not contiguous, in between there are wet regions.

The uniqueness of desert landmasses is not only universal but, within these major deserts, lie some unique ecosystems, characterised by the presence of flora and fauna exclusive to each habitat. The taxa of the great Indian desert are no exception to this. Life in the Thar desert is extraordinary and in spite of massive biotic and abiotic interventions, the world's largest concentration of large mammals and winter migratory birds exists in the desert. The Indian desert is not an isolated patch of arid zone but forms a part of an extensive desert belt comprising of the great Sahara and the arid regions of Arabia, Iran and Pakistan Scientific evidence indicates that the continuity of the Saharo - Tharian region proves that the Indian desert is not a human-made desert but is more than 100,000 years old.

This paper present the results of intensive surveys carried out jointly by a number of NGO's, institutes and individuals to uncover the biodiversity profile of the Thar desert and to prioritise its biodiversity rich sites

The Great Indian Desert and its Biodiversity

The Indian desert covers an area of about 0 32 million sq.km. which is nearly 12% of the total geographical area of India. It spreads over the four states of Rajasthan (62%), Gujarat (20%), Haryana and Punjab (9%), and in the west merges with the fertile plains of the Indus, in Pakistan. It is essentially a sand desert, most of whose area consists of dry undulating plains of hardened sand. The remaining region is largely a mass of loose sand, forming shifting sand dunes. The desert environment is inhospitable for plants, wild animals and human populations. Yet, the Thar desert is the most populated desert in the world. Population density here is 84 persons per sq. km. The density of certain animals and plants like *Antilope cervicapra* (blackbuck), *Gazella gazella* (Indian gazelle), *Boselaphus tragocamelus* (nilgai), *Sus scrofa* (wild boar); *Prosopis cineraria* (khejari), *Capparis decidua* (ker), *Acacia senegal* (kumbhat), and *Euphorbia granulata* (thor), besides a variety of grasses.

The Thar Ecosystem

The Thar desert is characterised among other things by extremes of temperature, the maximum reaching 50 degree Celsius in May - June and the minimum, in December – January, going down to -2°C It is also characterised by low rainfall, the annual precipitation being below 30 cms. Vegetation is sparse, arid and drought resistant Conservative estimates suggest that about 2000 animal species are found in the desert. These include a large number of mammals, birds and reptiles, sand lizards, turtles and a variety of snakes.

The Thar desert contains fascinating animal life in its open scrub forest, in association with sand dunes. The Indian sandgrouse, *Pterocles exustus*, the grey partridge, *Francolinus pondicerianus*, the great Indian bustard, *Choriotes nigriceps* and many other birds are endemic to this desert. The Thar desert receives as many as 30 winter visitors, most spectacular amongst them being the *kurjan* or demoiselle crane, *Anthropoides virgo*, millions of which visit several parts of the Thar each year. The Indian desert is one of the most remarkable habitats in the world for mammals. A variety of mammals are found in sandy, rocky,

riparian and aquatic habitats. There are 18 species of rodents covering 11 genera and 3 families, found in the desert biome. These rodent species are food for several mammals, birds and reptiles. The desert cat, *Felis sylvestris*, desert fox, *Vulpes vulpes pusilla*, the wolf, *Canis lupus pallipes*, the caracal, *Felis caracal*, the wild boar, *Sus scrofa cristatus*, the Indian desert gazelle, *Gazella gazella bennetti*, the blackbuck, *Antilope cervicapra*, and the nilgai, *Boselaphus tragocamelus* are some of the prominent mammalian species found in this desert.

Objectives and Methodology

Objectives

- To biologically classify the Indian desert into sub-classes or sites.
- To list the flora and fauna and understand the biodiversity value of these sites.
- To record the present status of sites, the threats operating on them, their conservation value and the role played by them in the socioeconomy of the area.
- To short list, from among these sites, those with the greatest biodiversity and socio-economic value (priority sites).

Methodology

In the absence of a precise methodology to prioritise desert sites for biodiversity conservation, a mixed approach was employed using a questionnaire supported by visual observations. The study covered socio-economic factors, peoples' science, the physical and physiographical situation, landforms and climate. Some 40 workers, scientists (07) and non-scientists (33) worked for over 9 months, from March through November – December, 1997, on this project. Investigators with a biological sciences background were put to study the biodiversity, using standard sampling techniques, while non-biologists were involved in recording an overview of the desert biodiversity in different areas of the Jodhpur, Jaisalmer and Barmer districts of the Thar desert.

The Biodiversity Questionnaire: An exhaustive questionnaire was prepared. This questionnaire covered points like the importance of biodiversity in the day to day life of the desert people, species richness of an area, its diversity and the utility of biodiversity as food, firewood, fodder, for agriculture, cottage industry, and the like. Use of plants and animals in traditional medicine systems was also recorded, including the use of endangered animals and plants. Attempts were made to understand the reasons for the availability of species in some areas and absence in others, and the steps necessary to save them. The knowledge and wisdom of the local communities was especially useful in determining this. Also studied was the biodiversity status of village commons, like *orans*, *gauchers*, wastelands and other areas managed by village institutions. We also looked at areas under the control of the government, like closed areas, forest enclosures, and wildlife sanctuaries, and parks. Sacred places like water bodies and water catchments were also identified. To study the human-biodiversity interface, we examined the biodiversity (animal - plant), collected peoples sayings and codified pieces of ancestral wisdom, and tried to understand the biodiversity based forecast systems and their validity.

The Coverage: The biodiversity prioritisation work was restricted to three districts of Thar viz., Jaisalmer, Jodhpur and Barmer, in western Rajasthan. The areas covered in this study were of varying types: (i) Unprotected (ii) Protected under certain legal or administrative provisions, like closed areas (iii) *Orans* (village forests) without any legal or administrative protection, but, enjoying the protection of the village community, and (iv) wildlife sanctuaries or national parks.

Villages Rasla and Kanasar and 13 other unprotected sites were studied using standard sampling methods, covering all major issues listed in the questionnaire. (Table 1)

The other habitats, like protected or closed areas, *Orans*, and sanctuaries were also studied. These investigations were based exclusively on the questionnaire.

Plant and Animal Sampling: Sampling sites were selected for plants and animals. Sampling was done from July through early October, in the high growth period following rains. A line transact method was employed to measure coverage by species. Intercepts and 10 quadrates were laid alternately on either side of the transact line to measure the frequency. The basal intercepts of each species was recorded along the transact to derive cover percentages and the number of individuals appearing in each quadrate was recorded to derive frequency.

Plant Community Study: Some 18 distinct plant communities are found in this area. Four of these communities are dominated by tree species. These were used as indicator species of plants as well as animal species in the surrounding areas. In interviews with people, especially with the women of pastoral communities, many trees were described as supporting particular kinds and quantities of understory.

To examine these interrelationships in the field, sample trees were tested for the character and quantity of their understory coverage and other associations, particularly with animals.

Tree Test Method: A sample of 44 trees were selected in a single quadrant in the village of Rasla. The total area of the study was approximately one km^2. The sample trees were selected from an alternating count in four compass directions from a central point. 20 *Zizyphus nummularia* (bordi trees), 14 *Capparis decidua* (ker trees) and 10 *Prosopis cineraria* (khumbat trees) were selected. At each tree, a compass point direction was chosen at random and five, 2500 cm^2 quadrates were laid extending to 2.5 meters from the base of the tree. The procedure was repeated on the opposite side of the tree, giving a total of 2.5 m^2 of sample coverage.

The quadrates were subdivided into twenty five, 25 cm^2 sections. In each section, the dominant species were recorded. The percentage of total coverage, bare ground, and total species were derived from this grid, including the total of perennial and annual species coverage for distances from 0 to 2.5 m.

The Village Subhabitats (Areas managed by village institutions)

Till recently, no attempt had been made to study the biodiversity of the areas protected and managed by village institutions. Each village institution area is an ecosystem in itself and is an excellent repository of biodiversity. To study the biodiversity of these village areas, two unprotected villages viz., Kanasar and Rasla were selected, primarily because of the little biotic intervention seen in these villages and also because they represented the major landforms of a Thar desert ecosystem in its natural setting. These villages, by and large, contained examples of all the important village institutions. These village institutions are:

1. **Gaucher:** Defined as gram panchayat controlled grazing lands.
2. **Oran:** Defined as areas where tree-cutting is banned by community consent and divine control, and where such restrain is actively observed.
3. **Fallow Lands:** Defined as Khatedari (private agricultural) lands with usually 'kharip' crops. Atleast 2-3 years in fallow, managed as closed fodder fields during the growing season and thereafter as community-grazing grounds.
4. **Plough Fields:** These are of two types (i) Traditional - Those in which ploughing is done by animals to avoid destruction of useful species in the fields during tilling. (ii) Disc - In which mechanised methods are used wherein a massacre of species takes place.
5. **Sanddunes:** Defined as natural sand masses, either stationery, or stabilised, or shifting. Usually with good moisture.
6. **Forest Enclosures:** Defined as land under the present control of the Forest Department, for plantation.
7. **Gravel Lands:** Defined as low productive areas with little soil cover and moisture.
8. **Wastelands:** Defined as areas with a mixture of characteristics and with low productivity.

Animals in the Village Institutions

The village institutions vary considerably in their topography, physiography and biota. Keeping this in view, it was attempted to record animal taxa available in different village institutions. For this, each of the institutional areas that was larger than 4 hectares was selected. A central point was identified randomly. Using the transect method, a 100 sq.m. area was covered, within which 10 quadrates of 10 sq.m. each were examined for the availability of animals. Taxa were recorded as sighted in these plots. The taxa were randomly selected.

Attempts were made to list all the plants and animals encountered in the eight institutional areas in the study villages. These were essentially unprotected areas. The population status of several species was worked out, based on direct observations, while several species of birds and reptiles were not actually observed but their presence was verified by the local people, especially by the *Kalbelias*, *Jogis* and *Bheels* and other knowledgeable old persons in the surveyed villages.

Prioritisation Considerations

This study clearly demonstrated the presence of a large number of animal species in the area, particularly mammals, birds, reptiles and a variety of arthropods. Though it was not possible to record the total taxa which survives in the desert, a large number of species were observed, recorded and got verified from the local people, who also told us their local names.

While corroborating these findings with earlier records, it seemed that biodiversity is gradually declining in these areas but has not been wiped out altogether. The earlier general faunistic surveys, specific group investigations and individual species studies, present a broad coverage of a wide zoogeographical area - the Thar desert. The contents and coverage of several other earlier investigations were not compatible with this study since we carried out these investigations in a totally different format using the village as a unit. Within the village, we considered all major habitats as ecosystems or village institutions, hitherto not investigated in any of the earlier studies. The earlier investigations were primarily meant to determine the faunistics, taxonomic and geographical

distribution of species, without considering the social fabric and institutional set-up of villages We, however, considered these latter aspects as very important for the conservation of biodiversity.

Existing Knowledge on Desert Fauna

Contrary to general belief, the Indian desert fairly abounds in plant and animal life, though most of the animals, except birds and a few diurnal mammals (such as antelopes, gazelles, etc.), are not easily visible to the casual observer. We have to look into burrows, under stones, on plant leaves and within roots, in ponds, puddles and the larger reservoirs and lakes, in order to see them

Almost all the major phyla of both the vertebrates and the invertebrates are found here, ranging from the tiny, microscopic protozoa to the blue bull. Though the fishes, amphibia, reptiles, birds and mammals are known taxonomically, the same cannot be said of the invertebrates. Consequently, some 50 per cent or more of the existing fauna still remains to be discovered and put on record

Biodiversity Rich Sites

The great Indian desert has harbored high populations and densities of certain animals like black buck, gazelle, nilgai, wild boar, sandgrouse and a number of other animals In fact it is worth investigating how such large populations were sustained on this famished land ! The abundant population of animals in the desert may also have been due to the love of the desert dwellers for them. It has been a part of their religion to protect them a feature which is unique to Thar

Before the turn of this century, larger mammals like lion (*Panthera leo*), Cheetah (*Acinonyx jubatus*) and the lynx (*Caracal caracal*) were fairly common in the southern part of the desert Even up to the 1930s, very large herds of black bucks (*Antilope cervicapra*) and wild boar (*Sus scrofa*) were found in western Rajasthan Tiger (*Panthera tigris*) and leopard (*Panthera pardus*) occurred in fair numbers in the rocky habitat. However, at present their populations have dwindled to the point of extinction The lion and cheetah are already lost from the desert The black bucks are now found only around certain villages, whose people protect them religiously

Unprotected Biodiversity Rich Sites

In this study we identified 15 unprotected village sites in Barmer, Jaisalmer and Jodhpur districts with fairly large areas ranging from 2000 bighas to over 38500 bighas (Table 1) Each of these sites support two to five large animal species of mammals and several species of plants. These sites represent excellent animal - plant communities which together support a large number of micro-organisms, large vertebrates, small grasses and perennial trees, which constitute the Thar ecosystem.

In this study one of the most important find is the 'Magra' system. In almost all the unprotected village sites we fond 'Magra' (low-lying hillocks or plateau) system as an predominant topographical feature, and it is around 'Magras' that animals and plant species have survived as it provides protection, shelter, and moisture in the areas around it. These areas serve as watersheds 'Magras' are less frequented by humans because of their location and there is consequently less human interference from agricultural activities, habitation or commercial activities. 'Magras' are therefore least exploited in the desert

Our study suggests that 'Magra Ecosystems', which are rich biodiversity sites, should be conserved and protected *in situ*, in order to sustain the needs of the villages located close to the 'Magras'

Protected Biodiversity Rich Sites

In deserts, by and large, people protect animals and plants as a part of the desert ethos There are also sites that are protected by the State Among the various sites protected by the people and the State, we found two of the protected sites of especial important - The Akal Fossil Park in Jaisalmer district and 'Kheechan' village in Jodhpur. The Akal Fossil Park is managed by the State Forest Department and other government agencies In contrast, Kheechan is totally dependent on village communities It is a small village where each year thousands of demoiselle cranes, *Anthropoids virgo*, stay from September through March. It is the village community of Kheechan village which takes care of their food and some 4000 - 8000 cranes are fed every day in a fenced area on the outskirts of Kheechan village.

Biodiversity Rich Closed Areas in the Thar Desert

In the three desert districts we found six sites which were good repositories of desert fauna and flora These sites have been assigned the status of 'Closed Areas' by the State Forest Department Trapping, capturing, molestation or killing of animals is legally prohibited here We found in these areas that village communities play a more important role than the forest department, as far as protection is concerned.

Each closed area is provided with a 'Magra' or sand dunes or sandy plain, as part of its habitat, which support a variety of animals and plants Table 2 summaries six biodiversity rich sites along with their predominant taxa

Biodiversity Rich 'Orans'

Like unprotected and closed areas in Thar, we found 'orans' to be biodiversity rich habitats. In Thar, each village has a small or large 'oran' with a variety of taxa. Of the many 'orans' surveyed by us, we found four orans, ranging between 3000 to 41000 bighas each and with a *magra* system and a variety of animals and plants, to be the most important ones. Each of these four 'orans' harbours over 300 species of animals and over 200 species of plants (Table 3).

We have been successful in tabulating some of the important plant species in different village institutions particularly forest enclosures, fallow land, 'gauchers' and 'orans', all supportig a variety of flora and fauna (Table 4). Interestingly most of these plant and animal species are common to other prioritised sites comprising unprotected, protected and closed areas.

Prioritisation Cautions

In this study we scanned a very large part of the desert, especially in the three districts of Thar - Jodhpur, Jaisalmer and Barmer. In most parts we found some kind of erosion and fragmentation in habitats due to a variety of biotic and abiotic pressures. Nevertheless, where the people follow the desert ethos and revere traditional wisdom, the habitats by and large are intact. As a matter of fact, in some such areas, one gets the impression that there is no necessity of prioritisation as the people's prioritisation is in operation, in the form of social controls. Biodiversity is thus protected. But, how long this situation will last is a million dollar question!

Transformation of Habitats: We found some areas totally transformed in their characteristics, like the Nachana - Mohangarh Belt of the Indira Gandhi Canal and several such areas, which have been turned into wetlands. Such habitats need further investigation before prioritisation is initiated because in such areas the total profile of the habitat has been changed and new plant and animal species have emerged.

Phytoecology and Prioritisation: We are of the opinion that unless and until the phytoecology of a habitat is properly screened, it cannot be determined whether an animal species considered for prioritisation will survive or not. Consequently, in almost all cases presented in this study we have considered all the intricate animal-plant interrelationships

Social Norms and Prioritisation: It is very important to understand the social fabric of the area before initiating any prioritisation programme. This is especially so in a fragile ecosystem like the desert, where every plant is used judiciously and animals are revered and cared for.

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Table 1: Unprotected Biodiversity Rich Village Sites in Thar Desert

Villages Considered for Prioritisation	*Tehsil / District*	*Area in bighas*	*Habitat Type*	*Predominent Taxa*	
				Animals	*Plants*
1. Kiradu	Barmer / Barmer	3653	Magara	Hystrix i. indica *Canis a. aurenus,* *Hyaena h. hyaena*	'Gughal' *Commiphora wightii,* 'Kumbhat' *Acacia senegal*
2. Dharvi	Sheo / Barmer	2900	Magara	Choriotis nigriceps, Canis a. aureus Vulpes vulpes pusilla	*Commiphora wightii,* *Acacia senegal*
3. Bhinyad	Sheo / Barmer	2412	Magara	Vulpes v. pusilla, *Felis silvestris ornato*	'Bhangari' *Blepharis sindica,* *Dactyloctenium sindicus*
4. Radana	Sheo / Barmer	5385	Magara	*Lepus Lepus pallipes,* *Canis a. aureus*	'Dhaman' *Cenchrus Ciliaris,* *Aereva persica*
5. Bisala 6. Rajmathai	Barmer / Barmer Pokaran / Jaisalmer	20268 17917	Magara Magara	Canis a. aureus, Vulpes n. pusilla *Lepus nigricollis,* *Vulpes v. pusilla*	*Tribulus terrestris,* *Zaleao edinita* 'Golan' *Coccinia grandis,* 'Kuri' grass *Urochola tericoides*
7. Bariyada	Fatehgarh / Jaisalmer	6452	Magara	*Vulpes v. pusilla,* *Felis silvestris*	'Deshi babul' *Acacia nilotica,* *Zizyphus nummularia*
8. Asadi	Sheo / Barmer	6668	Magara	Uromastrix hardwickii, Herpestes edwardsi, Felis oranta, *Vulpes v. pusilla*	'Sunaroo' *Zaleao redimita,* *Triantheus portulacastrum*
9. Netra	Bhopalgarh / Jodhpur	38565	Magara	*Herpestes edwardsi,* *Varanus varanus*	'Doodheli' *Euphorbia granulata*
10. Kanasar	Sheo / Barmer	2000	Magara	*Vulpes v. pusilla*	'Dhaman' *Cenchrus ciliaris*
11. Rasla	Fatehgarh / Jaisalmer	6400	Magara	*Varanus varanus,* *Varanus varanus,*	'Baker' *Indigofera spp.* 'Bhurat' *Cencrus spp.*
12. Nevara	Osian / Jodhpur	25901	Magara	*Vulpes v. pusilla,* *Herpestes edwardsi*	'Peelvan' *Cocculus pendulus,* *Zizyphus nummularia*
13. Malunga	Osian / Jodhpur	--	Magara	*Vulpes v. pusilla,* *Herpestes edwardsi*	'Gangani' *Grwia tenax*
14. Nachna-Mohangarh IGNP Area	Jaisalmer	--	Wetland	New fauna and flora settling	
15. Sardar-samand	Jodhpur	2.8 sq. km	Wetland	*Felis a. aranta*	Exotic sp. *Prosopis juliflora*

Table 2: Biodiversity Rich Closed Areas in the Thar Desert

Closed Areas Considered for Prioritisation	*Tehsil / District*	*Area*	*Habitat Type*	*Predominent Taxa*	
				Animals	*Plants*
1. Guda - Bishnoi	Luni / Jodhpur	424.58 sq.km.	Magara	*Antilope cervicapara rajputani, Gazella g. bennetii, Boselaphus tragocamelus*	'Khejari' *Prosopis cineraria,* 'Ker' *Capparis aphylla*
2. Dhava – Doli	Pachapadra / Barmer	424.76 sq.km.	Magara	*Gazella g. benneti, Vulpes v. pusilla, Felis oranta*	'Khejari' *Prosopis cineraria,* 'Ker' *Capparis aphylla, Salvadora oleoides*
3. Dechu	Phalodi / Jodhpur	2000 ha.	Magara / Mixed Sand dunes	*Uromastix hardwicki, Vulpes v. pusilla Felis s. aronta*	'Kheep' *Laptodenia pyrotechnica Crotolaria burhia*
4. Lohawat	Phalodi / Jodhpur	1240 ha.	Magara	*Canis aureus arun, Vulpes v. pusilla, Gazella g. bennetii*	*Cenchrus spp. Indigofera spp. Zizyphus nummularia*
5. Dhorimanna	Gudamalani / Barmer	6900 ha.	Sanddunes	*Vulpes v. pusilla,*	*Gazella g. bennetti* 'Arna', *Clerodendrum phloridis*
6. Ujjalan	Pokaran / Jaisalmer	3000 ha.	Sandyplane	*Vulpes v. pusilla, Herpestes erdwerdsi*	*Cenchrus spp. Indigofera spp. Justica sumiplex*

Table 3: Biodiversity Rich Orans in the Thar Desert

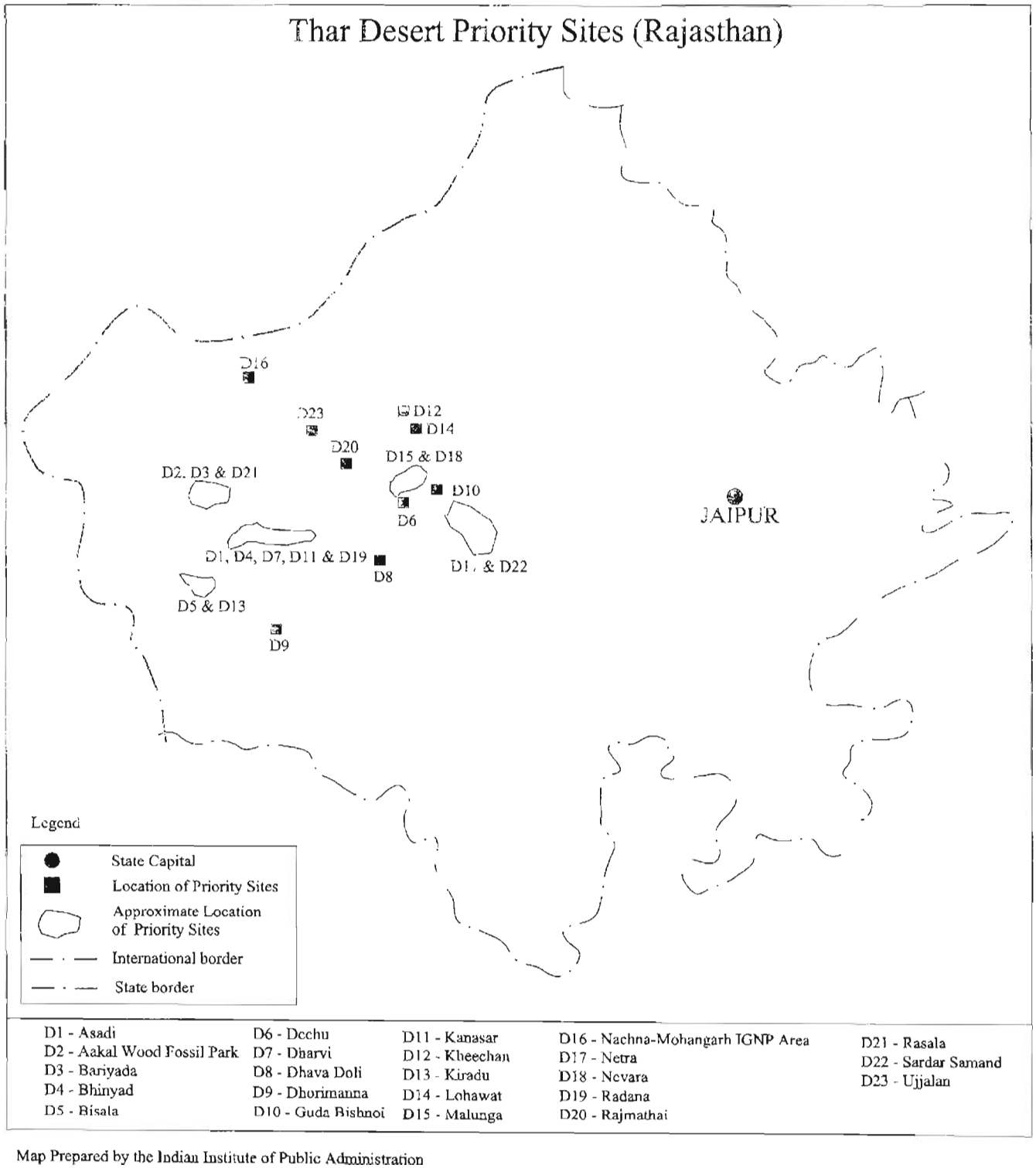
Orans Considered for Prioritisation	*Tehsil / District*	*Area in bighas*	*Habitat Type*	*Predominent Taxa*	
				Animals	*Plants*
1. Kolu-Pabuji	Phalodi / Jodhpur	15800	Sandy plane	*Vulpes v. pusilla, Uromastix hardwicki*	*Zizyphus nummularia, Lycium barbarum Cenchrus spp.*
2. Veeratra	Choutan / Barmer	18000	Magara	*Gazella bennetti, Vulpes v. pusilla, Black bucks*	*Cenchrus spp. Indigofera spp.*
3. Ramdeora	Pokaran / Jaisalmer	3000	Magara	*Vulpes v. pusilla,*	*Cenchrus spp. Solvodora spp. Lasiurus sindicus*
4. Bhadariyaji	Pokaran / Jaisalmer	41000	Magara	*Vulpes v. pusilla Felus S. oramat*	*Cenchrus spp. Seetzenia lanata*

Table 4: Some Important Species in Village Lands by Institutional Types

Species[1]	*Type*	*Enclosures*	*Fallow*	*Gaucher*	*Oran*
Aak (Calotropics procera)	Shrub	C	C		F
Bhekar (Indigofera cordifolia)	Annual Herb	C	F	F	C
Bhurat (Cenchrus biflourus)	Annual Grass	C	F		
Bordi (Zizyphus nummularia)	Tree/Shrub	F	C		F
Bui (Aerva persica)	Shrub	F	C	C	C
Chom Ghas (Corchrus depressus)	Perennial Herb		C	C	C
Dhaman (Cenchrus ciliaris)	Perennial Grass	C	F		
Dhaman (Cenchrus setigerus)	Annual Grass	C	C		
Ghantiya (Dactylotenium sindicum)	Perennial Grass	C	C		F
Guar (Cyamopsis tetragona)	Domesticate		F		
Jal (Salvadora oleoides and persica)	Tree				C
Ker (Capparis decidua)	Tree/Shrub		C		F
Khanti (Tribulus terrestris)	Annual Herb		C	C	
Khejri (Prosopis cineraria)	Tree	F	C		F
Lamp (Aristida spp.)	Annual Grass	C	C	F	C
Sato (Trianthema portulacastrum)	Annual Herb			C	C
Sevan (Lasiuris sindicus)	Perennial Grass	C	F		
Sinniya (Crotolaria burhia)	Shrub	F	C		F
Sinter (Convolvulus microphyllus)	Perennial Herb			C	C
Tumba (Citrullus colocynthis)	Perennial Herb	C	F		C

[1] "C" indicates species commonly found. "F" indicates a species frequently found.

Thar Desert Priority Sites (Rajasthan)



D1 - Asadi
D2 - Aakal Wood Fossil Park
D3 - Bariyada
D4 - Bhinyad
D5 - Bisala
D6 - Dechu
D7 - Dharvi
D8 - Dhava Doli
D9 - Dhorimanna
D10 - Guda Bishnoi
D11 - Kanasar
D12 - Kheechan
D13 - Kiradu
D14 - Lohawat
D15 - Malunga
D16 - Nachna-Mohangarh IGNP Area
D17 - Netra
D18 - Nevara
D19 - Radana
D20 - Rajmathai
D21 - Rasala
D22 - Sardar Samand
D23 - Ujjalan

Map Prepared by the Indian Institute of Public Administration

Prioritization of Conservation Sites in the Timberline Zone of West Himalaya

Uppeandra Dhar

1. Introduction

Biodiversity along altitudinal gradient in the Himalaya is characterized by a gradual replacement of elements observed at all organizational levels. The shift from tropical to alpine ranges, superimposed on a change in latitudinal gradients from the humid east to dry northwest, consequently reflects the various features of biodiversity richness, representativeness, uniqueness, naturalness and endemism in the Himalaya (Dhar 1996). The most prominent of these changes are represented by a distinct transition between temperate forest and alpine grassland ecosystems termed as timberline.

Natural timberline represents an ecological boundary of great complexity and reflects complex phenomena at all scales of investigations (Crawford 1989; Young 1993). Although timberlines are edge situations the people define and describe these variously across the globe (Griggs 1934, 1937, Marr 1948; Daubenmire 1954; Klikoff 1965; Troll 1973; Lauer 1978; Tranquillini 1979, Wardle 1965, 1971, 1985; Crawford 1989; Ohsawa 1990; Young 1993, Payette and Morneau 1993; Cairns 1994). The timberline, as defined by Crawford, is considered in the present context. According to this definition, the timberline zone consists of three distinct boundaries—forest edge, tree limit and Krummholz.

The timberline forms a mosaic of forest- meadow communities. Therefore, it represents a dynamic relationship of elements of both. These relationships are, however, variable in different parts and reflect the nature of ongoing environmental processes. Troll (1973) suggested that the altitudinal position and nature of timberlines is quite variable geographically. Usually the latitudinal position of the mountain determines the altitude of timberline. For example, in north temperate zones there is a reduction of ca 110 m for every 1° increase in latitude (Daubenmire 1954). Ohsawa (1990) provided an interpretation of latitudinal patterns of forest limit in south and east Asia mountains. Despite this relationship, it is well established that everywhere the timberline altitude coincides approximately with the 10°C summer isotherms (Wardle 1965, 1971, Grace 1972, 1989, Ohsawa 1990). In addition to global patterns of variation, the local and regional variations in altitude of timberline are observed and attributed to prevailing topoclimate of the area. For instance, in the study area, upper and lower limit of timberline varies with exposure on an order of ± 150m, dropping on cool northerly exposures and rising on warmer southerly exposures. In general, the timberline altitude (2800-3500m) in west Himalaya is comparatively low as expected from other adjacent latitudinal (25-35° N) counterparts (e.g. west Sichuan and Yunnan 3800-4500m, Tibet 4000-4300 m, east Himalaya 3800-4000m). This should, however, be viewed in spatial patterns of climate and vegetation distribution in Himalaya, where along east to west humidity gradient decreases and winter severity increases manifold (Singh and Singh 1987, 1992).

Because of the aforementioned spatial patterns of timberline, a considerable variation in species composition and processes have been noticed. The composition and processes are considered indicators of existing climatic conditions of the area, thus providing insight on patterns of climate change along geological past. Payette and Gargnon (1985) suggested that altitudinal and latitudinal movements of timberline act as palaeoclimatic indicators for reconstruction of Holocene climate. Similarly, the relationship of vegetation to climate at this ecotone has proved of great value in reconstructing the past dynamics of climate and vegetation (Ritchie and Hare 1971; Spear 1983, Payette et al 1985; Payette and Filion 1985; Cwyner and Spear 1991). The patterns and physiology of tree growth within the ecotone has attracted studies on climate changes (Hansen-Bristow et al 1988; Scuderi 1993), and such changes are observed at different spatial scales (Legg and Baker 1980, Luckman and Kearney 1986; Kullman 1988).

The timberline zone in the Himalaya is considered a cradle of high temperate and low alpine biodiversity elements. It is also a rich repository of highly sensitive elements, which include, endemic, endangered, medicinal and edible species. They are of considerable biological and

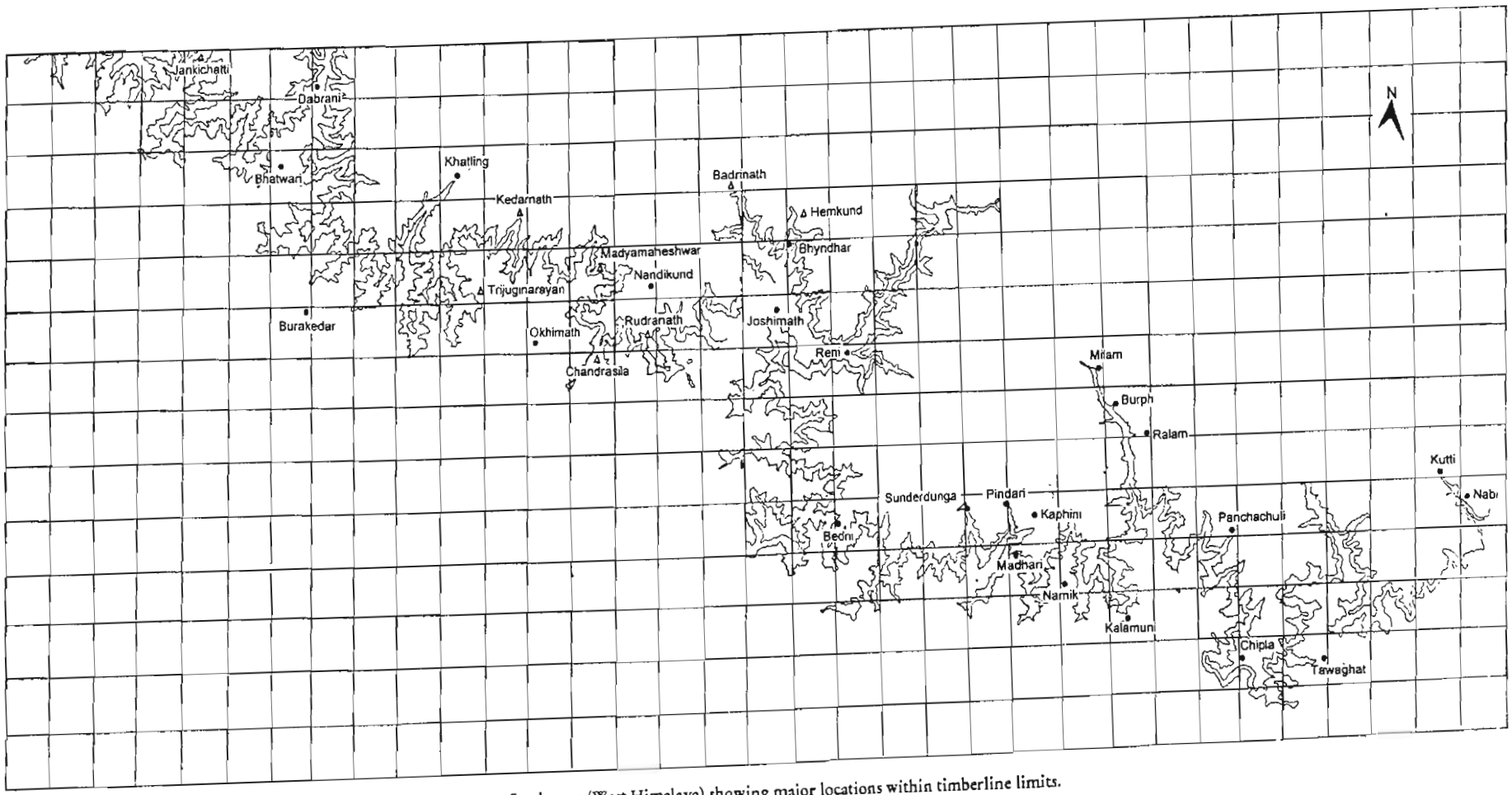


Figure 3.1: Study area (West Himalaya) showing major locations within timberline limits.

economic value. The potential of sensitive species has recently been analysed for Kumaun timberline (Rawal and Dhar 1997). Over 35% of the total timberline flora are endemic and, more importantly, of these 20% are narrow range endemics. Occurrence of these forms reflect the extent of rarities in the flora Richness in diversity and representativeness are among major attributes contributing to conservation value of timberline flora of Kumaun Himalaya. Among habitats, forest edges/open slopes, boulders/rock crevices and marshes/moist situations deserve priority attention. This zone at the same time is subject to anthropogenic pressures which, among others, include forest clearing, nomadic pastoralism and extraction of economically important plant species. As a result of these pressures, 19% of natural sub-alpine forest habitat has been depleted in recent years (WII 1992). Such alterations in habitat conditions have promoted the invasion of alien taxa, particularly the annuals. These processes have adversely affected nature, structure and composition of the timberline (Rawat and Rodgers 1987; Rawat and Uniyal 1993; Rawal and Dhar 1997).

In view of the diversity of its biological components, representativeness and susceptibility to changes, timberline studies assume significance not only at local or regional scales but also at a global level. Unfortunately, the data available on status, realized and potential values of biodiversity and the nature and extent of pressures on the ecotone, are inadequate. Realizing the importance of the timberline zone and the gaps in our understanding of this ecotone, this study envisages to (i) provide a kick start to building base line data, (ii) share concerns regarding the existing gaps in knowledge, (iii) highlight specific issues and constraints in utilizing available information for prioritization, and (iv) develop an approach for the optimal utilization of available information. We believe that prioritization of different sites within this sensitive zone will sharpen our focus of conservation initiatives and open avenues for future studies.

2. Objectives

1. To develop and update an inventory on biodiversity elements of the timberline zone of west Himalaya.
2. To select sites for prioritization on the basis of biodiversity and socioeconomic value
3. To suggest strategies for conservation of selected priority sites and stretches.
4. To develop a participatory methodology for prioritizing sites

3. The Area

The Himalaya is characterized by heterogenous dispersion of biodiversity elements. On the basis of geology, phytoclimate, altitude, vegetation and spatial pattern of distribution, the region is classified variously It is a difficult task to biologically classify a mountain system of immense diversity in gradients, altitude, latitudes, organizational levels and spatial scales. Biogeographically, a sharp and distinct contrast characterizes the eastern and western limits with blend of their elements in the centre. Presently the most acceptable system is that of Rodgers and Panwar (1988), who classified Himalaya into five provinces namely: Trans Himalaya, NW Himalaya, West Himalaya, Central Himalaya and Eastern Himalaya (Table 3.1).

West Himalaya covers an area of about 53,000 sq km (Kumaun 21,000 and Garhwal 32,000), of which 4,107 sq. km (5.7%) is protected. Within west Himalaya, the study area (timberline zone of west Himalaya) stretches from Garhwal in the west to Kumaun in the east (78° 07' 27" E to 80°53'20" E longitude, 29°53'5"N to 31°00'00"N latitude) covering an area of about 2,095 sq km (Fig. 3.1). Among the identified sub regions Kumaun and Garhwal cover 642 and 1450 sq km respectively (Fig 3.2).

Table 3.1: Distribution of Representative Political Boundaries within Provinces of the Indian Himalaya

Biogeographic Provinces	*Political boundary*	*Area sq. km*	*Total Area (%)*
Trans Himalaya	Jammu & Kashmir	186,200	44.07
	HP		
North west Himalaya	J&K, HP	69,000	16.33
West Himalaya	Hill districts of UP	53,000	
	HP	19,000	17.04
Central Himalaya	Sikkim and North Bengal		
	(West Bengal)	12,300	02.91
Eastern Himalaya	Arunachal Pradesh	83,000	19.64

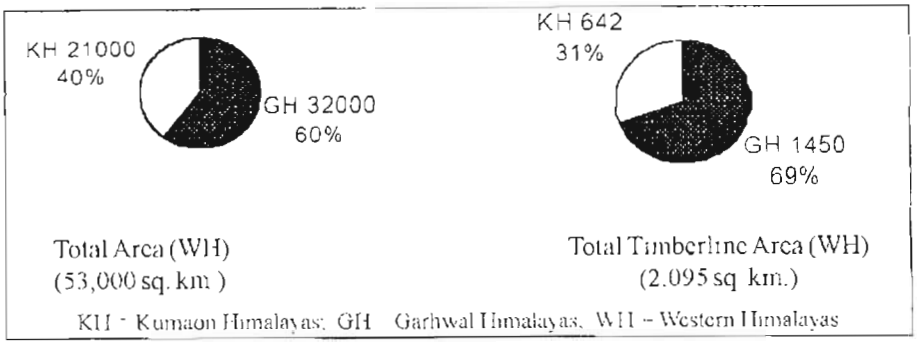


Figure 3.2. Distribution of TLA in sub regions of Kumaon and Garhwal

Land Use Classes

Among the landuse classes, the forests, which cover about 1500 sq km (72.5%) of the area, consist of three dominant physiognomic types

(i) Evergreen broad leaved (e.g. high altitude oak forests) - *Quercus semecarpifolia* (Kharsu oak) being the major constituent with undergrowth of *Rhododendron* species. This forest type marks the lower limit (around 2800 m) of timberline and at upper limit it merges into birch-rhododendron associations. However, at some places it represents the highest forest limit on comparatively dry slopes and is directly replaced by alpine pastures. Under thick canopy of *Q. semecarpifolia*, other dominant types, especially the evergreen needle-leaved (*Abies*) and deciduous (*Betula*), fail to survive. On moist sites, however, *Q. semecarpifolia* forms association with *A. pindrow*;

(ii) Evergreen needle-leaved (e.g. conifer forest) - a few pure conifer stands are confined to morainic deposits at the timberline zone of this region. However, fairly good associations of conifers (*Abies* and *Taxus*) are common with other physiognomic types. The canopy is generally open, allowing a thick undergrowth. *Rhododendron* and Betula are second story components. The shrub layer is dominated by the Himalayan bamboos (*Thamnocalamus spathiflora* and *Chimonobambusa jaunsarensis*),

(iii) Deciduous broad-leaved (e.g. birch forests) - *B. utilis* forms various associations with evergreen broad-leaved and evergreen needle-leaved types. The pure patches of *B. utilis* are characteristic at many places on upper fringe of timberline. In moist, shady localities thick patches of *B. utilis* and *R. campanulatum* delimit the forest growth in this region (Rawal and Pangtey 1994; Rawal and Dhar 1997).

(iv) In general, a gradual decrease in tree height from tall erect forests of *Abies* and *Quercus* to low statured "krummholz" of *Betula utilis* and *Rhododendron campanulatum* is evident. Therefore, in most cases, timberline is not sharply abrupt but is diffused in structure and variable in nature. This zone serves as a special habitat for the edge loving animals. Several endangered animals of the region include *Selenarctos thibetanus* (Himalayan black bear), *Soriculus nigrescens* (Himalayan shrew), *Panthera pardus* (leopard), *P. uncia* (snow leopard), *Moschus chrysogaster* (Himalayan musk deer), and *Capricornis sumatraensis* (serow) (Wildlife Institute of India, 1992). In addition, other protected species, e.g. *Muntiacus muntjak* (barking deer), *Hemitragus jemlahicus* (Himalayan thar), *Presbytis entellus* (common langoor), *Felis chaus* (jungle cat), *Vulpes vulpes montana* (red fox), also occur. This ecotone is an ideal habitat for rare pheasants such as monal (*Lophphorous impejanus*), koklas (*Pucrasia macrolopha*), and several altitudinal migrants like the snow cock (*Tetraogallus himalayensis*), laughing thrushes (*Garrulax* spp.) etc. (Ali and Ripley 1983).

Besides forest and the faunal components, the area is characterized by pastures and meadow lands - locally known as bugyal - (556 sq km; 26.6%) which is a support system for trans humance communities (Table 3.2).

Agriculture is sparse (18.25 sq km; 0.87%) in the area. However, cropping is practiced in the lower fringe of the zone and the major crops cultivated exclusively for sustenance include barley, buckwheat, potato and to some extent radish and amaranth. The area under snow is negligible (0.83 km; 0.04%). The percent area distribution of major land use classes in the study area is shown (Fig 3.3).

A number of important drainage systems traverse through the study area (Table 3.3). The network of drainage in the study area provides a valuable water resource throughout the foothills and further down in the plains. The valleys, thus formed, offer special micro sites for biodiversity elements of the timberline zone.

Table 3.2. Important alpine meadows (bugyal sites) in west Himalaya (After Rawat and Rodgers, 1987)

Region/valley	*Bugyal*
A. Kumaun	
Byans	Sanchum, Gunji, Garbyang, Palangar, Kutti, Yangti, Jeolingkong
Darma	Dawe, Bedang, Sipu, Dhakar, Dugtu, Nagling.
Panchuli	Balchhi, Panchuli, Chhipla
Ralam	Ralam, Rhamba
Johar	Burphu, Milam, Martoli, Tola, Khaliya, Dung
Pindari	Pindari, Sunderdhunga, Maiktoli
Girthi	Topidhunga, Lapthal, Sangchamala
B. Garhwal	
Nandadevi	Nandadevi, Dibrughetta, Deodi, Ramani, Dunagiri
Bhyundar	Hemkund, valley of flowers, Kakbhusandi
Niti	Malari, Bampa, Niti, Gothing
Badrinath	Badrinath, Mana, Basudhara
Kedarnath	Rudranath, Tungnath, Madhyamaheshwar, Kedarnath, Basukital
Gangotri	Deotal, Nilang, Bhaironghati, Gangotri,Gangnani
Yamunotri	Banderpunch, Yamunotri,
Tons	Kedarkantha, Sural dhar

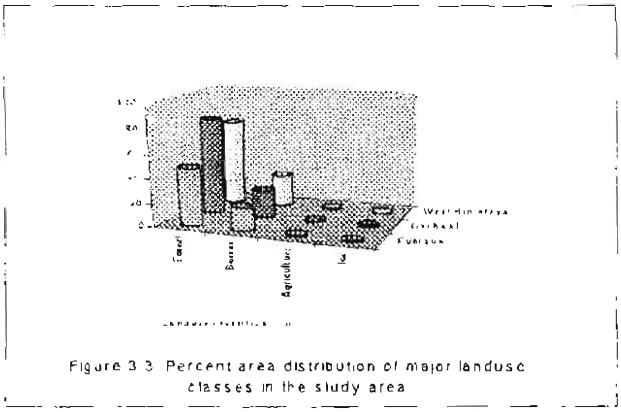
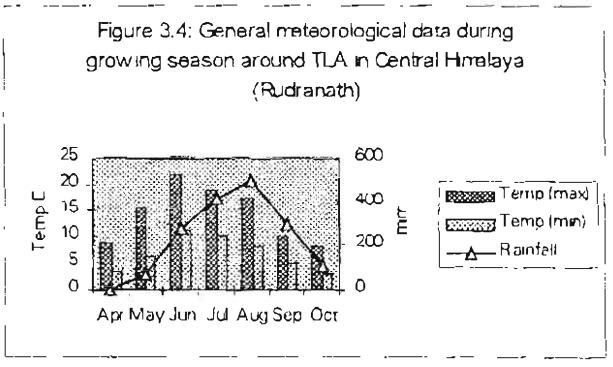


Figure 3.3 Percent area distribution of major landuse classes in the study area

Table 3.3. Important valleys and drainage systems in west Himalaya (After Rawat and Rodgers, 1987)

Region	*Major valley*	*Drainage*
A. Kumaun		
	Byans	Kutti, Kali, Yangti
	Darma	Dhauli east
	Panchchuli	Madkami, Zimba
	Ralam	Ralam gar
	Johar	Gori with tributaries
	Pindari	Pindar, Sunderdhunga gar
	Girthi	Girthi, Kyo gar
B. Garhwal		
	Nanda devi	Rishi ganga
	Bhyundar	Bhyundar ganga
	Niti	Dhauli west, Nitgar
	Badrinath	Alakhnanda
	Kedarnath	Mandakini ,Amrit ganga
	Gangotri	Bhagirathi
	Yamunotri	Yamuna
	Tons	Pins, Tons

The climate is cold The data on the climate of the study area is available only from Rudranath (Garhwal Himalaya) and that too from April- October (Fig 3.4).



The physiography of the area changes considerably with latitudes. While steep slopes are common, they are almost always interspersed with vast meadows and pasture lands.

4. Approach

Given the spatial scale of over 53,000 sq km , the preparation of inventory of biodiversity elements of timberline zone of west Himalaya, based on secondary data, involved collection and organization of available data. It was a very difficult task to collate the information, which at best is scattered and incomplete In order to achieve the desired progress in developing a rational approach for prioritization, it was thought that instead of finding fault with the available data, it was important to make the most of

it. There was a need to collect and collate available information in a standardized format which was compatible with the global format (Dhar 1997). While database was being organized in standardized formats, a two day Consultation Meeting of eminent experts was convened to deliberate on the approach of analysis and interpretation of data for prioritization. The objective of this exercise was to evolve a rational methodology for prioritizing strategies, sites and species. The suggestions of the experts were duly considered for analysis and interpretation. After developing the conceptual framework and the methodology, another Consultation Meeting was organized to brief the experts on the approach developed and to seek their suggestions. An opinion poll suggested that the methodology developed was largely acceptable and reproducible.

Survey and Collection

Information on plant diversity of timberline zone of west Himalaya was obtained from various sources. An extensive survey of published literature and relevant Ph.D. dissertations on the subject matter was carried out (Box 1). Source of information was drawn from various floras, Ph D. dissertations, research papers, reports, monographs, etc , data on vegetation from research publications and information on nativity from Index Kewensis. The data entry were further updated on the basis of unpublished parts of dissertations.

Organization

Database Format

A database format was developed considering the objectives of the study. For example, all the attributes were organized to accommodate relevant information, irrespective of the gaps in available literature. Besides general information on habit and habitat, attention was focused on vertical distribution. It was divided into three broad categories: taxa with the altitudinal distribution above the upper limit, i.e. 3400m, were considered as Plus Facultative, the ones with their distribution extending below the lower limit, i e. 2800m, as Minus Facultative and those strictly falling within the defined range, i.e. 2800-3400, were considered as Obligates (Fig. 4.1).

The information on Himalayan native species was focused on, besides recording spatial pattern of distribution at global and regional scale.

Plus Facultatives

3400m

Obligates

2800 m

Minus Facultatives

Figure 4.1: Upper and Lower Limits of TLA Considered in the Present Study

All the above information was recorded on location specific basis. However, in some cases locations were ill-defined. Species reported in an area slightly beyond limits of the timberline but covering part of the study area were considered in the analysis. Species distributed in the valleys were considered to be occurring in all the grids through which the river traversed. Although, habitats were divided into 16 types (Table 4.1) these divisions were not considered for analysis, because they were ill defined, they did not reflect the natural entity, were perceived differently by different authors, and were vague.

Table 4.1. Major Landuse Categories and their Corresponding Habitat Types

Land use class	*Habitat*
Agriculture	Among crop fields/villages Field borders
Barren	Dry open slopes Moist slopes Along paths Pasture/meadow lands Rocks/boulders
Forest	Forest/moist slopes undergrowths Forest edges Water courses/along streams/ Riverine
Glaciers	Moraines
Others	Shrubberries Climber Parasite Waste places

Use value was categorized into three types: edible, medicinal and others (fuel, fodder, ornamental etc.).

The available information obtained from secondary sources covered the following attributes: richness, representativeness, naturalness, endemicity, uniqueness and use value (Table 4. 2).

Table 4.2. Criteria used for analysing the Identified Attributes

Attribute	*Criteria*
Richness	No. of species
Naturalness	No. of native species
Representativeness	Plant Communities (formations)
Uniqueness	Rarity status
Endemicity	No. of endemics
Use value	Medicinal, edibles and others

Number of species in a unit area was considered indicative of richness and number of natives helped to assess naturalness. Likewise, occurrence of major communities (formations) in a unit area indicated representativeness (Table 4.3). Taxa restricted to the Himalaya (Indian Himalaya, Nepal) were considered as Himalayan endemic and the ones with the range extending slightly beyond the Himalaya (Pakistan, Bhutan and Burma) were referred as near endemic (NE). Considering the range extension, the endemic taxa were further divided into the following two groups (i) taxa restricted to one Himalayan province; as Narrow Range Endemic (NRE) and, (ii) taxa occurring in two or more provinces as Broad Range Endemic (BRE). The rarity status of the total number of species within a site was considered to reflect the uniqueness of the area.

Table 4.3. Communities of West Himalaya (After Singh and Singh, 1987)

	Forest formation types
1.	*Shorea robusta (Sal)*
2.	*S. robusta- Pinus roxburghii (Chir pine) Toona ciliata*
3.	*P. roxburghii- mixed broad leaf*
4.	*P. roxburghii*
5.	*Q. leucotricophora (Banj oak) - P. roxburghii -Q. leucotrichophora*
6.	*Q. floribunda (Tilonj oak) - Q. leucotrichophora*
7.	*Q. floribunda - Q. lanuginosa (Rianj oak)*
8.	*Q. lanuginosa- Q. semecarpifolia (Kharsu oak)*
9.	*Abies pindrow (Silver fir) - Q. semecarpifolia - Betula utilis (Bhoj)*
10	*B. utilis - Rhododendron campanulatum*
11	*R. campanulatum*

Mapping

At the outset, Survey of India toposheets were consulted. The area falling within the identified contours (2800-3400m) was identified and separate maps were prepared for locations, settlements, land use and drainage network within the study area. Locations were checked and confirmed from toposheets. A landuse map, showing different landuse categories, was also prepared. All maps were then reduced and finally three master maps, indicating localities, landuse and drainage, were prepared. Besides these, reserve forest and heritage sites were also marked on the maps.

The study area was further divided into uniform grid units (74.45 sq km.) on the basis of the intersection of longitudes and latitudes, at 5 minute intervals. The Timberline area for each grid was calculated with the help of a planimeter. Area falling under different landuse categories (agriculture, barren, forest, ice) was calculated separately for each unit.

The study area covered 153 grid units. Maps were not available for the area falling in 15 units. Of the total study area (2,095 sq km), the floristic data was available only for 1283 sq km (61%), falling in 80 grid units.

Analysis

Initially, available information for west Himalaya was pooled for the identified attributes (richness, nativity, rarity, endemics, forest formations and value) to calculate the proportional representation of the timberline area (TLA). A compendium of Himalayan plant endemics is not available. However, records indicate that 28.8% (Chatterjee 1939) are endemic to Himalaya, and Kashmir Himalaya as representative area of North west Himalaya, supports 36.5% plant endemics (Dhar and Kachroo 1983b). Computations on endemism was made on the presumption that, of the total West Himalayan species, 30% endemics occur in the study area.

Later, the analysis was undertaken at two spatial scales (i) Timberline Area and (ii) Grids. Species richness, naturalness, representativeness, uniqueness, endemicity and use value were analyzed for the total study area (TLA. Kumaun and Garhwal), followed by a similar analysis for each grid unit.

Identification of Clusters

A number of common species among the grids were recorded. Index of Similarity between grids was calculated following Sorenson's formula which is: IS= (2C/A+B) × 100, where IS is index of similarity, C is number of species common in two areas, A is total number of taxa in area A, and B is number of taxa in area B. Grids with more than 60% Similarity Index were identified as a cluster. Delineation of each cluster was further strengthened on the basis of the drainage network. The data obtained from the

Similarity Index were marked and superimposed on the data on drainage network, to finalize the identification of clusters.

Analysis of Identified Sites or Clusters

Species richness, nativity, endemicity, rarity and use value were analyzed for each identified cluster. The grids for which secondary data were not available were included in the cluster on the basis of similarity index, drainage network and proximity. The species which were recorded to be distributed throughout the study area were incorporated in all grids.

5. Prioritization

The approach of prioritization developed in the present study considered the relative importance of biological and socio-economic features of the study area with respect to richness of total area of west Himalaya. The rationale of this process was to prevent the observing and interpreting of data in isolation. Serious efforts have been made to evolve a reliable method of prioritization by providing a rationale at each step. Impediments during this process were also numerous.

Rationale

The timberline area, which is recognized as an indicator of climate change, supports biodiversity of very high biological and socioeconomic value. The area adequately qualifies as a priority site. Should this strategy be followed, considerable manpower and monetary resources would be required for immediate conservation action. It was, therefore, thought prudent to suggest prioritization of sites of smaller spatial scales initially and assess results of conservation inputs before replicating such action on other sites.

Whether the strategy to prioritize sites within the timberline zone should be based on biological value, or socioeconomic value, or both, was the next logical question. Considering the paucity of data available on biological value, and were more so on socioeconomic value, it was decided to utilize whatever information is available on both and pool them for the purpose of prioritizing among sites and species.

Since the area has not been extensively explored resulting in numerous gaps, it was difficult to develop strategies on scattered and incomplete information. While it would have been ideal to collect primary data on unexplored representative areas and to strengthen and update data base, the limitation of time, human and financial resource did not enable us to do so. Therefore, it was decided to develop a methodology, using on secondary data, such that the gaps in the data are exposed.

Since strategies cannot be developed on the basis of perceptions of just a few individuals, a participatory approach was adopted. Within a period of 10 months, two Consultation Meetings were organized to discuss the methodology and to obtain suggestions/ comments from experts of eminence. The relevant suggestions were considered. Overall, the experts in both the meetings responded positively and acclaimed the State of Art approach adopted.

Sites

Identification of Similar Sites or Clusters

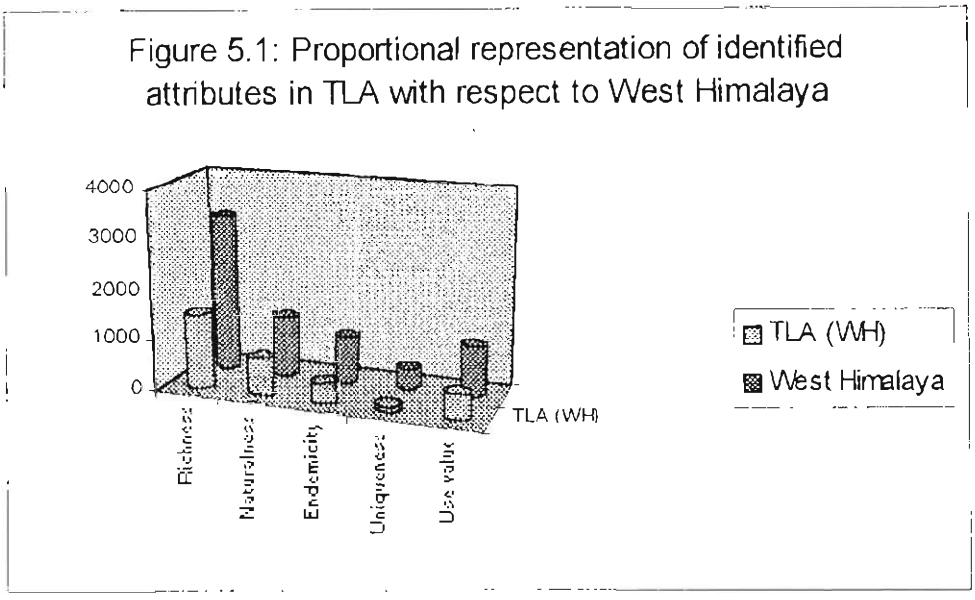
Twenty clusters or sites (A to T) were identified throughout the timberline zone of west Himalaya on the basis of species commonalities and drainage network. Depending upon the Similarity Index, a cluster thus formed could consist of one or more grid units. For example, H is a multigrid cluster, consisting of 5 grid units, having more than 60% Similarity Index. It lies within the source of Pinder river and covers the whole of Pinder valley catchment. On the contrary, M is a unit grid cluster, with less than 60% Similarity Index with the adjacent grids. It is located in the Bhyundar Ganga valley.

Levels of Prioritization for Identification of Priority Clusters

In order to identify priority clusters/sites, four levels of prioritization were followed (Table 5.1).

Table 5.1: Levels of Prioritization

Level I	Ranking of clusters on the basis of proportional representation of attributes with respect to West Himalayan TLA (Representative cluster).
Level II	Ranking of clusters on the basis of proportional representation of attributes with respect to cluster (Unique cluster).
Level III	Ranking of representative and unique clusters
Level IV	Identification of most representative grid unit within multi grid *clusters*



Representative Clusters

Identification and ranking of priority clusters was finalized on the basis of the proportional representation of cumulative features of biodiversity attributes of clusters, with respect to those of the timberline area of west Himalaya (Fig 5.1).

To start with, we gave equal weightage to all the identified attributes (richness, representativeness, naturalness, endemicity, uniqueness and value). The weightage of each identified attribute was kept uniform, in view of the fact that there were overlaps and a very thin line of demarcation among the attributes. For example, endemicity of a unit area was dependent on richness or for that matter representativeness also reflected the richness. Therefore, the identified attributes were interdependent and could not be analysed in isolation. Which is why the prioritization was based on cumulative scores of all the attributes. This was followed by ranking and scoring each attribute on the basis of proportional representation of the identified attributes in the timberline zone (TLZ) of west Himalaya, with respect to the total west Himalayan province. For example, naturalness of TLA of west Himalaya represents 62.36% of the total naturalness of west Himalaya. Compared to other attributes, naturalness scored six credits and thus ranked first among all the attributes (Table 5.2).

Accordingly, each cluster was ranked in ascending order for richness, representativeness, uniqueness, rarity and use value. The value was then multiplied with the score of that attribute. Finally, the values were summed, and clusters were prioritized in descending order so that the cluster obtaining the maximum credit was considered to be the top ranking cluster (Table 5.3, Fig. 5.2).

Table 5.2. Ranking and Scoring of Attributes for Prioritization

Attribute *% of TLA with respect to West Himalaya*	*Rank*	*Score*
Richness 49.71	III	x4
Naturalness 62.36	I	x6
Representativeness 45.89	V	x2
Endemicity 51.32	II	x5
Uniqueness 14.30	VI	x1
Use value 45.89	IV	x3

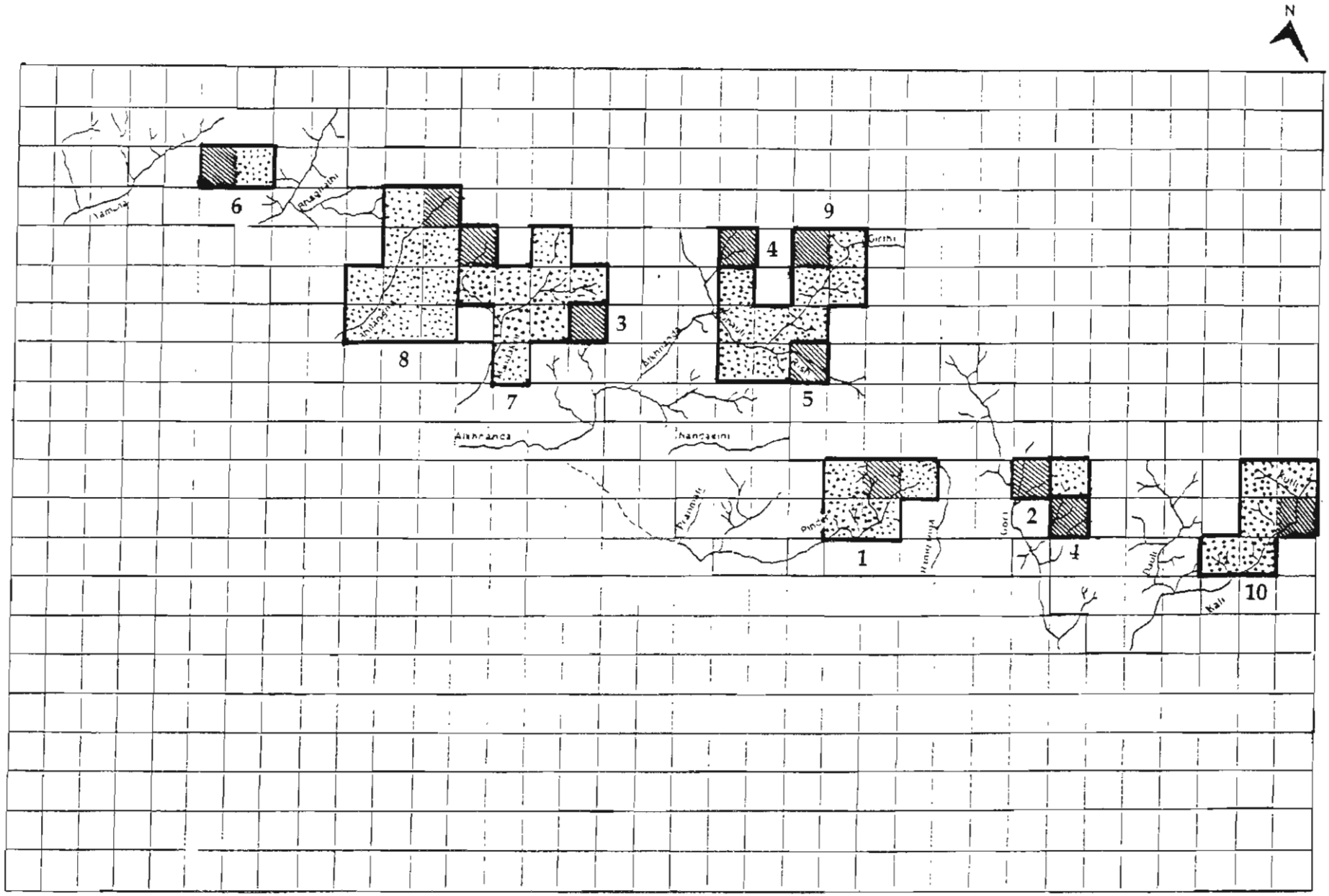


Figure 5.2: Priority clusters/sites within timberline zone of West Himalaya.

Table 5.3. Ranking of Representative Clusters

Rank	*Code*	*Site*
I	H	Pindari
II	M	Bhyundar valley
III	D	Ralam valley
IV	O	Kedarnath valley (Tungnath, Rudranath)
V	J	Nandadevi valley (Rishi ganga valley)
VI	I	Niti valley
VII	T	Dodital
VIII	A	Byans valley
IX	C	Panchachuli valley
X	F	Milam
XI	P	Kedarnath (Mandakini)
XII	Q	Bhilangana
XIII	L	Nandadevi (Nandakini)
XIV	E	Johar
XV	R	Gangotri
XVI	B	Darma
XVII	G	Ramganga
XVIII	K	Nanda devi
XIX	S	Yamnotri
XX	T	Dodital

Identification of Unique Clusters

Subsequently, unique clusters were identified on the basis of proportional representation of attributes with respect to an identified cluster. For example, each cluster was analysed for four attributes i.e., naturalness, endemicity, uniqueness and use value, on the basis of assigned scores while ranking attributes. Thus the only difference from the earlier analysis was that the top score was four instead of six. The grids were accordingly ranked in descending order. For example, cluster C of Panchachuli showed the highest cumulative score and, as such, was ranked I among unique clusters (Table 5.4)

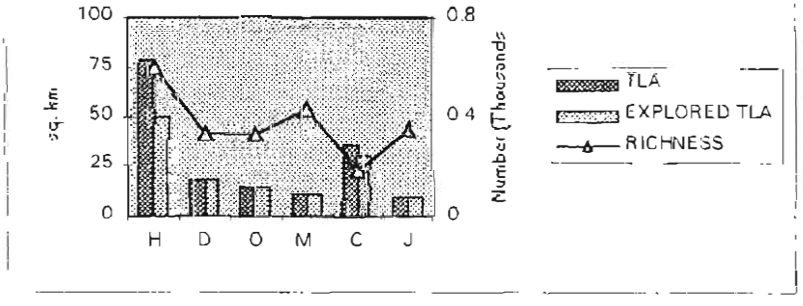
Table 5.4. Ranking of Unique Clusters

Rank	*Code*	*Valley*
I	C	Panchachuli
II	D	Ralam valley
III	H	Pindari
IV	O	Kedar nath
V	S	Yamnotri
VI	J, K	Nandadevi
VII	P	Kedarnath (Mandakini valley)
VIII	M	Bhyundar
IX	Q	Bhilangana
X	G, E	Ramganga, Gori
XI	T	Dodital
XII	L	Nandadevi (Nandakini)
XIII	B	Darma
XIV	F	Gori
XV	A	Byans
XVI	I	Niti
XVII	R	Gangotri
XVIII	N	Bhagirathi

Prioritizing Representative and Unique Clusters

The ranks thus assigned for both representative and unique clusters were summed up and the overall priority of clusters was finalized (Table 5.5) The identified clusters varied in percent area explored and did not show any relationship between area and richness For example, Cluster J was the smallest but had relatively high species richness compared to cluster C, which was relatively species poor but covered a larger area (Fig 5.3).

Figure 5.3: Area and Richness for top priority clusters



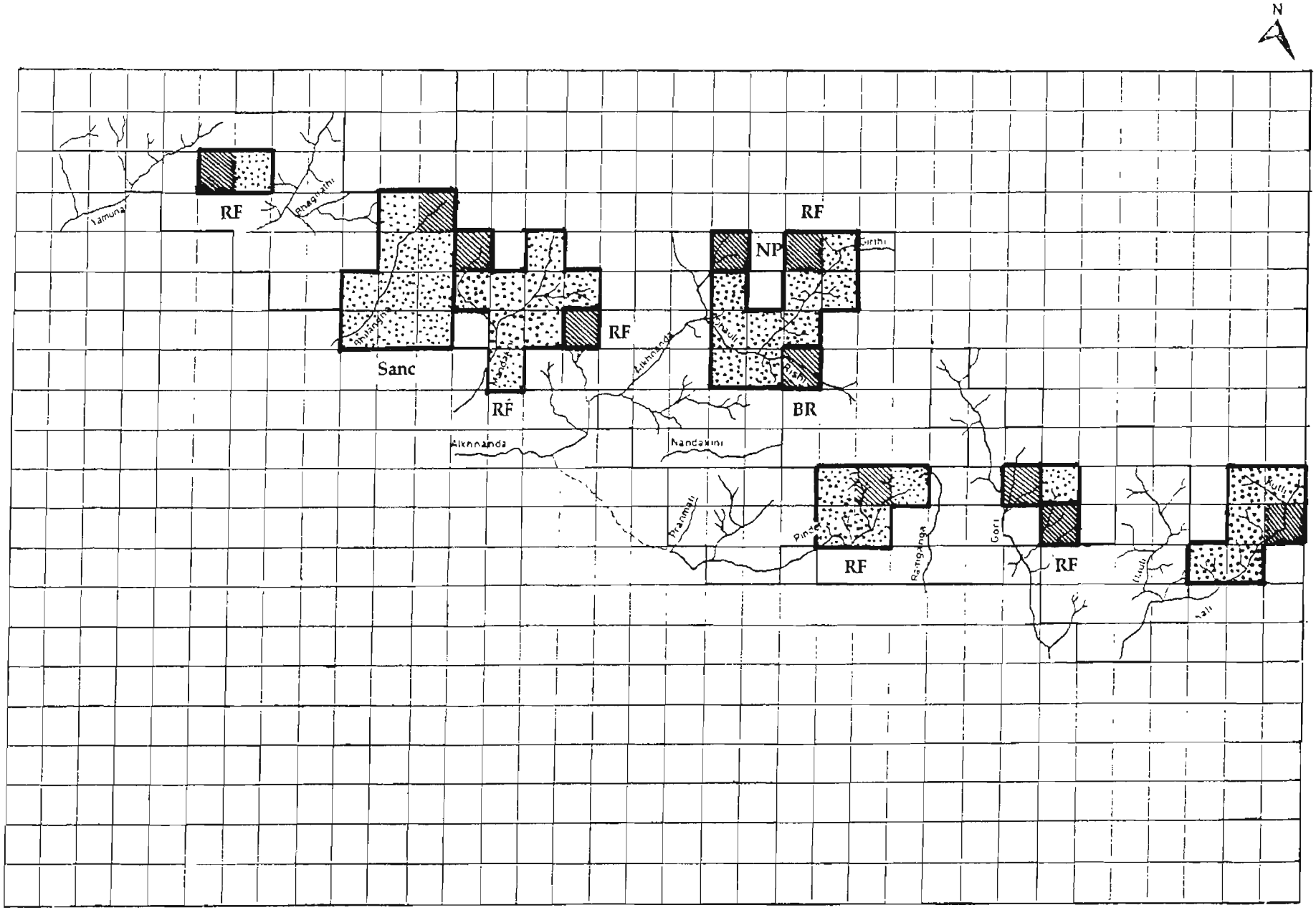


Figure 5.4: Priority clusters/sites within timberline zone of West Himalaya.

Table 5.5: Ranking of Top Priority Clusters

Cluster Rank	*Level*		*Total*	*Priority rank*
	Ist	*IInd*		
*A	8	15	23	X
B	16	13	29	
*C	9	1	10	IV
*D	3	2	5	II
E	14	10	24	
F	10	14	24	
G	17	10	27	
*H	1	3	4	I
*I	6	16	22	IX
*J	5	6	11	V
K	19	6	25	
L	13	12	25	
*M	2	8	10	IV
N	18	18	36	
*O	4	4	8	III
*P	11	7	18	VII
*Q	12	9	21	VIII
R	15	17	22	
S	20	5	25	
*T	7	7	14	VI

Analysis of Conservation Status of the Prioritised Sites

Conservation status of the top ranking priority sites was analysed on the basis of Rodgers and Panwar (1988). Of the identified top ranking clusters, three sites fall within a protected area, i.e., Valley of flowers National Park, Nanda Devi Biosphere Reserve, and Kedarnath Wild Life Sanctuary. Six are Reserved Forests (i.e., Pindari, Tungnath, Panchchuli, Dodital, Okhimath and Dunagiri). However, sites Ralam and Byans do not fall under any Protected Area Category (Fig 5.4, Table 5.6).

Table 5.6: Conservation Status of the Top Ranking Clusters

Rank	*Code*	*Location*	*Conservation status*	
			Present	*Proposed*
I	H	Pindari	RF	Sanc
II	D	Ralam	—	—
III	O	Rudranath, Tungnath	RF	—
IV	C	Panchachuli	RF	—
IV	M	Hemkund, Bhyundar	NP	—
V	J	Dibrugheeta, Deodi	BR	—
VI	T	Dodital	RF	Sanc
VII	P	Okhimath,	RF	—
VIII	Q	Kedarnath, Khatling	WLS	NP
IX	I	Malai, Niti, Dunagir	RF	—
X	A	Byans	-	—

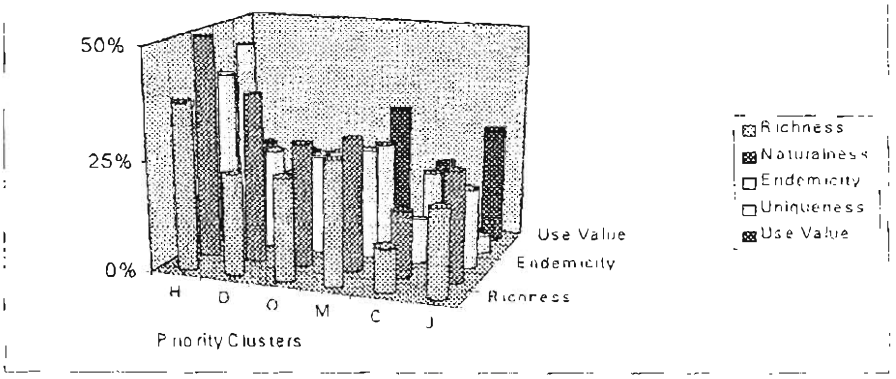
RF = Reserve Forest, P = Park, Sanc = Sanctuary, NP = National Park; BR = Biosphere Reserve.

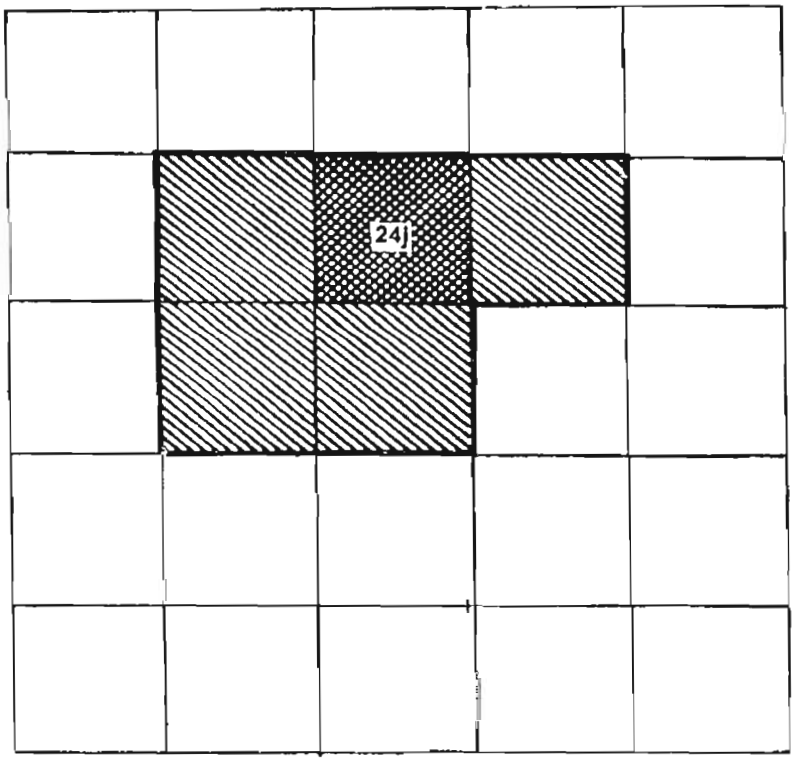
Identification of Representative Grid Unit within Prioritized Clusters

The most representative grid with maximum species, natives, endemic and rarities was identified within each prioritized cluster of multiple grids (Fig. 5.5). However, in some cases where a unit grid represented the cluster, the same was identified as the most representative grid unit. The location and status of representative grid units in six top ranking clusters is shown (Fig. 5.6 to 5.10).

The approach of prioritization has narrowed and sharpened our focus on representative grid unit of a prioritized site (cluster) for initiating appropriate conservation action. In the Himalayan context, secondary data has been, for the first time, effectively utilized for setting conservation priorities. This is the hallmark of the present study.

Figure 5.5 Proportional representation of cluster (I level)

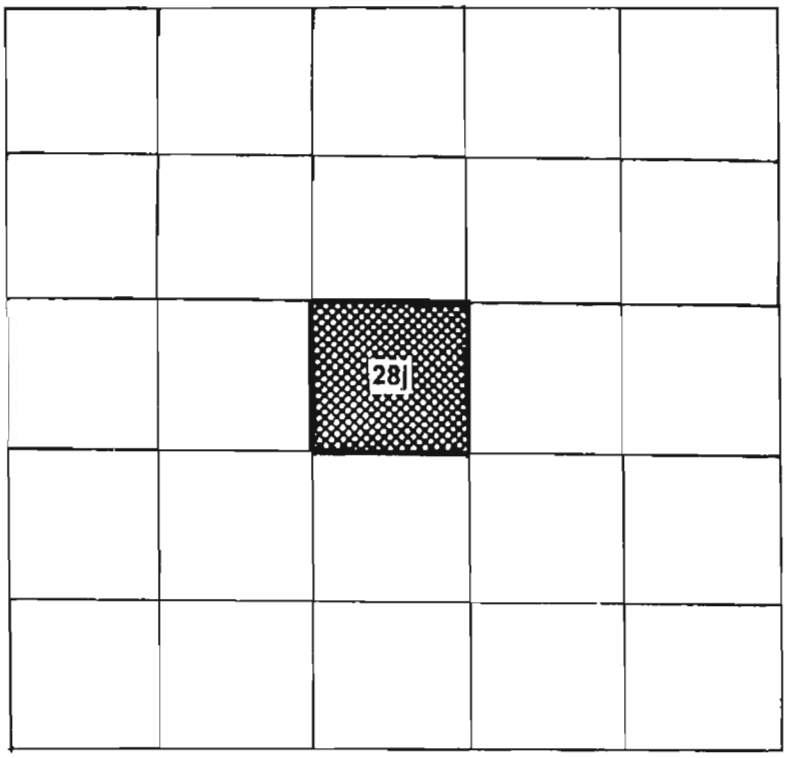




Rank I: Cluster H

Representative grid	24j
TLA	14.48 sq km
% TLA of Cluster	18.88
% Richness	99.33
% Naturalness	99.47
% Endemism	99.48
% Uniqueness	100
% Use value	100
Major locations	Pindar, Kaphni, Sunderdhunga
Drainage	Pinder River, Sunderdhunga Gar
Reserve forest	Sunderdhunga RF
Shrines/ Tourist places:	Pindari glacier

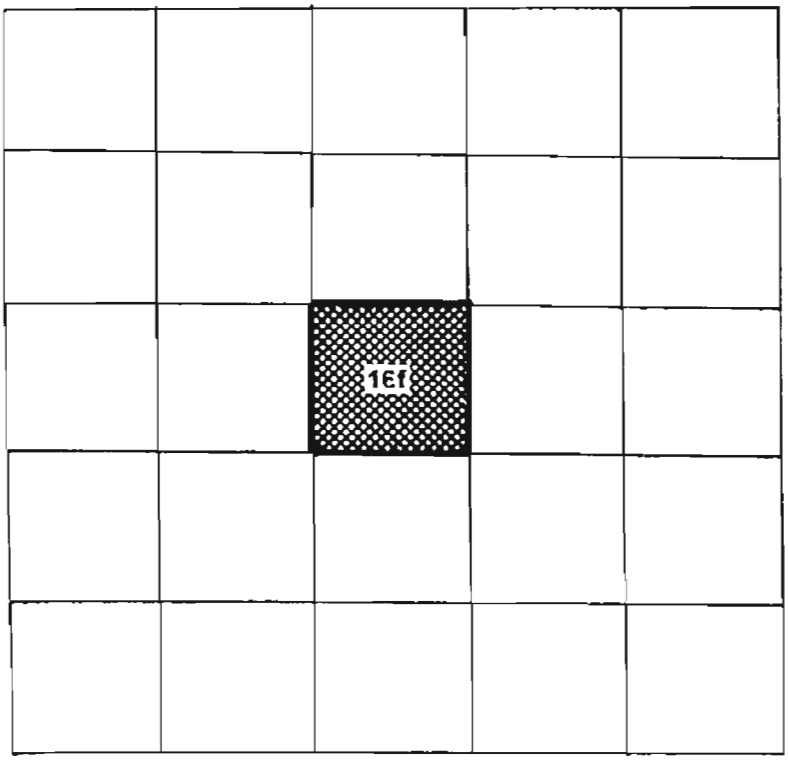
Figure 5.6



Rank II: **Cluster D**

Representative grid	28j
TLA	17.85 sq. km
% TLA of cluster	100
% Richness	100
% Naturalness	100
% Uniqueness	100
% Endemism	100
% Use value	100
Major locations	Ralam, Burphu
Drainage	Ralam gar
Reserve Forest	--
Shrines/Tourist places	--

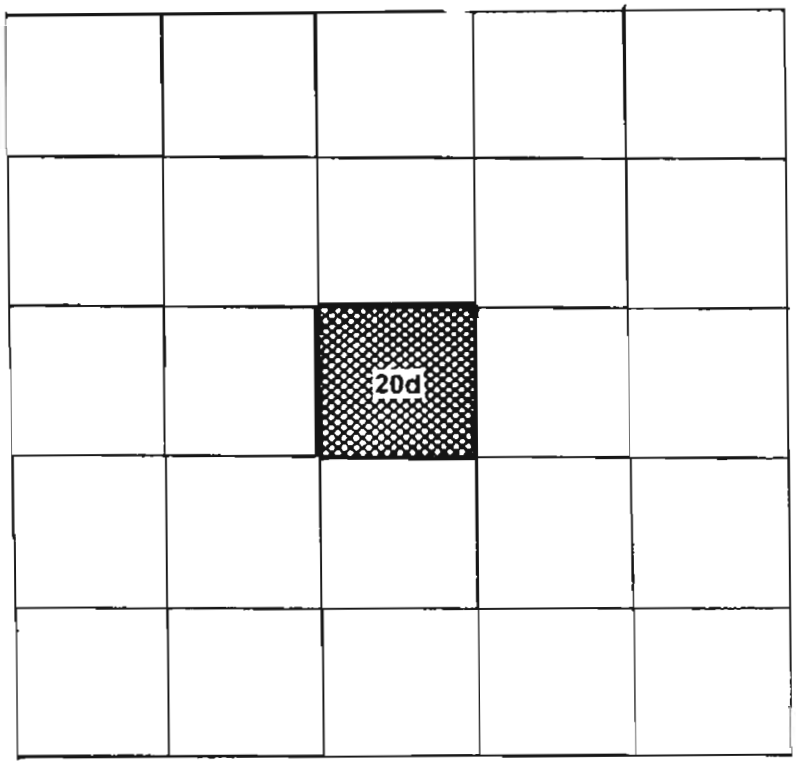
Figure 5.7



Rank III: **Cluster O**

Representative grid	16 f
TLA	15.95 sq km
% TLA of cluster	100
% Richness	100
% Naturalness	100
% Endemism	100
% Uniqueness	100
% Use value	100
Major locations	Rudranath, Tungnath
Drainage	--
Reserve Forest	Malla Nagpur RF
Shrines/Tourist places	Rudranath

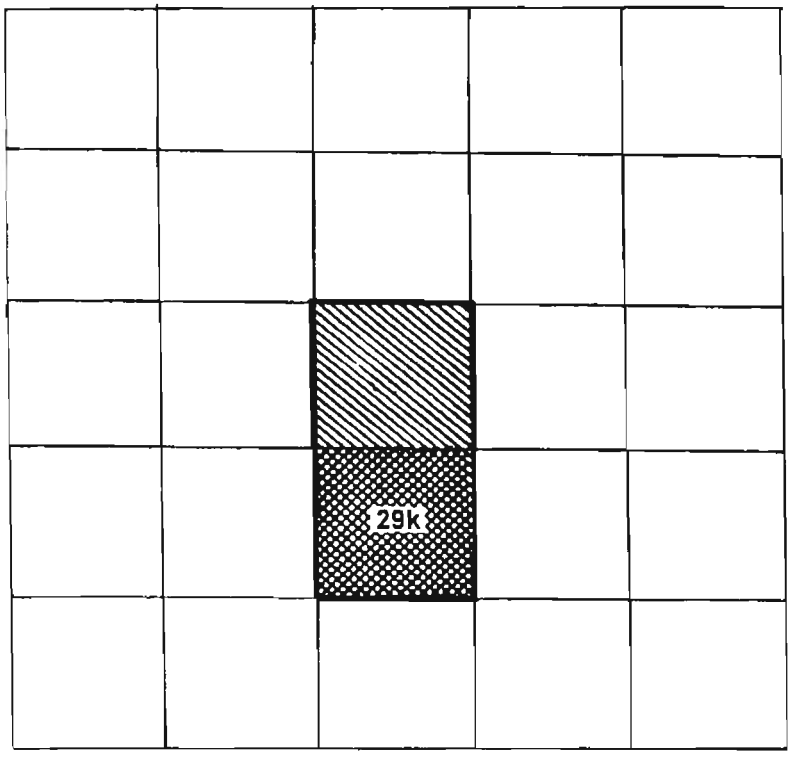
Figure 5.8



Rank IV: **Cluster M**

Representative grid	20d
TLA	11.73 sq km
% TLA of cluster	100
% Richness	100
% Naturalness	100
% Endemism	100
%Uniqueness	100
% Use value	100
Major locations	Hemkund, Ghangaria
Drainage	Bhyundar ganga
Reserve Forest	Padukeshwar RF, Valley of flowers NP
Shrines/ Tourist places	Hemkund Gurudwara

Figure 5.9



Rank IV:	**Cluster C**
Representative grid	29k
TLA	28.65
% TLA of cluster	85.57
% Richness	100
% Naturalness	100
% Endemism	100
% Uniqueness	100
% Use value	100
Major locations	Panchachuli
Drainage	Madkani
Reserve Forest	Madkani RF
Shrines/ Tourist places	Panchachuli glacier

Figure 5.10

Box 1. Source of Secondary Data (only major publications*)

1. Books

The wealth of India; Raw materials. (1970-1988) Vol. I-XI.
Index Kewensis Plantarum Phanerogamarum Vol. 1-2. 1883-1885 and 15 Suppl. 1886-1970.
Ethnobotany of the hill tribes of Uttarkashi: Plants used in rituals and psychomedicinal practices. Badoni 1988.
Flora of Himachal Pradesh (1-3). Chowdhery and Wadhwa 1984.
Orchid flora of North - West Himalaya. Deva and Naithani 1986.
A forest flora for Kumaun. Osmaston 1927.
Orchids of Kumaun Himalaya Pangtey et al 1991.
Catalogue of plants of Kumaun and of the adjacent parts of Garhwal and Tibet. Duthie 1906 (Reprint 1974)
Ethnomedicinal plants of Mandi District, Himachal Pradesh. Gaur and Singh 1992.
Contribution to ethnobotany of India. Jain 1991
Dictionary of Indian folk medicine and ethnobotany Jain 1991
A contribution to the flora of Gopeshwar (Chamoli- Garhwal). Kala and Gaur 1989.
Flora of Bashar Himalaya. Nair 1977.
Flora of Chamoli. (Vol. 1-2). Naithani 1984.
Red data book of Indian plants (Vol. 1-3). Nayar and Sastry 1987-1990.
Planning a wildlife protected area network in India. Rodgers and Panwar 1988.

2. Research Papers

A contribution to the flora of Dodital- A high altitude lake in the Garhwal Himalaya (Uttarkashi) U.P Negi et al 1985.
A contribution to the flora of Khatling glacier in the Garhwal Himalaya (District-Tehri), Negi et al 1988.
Diversity, endemism and economic potential of wild edible plants of Indian Himalaya. Samant and Dhar 1997
An ethnobotanical study of tar Pradesh Himalaya in relation to veterinary medicines. Gaur et al 1992.
Diversity and status of plants in Nanda Devi Biosphere Reserve. Samant 1994
Medicinal plants of Kumaun Himalaya and strategies for conservation. Pandey et al 1993
Sensitivity of timberline flora in Kumaun Himalaya, India: conservation implications. Rawal and Dhar 1997.

3. Ph. D. dissertations

Alpine flora of Kumaun Himalaya. Ph. D. thesis. Rawat 1984
Herbaceous flora of District Uttarkashi. Ph.D. thesis Badoni 1990.
Edible wild plant of Garhwal Himalaya: An ethnobotanical survey. Ph. D. thesis Negi 1986.

Prioritisation of Areas for Biodiversity Conservation of Alpine Zone in the Trans- and Greater Himalaya in India

A.J.T. Johnsingh, G.S. Rawat, S. Sathyakumar, P.V. Karunakaran and Jatinder Kaur

Introduction to the Himalaya

The Himalaya, one of the most astounding natural regions on earth due to its geo-hydrological, biological, aesthetic, social and cultural values, is the major life-line of the Indian subcontinent. It is one of the richest biogeographic zones in India owing to its location at the junction of three major realms: Indo-Malayan, Palaearctic and Afro-tropical. Humans, being integral parts of the Himalaya, have been exerting considerable impact on the Himalaya by utilizing, managing and exhausting its resources. As a result, the Himalaya now harbours more endangered taxa than any other region of the country, which is also partly due to the fragile nature of this mountain ecosystem (Rodgers & Panwar, 1988). Like most other parts of the world, this region has experienced drastic changes in its ecological, socio-economic, cultural and political scenario during the recent past, resulting in the fast depletion of natural resources, and a complexity of environmental problems.

Classification and Origin

The Himalayan Mountains stretch from Chitral in the north west to Namche Barwa near southern China, extending as an arc for about 3000 km with a width varying from between 150 to 400 km. The main system comprises three zones: the Outer Himalaya (ranging from 900 to 2,000m above msl), the middle Himalaya (upto 4,000 m), the Greater Himalaya (upto 8,800m), and the Trans-Himalaya or the high altitude cold desert situated to the north of the Greater Himalaya. The Shivaliks run parallel to the Outer Himalaya on the southern side and to the north of the Indo-Gangetic plains. The Himalaya covers about 10% (ca. 4,22,300 km^2) of India's total land surface. It can be classified on the east west axis into four zones viz., North Western, Western, Central and Eastern Himalaya (Schaller, 1977).

In the early Cretaceous, more than 100 million years ago, the land that is now Tibet and the Himalayan region, was covered by Tethys Sea which separated Eurasia from the southern continent, Gondwanaland. In the mid Cretaceous the Indian peninsula separated from Gondwanaland and drifted northwards. In the late Cretaceous and early Tertiary, it met the Eurasian continent during which the northern edge of the Indian peninsula slid beneath the Eurasian continent, resulting in the elevation of the Tethys Sea, and the eventual formation of Himalaya and Tibetan highlands (Wadia, 1966).

Biogeography

The formation of the Himalaya was a slow and gradual process, which created numerous habitats and corridors for the dispersal of floral and faunal elements from three major biogeographical realms. Moreover, the great deal of variation in altitude, latitude, topography, rainfall and expositions in the Himalaya have resulted in a unique array of varied habitats and species. The red deer or *Hangul* (*Cervus elaphus hanglu*) and the ibex (*Capra ibex sibirica*) are examples of a Mediterranean temperate inflow while the Himalayan musk deer (*Moschus chrysogaster*), serow (*Nemorhaedus sumatraensis*) and goral (*Nemorhaedus goral*) immigrated from the Oriental temperate region (Rodgers, 1988). A distinct distribution of the larger mammals is another feature of the Himalaya. For instance, takin (*Budorcas taxicolor*) is present only in the Eastern and parts of Central Himalaya; serow occurs from the Eastern Himalaya to as far west as Jammu & Kashmir; goral distribution goes further west into Afghanistan, and the ibex, markhor (*Capra falconeri*) and urial (*Ovis orientalis*) are distributed only in the North West Himalaya (Schaller, 1977).

Today, there are about 10,000 species of vascular plants reported from the Himalayan region, of which nearly 3,500 are endemic and 200 are critically endangered (Rawat 1984). The Himalayan region is also the home for several unique, rare and endemic mammalian fauna. Endangered and charismatic animals are the snow leopard (*Uncia uncia*) and brown bear (*Ursus arctos isabellinus*). The

status of most of the mammals is insufficiently known. Amongst birds, pheasants (17 species and 18 sub-species in India) form one of the most conspicuous groups of indicators, not only for biodiversity but also for habitat quality. Very little information exists on other faunal groups such as reptiles, amphibians, fish and invertebrates

Conservation

Over 51 million people inhabit the Himalayan ranges in India (Anon 1993) The human population in the Himalaya has increased over 170% since 1931 (Moddie 1981) and the resultant impact on forest and wildlife resources, though devastating, is not yet quantified. Large scale habitat loss and destruction due to extension of agricultural lands, construction of developmental projects, livestock grazing, collection of fuel wood, fodder, and medicinal plants, and the poaching of animals, have contributed substantially to the loss of biodiversity in the Himalaya.

To stop the further loss of biodiversity in this fragile ecosystem and in other parts of the country, the Government of India in its National Wildlife Action Plan (Anon, 1983) recognised the need to establish a network of scientifically managed protected areas such as National Parks (NP) and Wildlife Sanctuaries (WS) to cover representative and viable samples of all significant biogeographic sub-divisions within the country This led to a detailed biogeographic classification and to the planning of a protected area (PA) network within the country (Rodgers & Panwar 1988), including the Himalayan region Various Himalayan states have since then made considerable efforts to declare areas as NPs and WSs. Currently there are 92 PAs, including 3 Biosphere Reserves (BRs), 18 NPs, and 71 WSs, in the entire Himalayan region, covering 6% of its total geographic area (Rodgers & Panwar 1988).

The alpine zone (above tree limit) in the Himalaya harbours a wide variety of plants and animals. Plants are characterized by short-stemmed perennial herbaceous growth habits, semi-prostrate shrubs, ferns, lichens and mosses. The alpine meadows are used as summer grazing grounds both by migratory and local pastoralists. About 1.12 million goats and sheep graze in the alpine pastures of the five Himalayan states, as per a 1988 estimate (Lal *et al* 1991). Each year, bare sites of 0.5-1.0 ha are created within the alpine meadows as a result of the camping and trampling by livestock (Ram & Singh 1993). Increasing tourism, pilgrimage and medicinal plant collection also pose a continuous threat to the alpine areas in the Himalaya. These pressures lead to erosion and promote landslides, avalanches and floods posing a grave threat to the ecological stability of the area

Need for Prioritisation of Areas for Conservation

Compared to some other biogeographic zones of India, the Himalaya seems to have a higher percentage of its area under PAs, but this alone may not be enough to secure its biodiversity, considering the ecological variability from west to east, and north to south, the fragility of the ecosystem, and the rapidly growing human and livestock population which puts enormous pressure on the fragile mountain habitat At the same time, quite a few PAs in the Himalaya include rocky and acolian zones devoid of major life forms, which merely add to the geographical area. Presently, over 65% of the PAs in the Himalaya are at altitudes ranging from 2,000 to 4,000m, which is also the most inhabited zone in the Himalaya. Moreover, most of the existing PAs are small and are seriously threatened by human and biotic pressures from within and outside. Chundawat & Rawat (1994) have emphasized the need for planning and declaring large PAs covering wintering ranges so that viable populations of large mammals could be protected.

Wildlife protection and management in the Himalaya suffers due to difficult terrain, remoteness, hostile climatic conditions, lack of funds, low manpower, poor infrastructure, and a lack of motivation amongst the wildlife staff and a lack of political will of the governments. Protection levels are decreasing in most areas due to these factors So far only a few wildlife management plans have been written for the PAs in the Himalaya (Mallon & Bacha, 1989, Pandey, 1990; and Rana, 1995). From the foregoing, it is evident that conservation efforts in the Himalaya are inadequate and need to be improved. Proposals regarding the addition of more areas to certain existing PAs and for the declaration of new PAs, by Rodgers & Panwar (1988), could not be followed up by the State Forest Departments due to various constraints. Fortunately, during the last two decades several ecological studies and wildlife surveys have been conducted in the Himalaya, which have contributed significantly to our knowledge on the conservation of alpine ecosystems. Notable among them are Green (1985), Fox *et al* (1991), Mallon (1991), Chundawat (1992), Sathyakumar (1994a), Manjrekar (1997), Bhatnagar (1997), Mishra (1997) and Kala (1988) Using the data and findings from these and other studies, a very useful exercise can be done to identify key areas for conservation.

The Approach

We adopted the following criteria for prioritizing areas for biodiversity conservation in the alpine zones of the Himalaya:

(i) Large mammalian diversity and abundance
(ii) Vegetation, floral diversity & conservation status of species
(iii) Endemism among plants and animals
(iv) Important catchment areas and river sources
(v) Representative localities of the biogeographic zone
(vi) Gaps in the contiguity of the PA network, in the biogeographic zone

Trans-Himalaya

The rain shadow region lying immediately north of the Great Himalayan ranges and constituting mainly the Tethyan sea bed is referred to as the Trans-Himalaya. It has been classified as the High Altitude Cold Deserts (Zone I) of the biogeographic classification by Rodgers & Panwar (1988). Most of the Trans-Himalayan zone occurs above an elevation of 3,000m and is characterised by low temperatures, high aridity, lack of adequate soil, short growth season and, as a result low plant productivity. Owing to this harsh environment, specialized plants and animals occur in relatively low densities, often in geographically isolated populations, which are vulnerable to local extinction. Of ca. 26 mammal species of Trans-Himalaya, 17 (65%) are included in the Schedule I & II of the Indian Wildlife (Protection) Act 1972 (Anon, 1972), and 15 are listed in the Appendix-I of the CITES. The IUCN recognises two species (snow leopard and wild yak *Bos grunniens*) as endangered, and three (Tibetan wolf *Canis lupes chanco*, brown bear and smooth Indian otter *Lutra perspicillata*) as vulnerable. Apart from these, the region is home to many endangered birds (black necked crane *Grus nigricollis*, bearded vulture or lammergeier *Gyps barbatus*) herpetofauna (*Cyrtodactylus lawderanus*, *Smeella ladacensis tsaglulense*) and plants (*Saussurea bracheata*, *S. gnaphalodes*). Many of the plants are of medicinal value. *Saussurea costus* is used to treat asthma, cough, tooth ache and ulcer; *Humulus lupulus* as wormicide and *Ephedra gerardiana* as a heart stimulant.

Due to relatively low productivity, large mammal species need to range over vast areas and many of them have distinct seasonal ranges. Owing to this and the overall vulnerability of the region, large protected areas are needed to maintain viable populations of most species. Many Trans-Himalayan areas are threatened with excessive grazing by local and migratory livestock (Chundawat & Rawat, 1994).

The Trans-Himalaya covers *ca.* 2.6 million km², of which *ca.* 1,84,000 km² occurs within India. Most of this area occurs in the Ladakh region of Jammu & Kashmir, followed by Lahul-Spiti and Chamba districts in Himachal Pradesh and parts of northern Sikkim (Chundawat & Rawat 1994). Only small pockets of the cold arid zone occur in the Uttarakhand Himalaya, i.e., to the north of the Nanda Devi massif.

With the increased rate of habitat loss and the limited resources available in the country, conservation efforts in this fragile ecosystem need to be more focused in regions with high diversity of representative flora and fauna and/or in regions where populations of threatened/endangered species occur.

Biogeographic Classification

This zone is more extensive outside the Indian territory, mainly in Tibet. In India, this zone is classified into three biotic provinces: (i) Ladakh Mountains covering all the rugged mountainous terrain of Ladakh, (ii) Tibetan Plateau of Ladakh, adjacent to Lahul-Spiti district of Himachal Pradesh, and a few areas north of Nanda Devi Biosphere Reserve in Uttar Pradesh and (iii) Sikkim Plateau, covering the Tibetan Plateau region in north Sikkim (Rodgers & Panwar 1988).

Biological Values

This region is inadequately documented for faunal and floral richness, except Mallon (1991); Fox *et al.* (1991); Chundawat & Rawat (1994); Manjrekar (1997). Some of the 15 mammalian species listed in Schedule I of the Indian Wildlife (Protection) Act 1972 (Anon, 1972) include snow leopard, Tibetan wild ass (*Equus kiang kiang*, *E. k. polyodon*), wild yak (*Bos grunniens*), Tibetan wolf, Pallas cat (*Otocolobus manul*). Botanically, the vegetation of the cold arid region of Himalaya is of interest, with a high level of endemism and occurrence of many medicinal plants, used both traditionally and in the modern system of medicine. The presence of glaciers (e.g., Siachen), marshes (e.g., Sangti) and lakes (e.g., Tso-Moroti) enhance the biological and ecological values of this area.

Existing Conservation Status

In the Trans-Himalayan region, there are two NPs and five WSs covering a total of 10,022 km² (Rodgers & Panwar 1988) which is *ca.* 5.4% of the total area (Table 1). The Hemis and Pin Valley NPs support populations of mountain ungulates and snow leopard. Studies have been conducted in Hemis NP by Chundawat (1992) and in Pin Valley by Bhatnagar (1997) and Manjrekar (1997). No information exists for Changthang and Lipa Asrang WSs on wildlife status. A small portion of the Trans-Himalayan region in U.P. is covered by the buffer zone of the existing Nanda Devi Biosphere Reserve. There are no PAs in the Trans-Himalayan region of Sikkim.

None of the State Governments could declare any of the proposed PA as recommended by Rodgers & Panwar (1988). We advocate that efforts should be made to follow up these recommendations on proposals for new PAs. Recent surveys have identified areas which have potential for wildlife conservation (Shah 1994, Saleem-ul-Haq, Jammu and Kashmir Wildlife Department, *pers.comm*) As not much information exists for most areas, we propose that surveys be conducted in the proposed PAs and other potential areas for identifying and delineating boundaries and to prioritise them for conservation action.

Conservation Proposals

Rodgers & Panwar (1988) proposed three NPs and 11 WSs (Table 1). About 10,113 km² (6% of the total area) would have been added by the implementation of the above proposal The key recommendations are given as follows.

(i) The existing Hemis NP should be extended to 3,300 km² to the east and west to include Shang and Kanji Game Reserves, and to the south to include Khurna valley.

(ii) Karakoram and Ladakh ranges in the Siachen Glacier and Shyok catchment should become a Park/Sanctuary complex of 4,000 km²

(iii) In the south-east of Ladakh, the inland drainage lake areas with wild ass and black-necked crane, was proposed as the Rupshu Cold Desert Park/ Sanctuary, with an area of 2,000 km².

(iv) Chang-Chenmo with Tibetan gazelle (*Procapra picticaudata*) and Tibetan antelope (*Pantholops hodgsoni*), and Daultbeg-Depsang with wild ass and Tibetan gazelle were proposed as Parks of 500 and 300 km² respectively.

(v) The Rangdum Wildlife Reserve with good population of ibex and brown bear should be upgraded to a WS of 200 km².

(vi) Sabu-Chakur Wildlife Reserve, close to Leh, should be a declared as a WS of *ca* 40 km²

(vii) The lower Suru valley wildlife areas should be declared as a WS of 100 km²

(viii) To the south of Hemis the Nunkun Mountains, linking to Dachigam extension area should become a WS This would afford protection to bharal and snow leopard.

(ix) The area to the north of the Chenab River in the Kistwar-Lahul border has important wildlife values which needs to be surveyed and made into a PA.

(x) There are no PAs in the Lahul valley Survey to identify an area containing elements of the Tibetan fauna and flora is required.

Protected areas, as proposed by Rodgers & Panwar (1988) are given in Table 1 Survey would be required to identify the extent and boundaries of these proposed PAs. Fox *et al* (1991) have proposed the reassessment of the current array of proposed PAs by Rodgers & Panwar (1988) to enhance protection of the endangered Ladakh urial and Tibetan argali (*Ovis ammon hodgsonii*)

Apart from the above proposals by Rodgers & Panwar (1988), we suggest the following (Fig. 1):

1 Relict patches of riverine vegetation, forest and scrub in the Trans-Himalaya are to be accorded top priority and declared as 'botanical hotspots' Such hot spots should protect wherever *Juniperus macropoda* patches, which are rare now, occur These riverine patches are very important for lynx (*Felis lynx*), a critically endangered species in India (Chundawat & Rawat, 1994).

2 Recent wildlife surveys in Chang-Chenmo area by Saleem-ul-Haq in Ladakh have resulted in identifying populations of wild yak and potential areas for their conservation. (Johnsingh & Mishra 1997)

3. Surveys have to be conducted in Nubra Valley for identifying potential areas as PAs to conserve species such as Nubra pika (*Ochotona nubrica*), which is considered globally threatened, lynx and relict stretches of riverine habitats, with willow scrub and *Caragana*-Steppe patches.

4. The Zanskar area, rich in wildlife, needs to be surveyed for establishing protected areas. The river Zanskar provides an ideal habitat for ducks and migrating teal *Anas crecca* (Mallon & Bacha 1989). The lower Zanskar and Rumbak valleys are characterised by arid vegetation communities dominated by *Ephedra gerardiana* and *Capparis wightiana* which need to be protected.

5. Sathyakumar *(in press)*, and S.Pandey (Himachal Pradesh Forest Dept. *pers comm*) have reported that Lingti and Ensa Valleys in Spiti hold good populations of brown bear and other wildlife The upper areas of Lingti valley and Ensa valleys have no human habitations. Bharal (*Pseudois nayaur*), wolf and snow leopard (*Uncia uncia*) are reported to occur in Lingti valley, and ibex, and snow leopard are present in Ensa valleys (N. Manjrekar *pers comm*). Surveys would be required to identify extent for proposing new PAs in these valleys.

Shah (1994) during her survey for Tibetan wild ass and other wildlife in the Lachung and Lachen valleys of north Sikkim estimated 74-120 kiang and recorded other mammals such as Tibetan gazelle, bharal, great Tibetan sheep, red fox (*Vulpes vulpes*), wolf, Tibetan woolly hare (*Lepus oiostolus*) and snow leopard.

We suggest that surveys be conducted to assess the feasibility of proposing new PAs in these two valleys. This would be necessary as there are no PAs in the Trans-Himalayan region of Sikkim and conservation action would be required to minimize destruction due to developmental activities, such as road construction (Sathyakumar 1999).

Alpine Zone in the Greater Himalaya

The treeless zone between the *treeline* and *snowline* comprising the meadows, pastures, scrub and rocks is considered the *alpine zone*. This zone is rich in biodiversity, high in productivity and is a treasure of a large variety of medicinal plants. The alpine zone is not uniform belt along the entire stretch of the Greater Himalaya. As the mean elevation of the *treeline* is at 3,300±200 m in the North Western and Western Himalaya, the alpine zones are more extensive when compared to the Central and Eastern Himalaya, where the mean elevation of the *treeline* is 3800±200 m. As in the Trans-Himalaya, the environmental conditions are very severe and hence only stunted scrub, meadows, pastures and a few plants in the moraines and glaciers exist. Although the alpine zone is under snow for about 4 to 6 months and has a short growth season, it is highly productive and supports large populations of wild and domestic ungulates. Species such as bharal, Himalayan tahr (*Hemitragus jemlahicus*), Himalayan musk deer (*Moschus chrysogaster*), brown bear, red fox and the Himalayan monal (*Lophophorus impejanus*) depend substantially on the alpine zones of the Greater Himalaya for their survival.

About 2500 plant species have been reported from the alpine zones of the Greater Himalayas of which *ca.* 200 are highly endangered, >100 are threatened, and more than 300 species are used for medicinal purposes (Rau, 1975). Due to extreme cold climatic conditions and short growth period, regeneration is poor and pressures such as livestock grazing and medicinal plant collection have resulted in serious threats to the alpine flora in the Greater Himalaya.

Biogeographic Classification

The alpine zone in the Greater Himalaya along with the sub-alpine and temperate zones of the Himalaya constitute the Biogeographic Zone 2 (Rodgers & Panwar 1988). Of the total 2,03,912 km² covered by this Zone, 17,642 km² (*ca.* 9%) constitute alpine zones (Rodgers & Panwar 1988; Lal *et al.* 1991). Due to the differences in geographical locations of different regions of the Greater Himalaya on an east-west axis, climatic variations have led to distinct zonation based on biogeography. Based on this criteria, Rodgers & Panwar (1988) have categorised the Himalaya into four bio-units, viz., North West Himalaya (2A) covering Kashmir to Sutlej in Himachal Pradesh, characterised by Mediterranean climate with western taxa such as ibex ; Western Himalaya (2B) from Sutlej to Gandaki in Nepal, dry in nature and with a mixture of western and eastern species such as deodar (*Cedrus dodara*), hemlock spruce (*Tsuga brunoniana*), brown bear; Central Himalaya (2C) from Gandaki through West Bengal and Sikkim to Central Bhutan with moist climate and western elements (tahr and red panda *Ailurus fulgens*); and Eastern Himalaya (2D) from central Bhutan to eastern Arunachal Pradesh with moist and warmer conditions with Chinese taxa (e.g, takin).

Biological Values

The richness of the alpine zones of the Greater Himalaya is well documented, (eg. Rawat, 1984; Ram *et al.* 1988; Kala *et al.* 1997). The alpine areas in the Greater Himalaya are very rich in flora. About 90 species of alpine flora are listed in the Red Data Book of Indian Plants, (Nayar & Sastry 1990). Some of the species of global importance include *Saussurea obvallata*, *Meconopsis aculeata*, *Nardostachys jatamansi*, *Picrorhiza kurrooa*, *Aconitum heterophyllum*, *Parnassia nubicola*, *Boschniackia himalaica*, *Falconeria himalaica*, *Cireaeaster agrestis* and *Eremurus himalaicus*. Most of the medicinal plants grow only in the alpine areas. A few species of bush warblers (large bush warbler, *Cettia major*; olivaceous leaf warbler, *Phylloscopus griseolus*, pipits (vinaceous breasted pipit, *Anthus roseatus*) and accentors (robin accentor, *Prunella rubiculoides*) are exclusive species of alpine habitats.

Existing Conservation Status

In Zone 2, there are 12 NPs and 21 WSs covering 42,735 km² (Rodgers & Panwar 1988) of which alpine areas constitute only a small proportion and most of the area includes subalpine and temperate forests (Table 2). Excepting a few PAs such as Nanda Devi NP and Valley of Flowers NP, where alpine areas are inviolate, all other alpine areas are extensively used by local villagers and pastoral communities. The present status of alpine areas in Jammu & Kashmir is not known due to insurgency. PAs such as Dachigam NP, Overa-Aru, and Kistawar WSs are believed to afford protection to alpine habitat and fauna, such as hangul, brown and black bears (*Ursus thibetanus*). In Himachal Pradesh, the Great Himalayan NP, Kais WS, Tundah WS, and Kugti WS are reported to have brown bear- an indication of good alpine habitat. Alpine areas of Govind Pashu Vihar are in a poor state due to extensive

livestock grazing largely by *Gujjars*. Most of the alpine areas in Garhwal suffer due to pilgrimage and tourism. In Sikkim, apart from Khangchendzonga NP, the existing status of wildlife habitats in the alpine area is not known. In Arunachal Pradesh, PAs such as Namdapha NP, Mouling NP, Mehao NP, and Kamalang NP extend up to the alpine areas. Developmental projects, particularly construction of roads in Sikkim, pose a serious threat to the conservation of alpine areas.

Conservation Proposals

Rodgers & Panwar (1988) proposed 10 NPs and 18 WSs, including extensions to some existing PAs, for alpine areas throughout the Himalaya (Table 2). About 14,042 km², (7% of the total area), would have been added by the implementation of the above proposal. However, most of the proposed PAs cover substantial temperate and subalpine forested areas and though the actual extent of alpine areas is not known, it is believed to be a small proportion. It was not feasible for the concerned state Governments to implement all the proposals for new PAs in this zone, as proposed by Rodgers & Panwar (1988) due to several reasons. For instance, the proposals for new PAs (Dodital and Yamunotri WSs) in the Uttarakhand region were not acceptable to the State Government. (Bhaduria, former Chief Wildlife Warden, Uttar Pradesh *pers. comm.*). Similarly, some areas suggested as extensions to existing PAs and proposals for new PAs could not be implemented as they either had extensive use by human and livestock or by both. Insurgency and political instability also contributed to the inability to establish the PAs recommended. Preliminary notification has been done for a few PAs such as Dibang WS in Arunachal Pradesh (Pratap Singh, Arunachal Pradesh Forest Dept. *pers. comm.*) We recommend the following to enhance the conservation status in alpine areas (Fig 1 & 2).

North Western Himalaya

(i) Dachigam NP should be extended to the north-west This extension covers part of the hangul's summer range and would link up to the proposed Nunkun mountain WS (Ref. viii of conservation proposal for Trans-Himalaya)

(ii) Overa-Aru and Gulmarg should be notified as WS. Overa-Aru should be extended by 100 km² to link up with the Ladakh wildlife areas near Nunkun

The Pir Panjal should be declared a WS of 100 km². The Gamgul WS in Himachal Pradesh and the adjacent forest area in J&K should be given a sanctuary status which can be an alternate home for the hangul. The above three proposals have already been made by Rodgers & Panwar (1988).

In addition to the above, we suggest the following:

1. Most of the upper catchments of major rivers and their sources such as Badrinath, Gangotri, Yamunotri are pilgrim centres in the North west and Western Himalaya They should be protected The oak forests (*Quercus semecarpifolia*) around the southern fringes of Gangotri WLS are reported to have an isolated population of tiger. Efforts should be made to explore the possibility of motivating the priests of the temples and the pilgrims to play a role in their conservation.
2. The Great Himalayan NP should be extended towards Kanawar WS to include alpine, sub-alpine and temperate habitats in order to make a large contiguous conservation unit to benefit Himalayan musk deer, Himalayan tahr, Himalayan monal and Western Tragopan (*Tragopan melanocephalus*)
3. Surveys should be conducted in Bara Banghal in HP, which is west of Manali, to assess wildlife status.

Western Himalaya

We re-emphasise the following proposals made by Rodgers & Panwar (1988) with justification

64 km² of existing wildlife habitat south west of Rupi-Bhawa WS should be added to make it 189 km²

Declaration of Yamunotri WS, for reasons mentioned in 1 for north west Himalaya.

Dodital is facing serious threats from increased visitation by tourists and anglers, as this water body holds a good population of introduced trout Moreover, the adjacent oak patches provide a home to endangered musk deer and pheasants. Dodital and the surrounding forest areas need a sanctuary status.

Kedarnath WS should have a core area of 300 km² as NP 100 km² of *Kharshu, (Quercus semecarpifolia)* and *Moru, (Q. dilatata)* habitat from adjacent Trishula RF (500 km²) should be added to Kedarnath WS.

In addition to the above, we suggest the following areas

1. The alpine areas between Govind Pashu Vihar WS in UP and Sangla WS in HP should be declared as a protected area which would result in a large conservation unit at the interstate boundary. It has elements of both the north west and western Himalaya as it is located in the transition zone (Sathyakumar, *in press*).
2. Surveys are required to identify areas north of Askot WS and Panchchuli basin as protected areas.

Central Himalaya

The following proposals made by Rodgers & Panwar (1988) should be prioritised due to the reasons mentioned.

Khangchendzonga NP is recommended to be extended in the north by 97 km² to include high altitude wildlife areas. It is recommended to create Tolung WS (230 km²) and Dzongri WS (468 km²), adjacent to the Park, in the catchment area of Teesta river

Nimphu WS (167 km²) is proposed in north-east Sikkim, which will be contiguous with protected forests in Bhutan. Apart from significant populations of tahr, bharal and snow leopard, there have been reports of Mishmi takin in the area, which could be the western most occurrence Besides, a small population of the endangered Sikkim stag (*Cervus elaphus wallichi*) is reported to range in this area (Ajay Rastogi, ICIMOD, Nepal *pers comm*)

Pangola NP (108 km²) is proposed in the south-east of Sikkim, bordering Bhutan and West Bengal.

A 21 km² extension is proposed for the Kyongnosla Alpine WS which will protect habitat for pheasants, musk deer, and red panda.

In addition to the above, we suggest that there should be Trans-frontier Reserves protecting :

Chumbi valley between Bhutan and India and Areas between Sikkim and Tibet surveys are needed in the above two areas.

Eastern Himalaya

We re-emphasise the proposals made by Rodgers & Panwar (1988) in Arunachal Pradesh, with additional information.

1. Walong in Lohit valley should be protected with an area of 1500 km² which can improvethe conservation status of Temminck's tragopan (*Tragopan temminckii*). Mishmi blood pheasant (*Ithageinus cruentus kuseri*), red goral (*Nemorhaedus baileyi*), serow, takin and red panda.
2. Final notification for Dibang NP in Dibang valley should be given. This area has the floral and faunal attributes of Walong.
3. A Park-Sanctuary unit of 600 km² is proposed at Tawang, in the north-west of Kameng, bordering Bhutan. This area has bharal, snow leopard and satyr tragopan (*Tragopan satyra*).
4. More surveys are needed in the alpine areas of Arunachal Pradesh.
5. A Trans-frontier Reserve, to protect areas between India, Tibet and Myanmar, is suggested which may protect species such as takin, and snub-nosed monkey (*Rhinopithecus roxellanae*).

Priority Areas for Conservation

Having done the above exercise, we would identify the following areas for priority conservation Hemis National Park (in Jammu & Kashmir; 1500 km²; for bharal, urial, argali, and snow leopard), Pin Valley National Park (Himachal Pradesh; 675 km², ibex and snow leopard) and Karakoram-Chang-Chenmo wildlife sanctuaries (Jammu & Kashmir; 4000 km²; bharal, urial, and snow leopard) are the areas identified in the Trans-Himalaya. In North-West Himalaya we identify Dachigam National Park (Jammu & Kashmir; 141 km², hangul, black bear, and brown bear), Great Himalayan National Park (Himachal Pradesh; 765 km²; tahr, bharal, musk deer, second known population of western tragopan and snow leopard) and Kistwar National Park (Jammu & Kashmir; 400 km²; brown bear) The areas identified in the western Himalaya are Nanda Devi National Park (Uttar Pradesh, 650 km², bharal, tahr, snow leopard, World Heritage Site), Kedarnath Wildlife sanctuary (Uttar Pradesh, 975 km², mountain ungulates and pheasants) and Valley of Flowers National Park (Uttar Pradesh, 88 km², floral diversity). In the central Himalaya only Khangchendzonga National Park (Sikkim, 850 km²), which with the proposed extension can support Trans-Himalayan flora and fauna, is recommended. In the eastern Himalaya (Arunachal Pradesh) we suggest that the entire temperate, sub-alpine and alpine habitats, which may be free from severe biotic pressures, would need special conservation attention in the form of surveys and protection from unplanned development and poaching.

Summary and Recommendations

The forgoing account clearly indicates that biodiversity conservation in the Himalaya cannot be restricted only to the network of PAs or other prioritized areas. Most of the areas outside PAs such as Reserve forests, village forests, agriculture/farm lands, pastures, orchards, human inhabitations and waste lands, by their interspersion and juxtaposition, form wildlife habitats and corridors which are crucial for the survival and dispersal of many species. In fact, there exists a strong case for planning and executing conservation efforts by considering the entire stretch of the Himalayas as a large Biosphere Reserve, where PAs can serve as core areas and other areas outside PAs as buffer and multiple use zones. Evolving a policy for the conservation of the Himalaya, which provides water to over 300 million people in the Gangetic plains, is to be accorded top priority. This should be followed by a conservation strategy that would involve intensive protection and management inputs for the PAs and regulation of wildlife resource utilization in other areas, in a sustainable manner. Rawat *et al* (1996)

have proposed that the conservation plan for the Himalaya should aim at minimising people-park conflict through rational resource use, education, ecodevelopment and avenues for self employment.

Four major threats viz., livestock grazing, tourism and development, medicinal plant collection and poaching need to be addressed for the conservation of biological resources in the Himalaya.

The ever increasing livestock population in the Himalaya pose a serious threat for long term conservation in the Himalaya. Mishra (1997) reported an increase of 38% in livestock holdings in the last decade, in the three villages sampled in Kibber WS, in the Trans-Himalaya. Recent changes in lifestyle and the growing economy have added new dimensions to this problem. Most of the grazing lands in the Himalaya are now being grazed by a larger number of livestock for a longer duration of time. Even in PAs such as Pin Valley NP, migratory graziers bring in more livestock than what is permitted by the Wildlife Department (Manjrekar, 1997). This not only reduces the food available for the wild ungulates during late autumn and early winter, but also retards productivity in the following years due to cumulative impacts of over grazing, tramping and weed proliferation (Sathyakumar *et al.* 1993). Total ban of livestock grazing in selected areas is strongly recommended not only for conserving areas of high biological value but also to act as control sites for monitoring and research, as in the case of Nanda Devi NP (Sathyakumar, 1993). Rotational grazing should be put to practice. Regulation of livestock numbers and duration of time spent in the grazing areas are also other practical solutions.

Uncontrolled tourism and developmental projects have contributed substantially to the destruction of wildlife resources in the Himalaya. Most of the pilgrim centres are located at the river sources or at the upper catchment areas, which are visited by thousands of pilgrims during the season. In order to cater to this growing pressure from tourism and pilgrimage, a substantial amount of fuel wood, fodder and other non timber forest produce are collected from the forest, year after year. Associated impacts include construction and maintenance of roads, bridges, grazing by mules and horses, and garbage accumulation. The possibility of involving the temple authorities and the pilgrims in the conservation of these areas, as is done by some Buddhist religious places and monks, should be explored and advocated.

Construction of roads in the high Himalayas has been a serious threat, as in the case of northern Sikkim where para military forces have caused extensive habitat destruction while making roads. (Sathyakumar, *1999*). Moreover, whatever relict sparse vegetation is available it is used as firewood as a part of the road construction activities. Under normal conditions in the Himalaya, 11 tonnes of wood per km of tar road are used during the construction phase (Baurman 1990). This is of special concern when construction takes place in areas of relict vegetation and high diversity.

Traditionally, local people in the Himalayan region have been extracting medicinal herbs for their own use. The invasion of the market economy has resulted in an uncontrolled exploitation of medicinal plants. This threat to the alpine flora needs to be controlled or regulated. A total ban would be required for a few areas of global significance, like the Nanda Devi NP. Regulation and monitoring of medicinal plant collection is essential in all other areas. Cultivation of medicinal plants has been of very little success in a few areas. Transfer of scientific knowledge on artificial propagation of these medicinal plants from trained cultivators to the common man, and financial support from Governments and NGOs, through ecodevelopment, are major needs.

Poaching in the Trans-Himalaya is relatively less as compared to the Greater Himalaya, because most of the local people in this region are Buddhists and do not kill animals. Poaching in the trans-Himalaya is largely by the para-military personnel who use or lend their sophisticated fire arms for killing mountain ungulates, mostly for meat and occasionally for trophy (Dr M.K. RanjitSinh, Director, WWF-Tiger Conservation Programme, *pers. comm.*) Poaching is a serious problem in the Greater Himalaya as the local people poach on mountain ungulates and pheasants, wherever possible. Strict anti-poaching measures need to be taken up by having a team of well paid, well equipped and motivated wildlife staff. Conservation education and wildlife tourism are the other options available to counter this problem. We should also debate and decide whether promotion of sport hunting, which should benefit local people, can help us control poaching, which is rampant now. We conclude with a plea that the conservation areas mentioned in 3.2.5 would need special protection to safe guard their ecological, floral, and faunal values.

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Table 1: Existing and Proposed* PAs in the Trans-Himalaya Biogeographic Zone in India

State	*Bio.Zone*	*Existing PAs*	*Size (km²)*	*Proposed PAs and extension to existing PAs*	*Size (km²)*
J & K	1 A	Hemis NP	1500	Hemis WS	3,300
		Karakoram WS	3000	Karakoram NP	2,000
		Pin Valley NP	675	Kanji WS	300
		Over-Aru WS	425	Rangdum WS	550
				Lower Suru WS	100
				Boodh karbu WS	80
				Sabu-Chakur WS	70
				Gya-Miru WS	340
				Tongri WS	70
				Lungnag WS	1,000
				Rizong-basgo WS	400
HP	1 A			Pandrabis WS	575
				Srikhand NP	478
Total	109268	2 NP, 2 WS	5600	1 NP, 11 WS	9313
J & K	1 B	Changthang WS	4,000	Chang-Chenmo NP	500
		Kibber WS	379	Daultbeg-Depsang NP	300
SIK	1 B	Singba WS	43	Nimphu WS	167
				Chho Lhamo NP	200
				Tawang NP	300
				Tawang WS	300
				Walong NP	300
				Walong WS	300
Total	74627	3 WS	4422	5 NP, 3 WS	2367
Grand Total	183895	2 NP, 5 WS	10022 (5.4%)	6 NP, 14 WS	11680 (6.35%)

* Rodgers & Panwar (1988): PAs=Protected Areas: NP= National Park: WS= Wildlife Sanctuary: GR= Game Reserve.

Table 2: Existing and Proposed* PAs in the Himalayas Biogeographic Zone in India

State	*Bio.Zone*	*Existing PAs*	*Size (km²)*	*Proposed PAs*	*Size (km²)*
J&K	2 A	Dachigam NP	141	Khandadar WS	50
		Kistwar NP	400		
		Gulmarg WS	180		
		Overa WS	32		
		Limber WS	26		
		Lachipora WS	80		
		Hirapora WS	110		
HP		Kanawar WS	54		
		Shikari Devi WS	214		
		Manali WS	32		
		Kugti WS	379		
		Nargu WS	279		
		Tundah WS	64		
		Gamgul Siahbehi WS	109		
		Sechu Tuan Nala WS	103		
		Great Himalayan NP	765		
		Kais WS	15		
		Rupi Bhaba WS	125		
		Khokhan WS	14		
		Lipa Asrang WS	31		
Total	68,822	3 NP, 16 WS	3043	1 WS	50
HP	2 B	Darangati WS	42	-	-
		Sangla WS	650		
		Talra WS	26		
		Churdhar WS	56		
UP		Nanda Devi NP	650	Pindari WS	200
		Valley of Flower NP	88	Dodital WS	100
		Gangotri NP	2390		
		Govind Pashu Vihar WS	481		
		Kedarnath NP	975		
		Ascot Musk Deer WS	600		
Total	50,477	4 NP, 5 WS	5958	2 WS	300
SIK	2 C	Khangchendzonga NP	850		
		Kyongnosla WS	31		
		Tolung WS	468		
		Dzongri WS	108		
		Pangola NP	230		
WB		Singalila NP	78	-	
Total	52710	2 NP, 1 WS	959	1 NP, 4 WS	806
AP	2 D	Namdapha NP	1,985	Lado WS	500
		Mouling NP	483		
		Mehows NP	282		
		Kamlang WS	783		
		Dibang WS	4149		
Total	79334	3 NP, 2 WS	7682	1 NP, 1 WS	500
Grand Total	203912	12 NP, 24 WS	17642 (9%)	8 WS	1656 (0.812%)

* Rodgers & Panwar (1988): PAs=Protected Areas; NP= National Park; WS= Wildlife Sanctuary; GR= Game Reserve.

Appendix

Reference points for Figures 1 and 2.

(i) Existing PAs.

Bio.zone	*State*	*PAs*	*Reference points.*
1A	J&K	Hemis NP	1
		Karakoram WS	2
		Overa-Aru WS	3
	HP	Pin Valley NP	4
1B	J&K	Changthang WS	5
	HP	Kibber WS	6
2A	J&K	Dachigam NP	7
		Kistwar NP	8
		Gulmarg WS	9
		Overa WS	10
		Limber WS	11
		Lachipora WS	12
		Hirapora Ws	13
	HP	Kanawar WS	14
		Shikari Devi WS	15
		Manali WS	16
		Kugti WS	17
		Nargu Ws	18
		Tundah WS	19
		Gamgul Siahbehi WS	20
		Sechu Tuan Nallah WS	21
		Great Himalayan NP	22
		Tirtan WS	23
		Kais WS	24
		Rupi Bhaba WS	25
		Lipa Asrang WS	26
2B	HP	Daranghati WS	27
		Sangla WS	28
		Talra WS	29
		Churdhar WS	30
	UP	Nanda Devi NP	31
		Valley Of Flowers NP	32
		Gangotri NP	33
		Govind Pashu Vihar WS	34
		Kedarnath WS	35
		Askot Musk Deer WS	36
2C	SK	Khangchendzonga NP	37
		Kyongmosla WS	38
	WB	Singalila NP	39
2D	AP	Namdapha NP	40
		Mouling NP	41
		Mehows NP	42
		Kamlang WS	43
		Dibang WS	44

(ii) Proposed PAs (Rodgers & Panwar, 1988).

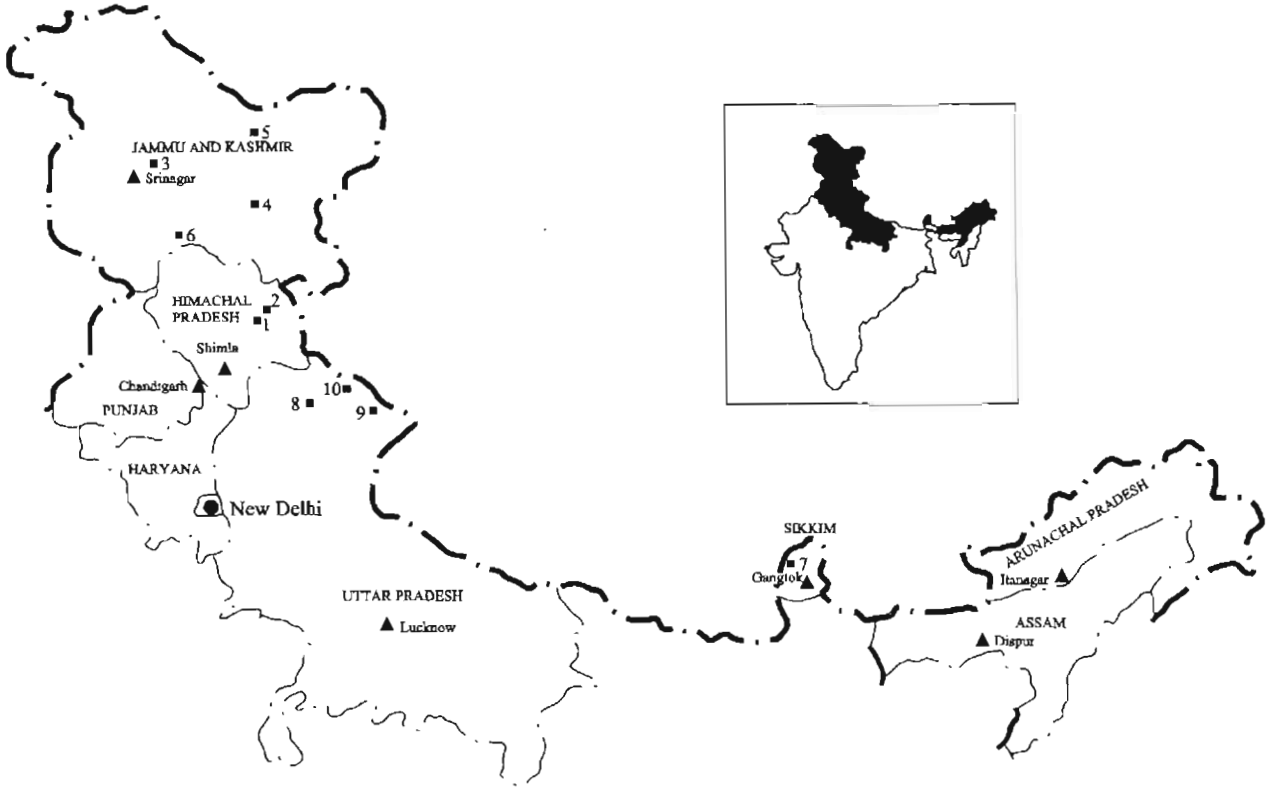
Bio.zone	*State*	*Proposed PAs*	*Reference points.*
1A	J&K	Hemis NP	1
1A	J&K	Rangdum WS	a
		Kanji WS	b
		Lower Suru WS	c
		Boodh Karbu WS	d
		Sabu Chakur WS	e
		Giya-Miru WS	f
		Tongri WS	g
		Lungnag WS	h
		Rizong-basgo WS	d
	HP	Pandrabis WS	i
		Srikhand WS	i
1B	J&K	Chang-Chenmo WS	j
		Daultbeg-Depsang WS	k
2A	SK	Nimphu WS	l
		Chho-lhamo NP	m
		Badamtan, Kitam	n
	J&K	Khandadar	o
2B	UP	Pindari WS	p
		Dodital WS	q
2C	SK	Tolung Ws	r
		Dzongri WS	s
		Pangola WS	t
2D	AP	Lado WS	u
		Tawang	v
		Walong	w

(iii) Suggested PAs (by this study).

Bio.zone	*State*	*Name*	*Reference points.*
1A	J&K	Nubra valley	I
1A	J&K	Zanskar area	II
1B	HP	Lachung & Lachen valley	III
		Riverine and relict patches of Juniper forest	
1A	HP	Lingti & Ensa valley	IV
2A		Bara Banghal	V
2A		Extension of Kanawar	VI
2B	UP	Area north of Askot (Panchchuli basin)	VII
		Alpine area between Govind WS (UP) & Sangla WS (HP)	VIII
1B	SK	Chumbi valley	IX
		Area between Sikkim and Tibet	X
2D	AP	Junction of India, Tibet and Myanmar	
		Temperate, sub-alpine and alpine habitats need special conservation attention	XI

J&K=Jammu & Kashmir; HP=Himachal Pradesh; UP=Uttar Pradesh; SK=Sikkim; AP=Arunachal Pradesh; WB=West Bengal.

BCPP PRIORITY SITES IN THE INDIAN MAINLAND (TRANS AND GREATER HIMALAYAS)



Legend

- International Border
- State Border
- Coastline
- National Capital
- State Capital
- BCPP Priority Site

Note: The entire trans and greater himalayan region in Arunachal Pradesh was highlighted as a priority. However, since no specific site was mentioned as a priority site, none have been plotted.

In addition, Chang-Chemo, a site in Jammu and Kashmir, has not been plotted since its exact location is not available.

HIMACHAL PRADESH
1 - Great Himalayan National Park
2 - Pin Valley National Park

JAMMU AND KASHMIR
3 - Dachigam National Park
4 - Hemis National Park
5 - Karakoram Sanctuary
6 - Kishtwar National Park

SIKKIM
7 - Khangchendzonga National Park

UTTAR PRADESH
8 - Kedarnath Sanctuary
9 - Nanda Devi National Park
10 - Valley of Flowers National Park

MAP PREPARED BY THE INDIAN INSTITUTE OF PUBLIC ADMINISTRATION

Prioritisation of Forests for the Conservation of Biodiversity in India: A Methodological Framework

Raman Mehta

The concept document of the Biodiversity Conservation Prioritisation Project (BCPP) recognised forests as one of the ecosystems to be prioritised within the sites subgroup. Due to the enormity of the task, and a paucity of data, it has not been possible to do a detailed prioritisation. An attempt is being made here to try and demonstrate two different types of methodologies which could be used in future to try and prioritise biodiversity rich forest sites.

The objectives of the forest prioritisation component of the BCPP were:

(1) To prioritise sites and stretches of Indian forests on the basis of their biodiversity and socio-economic value.
(2) To evolve a rapid and participatory methodology for the prioritisation of Indian forests

Process of Evolving the Methodology

Initially, the methodology for prioritising Indian forests was formulated through a process of formal and informal meetings with several experts within and outside the country, affiliated to organisations like the Indira Gandhi National Forest Academy (IGNFA), the Forest Survey of India (FSI), the Forest Research Institute (FRI), the Wildlife Institute of India (WII), the Food and Agriculture Organisation (FAO) and the World Resources Institute (WRI). It also underwent changes as it was realised that many of the assumptions, which one had started out with, were not true.

The broad framework of the methodology was evolved during the BCPP project design workshop held in April, 1996, at New Delhi. Subsequent discussions, as outlined above, led to the formulation of the following methodology.

(1) The optimal crown cover density for the different forest types and sub-types, as specified by Champion and Seth (revised classification), would be determined.
(2) Crown cover density maps would be prepared separately for each state indicating only those areas which have an optimal crown cover for each of the forest types.* These maps will mark out the different forest types and sub-types and also the different biogeographic zones.
(3) These data will then be discussed with experts in, and for, each state, including with knowledgeable NGOs, to demarcate those areas which are actually undisturbed or minimally disturbed, and have a high biodiversity value.
(4) Detailed species lists of flora and fauna will then be compiled for the demarcated areas using various sources including forest working plans, FSI inventories, listings of the Botanical and Zoological survey of India etc.
(5) Based on the compiled lists, priorities will be allocated to the sites.
(6) The prioritisation will then be analysed in terms of socio-economic and ease of conservation aspects and a revised list of priorities developed. Data on these aspects will be collected separately.
(7) This list will then be discussed at state levels and with selected local communities, and again revised, if required, to accommodate the views expressed in such discussions.
(8) The list that emerges from this process will then be discussed at a national seminar and finalised

There was, however, a change in the methodology detailed above because:

(1) The ICFRE, which had agreed to carry out the prioritisation exercise, pulled out unexpectedly. This

*The assumption here is that any forest area that has less than an optimal crown cover density would be degraded and therefore be unlikely to have the best possible biodiversity profile (though the converse is not necessarily true). Here it must be remembered that only natural biodiversity is being valued and introduced and exotic species are not being considered.

However, by this method, at least some sites which harbour unique ecosystems and species, or are the last representative sites of their type, even if degraded, would be excluded. These would have to be identified separately

led to two problems. One, the BCPP Steering Group had to start looking for another agency/individual which would be willing to take up the task of forest prioritisation. And two, access to the data of the FSI as well as FRI which one was assuming would be made available, became more difficult. This led to an unanticipated loss of time, and not much progress could be made for several months.

(2) It was found that defining the "optimal crown cover density for each forest type" was not easy and data on this aspect was not available. Therefore, it was decided to use the more easily applicable notion of prioritising from all those forests having a crown cover density of 40% or above, irrespective of the forest type.

(3) It was found that detailed data regarding the distribution of fauna and flora species in forests across the country were not available. Also, whatever data were available, were not comparable across sites. One would, therefore, have to rely on indirect indicators.

(4) Earlier it had been assumed that biodiversity values to forest sites would be ascribed in the following manner:

   (a) The site with the greatest number of species would be given the top priority.
   (b) The site that adds the maximum number of species to the top priority site would become the next priority, and so on.
   (c) After priorities have been formed on this basis, the list of prioritised sites would be checked to ensure that other relevant values are also appropriately reflected in the prioritised list. These values would include:
      (i) representativeness
      (ii) uniqueness
      (iii) naturalness
      (iv) link with other valuable areas
      (v) potentially valuable but unstudied areas

However, because of the problems of the lack of data on occurrence of species in forest areas and the problems with comparability between the available species data of different sites, this method could not be followed. It was then decided to try and ascribe the biodiversity values to forest sites in another manner. It was assumed that each forest area started off being equally valuable. However, the disturbance to the habitat over the years would have led to a decline in its biological value. It was decided to try and establish how much of a difference these disturbances would have made to the natural species composition of a forest, and thereby get a picture of its relative value with respect to other forests.

Based on the above, a revised methodology for the prioritisation of forests was formulated. This is detailed below:

(1) To digitise and prepare, using the FSI Forest Cover Maps on a scale of 1:250,000 as a source, maps for each Indian state showing forests having a crown cover density of 40% or above.

(2) To mark on these maps, the boundaries of all forest divisions as well as national parks and sanctuaries.

(3) To identify, with the help of a matrix (attached at Annexure – A), the relative biodiversity richness of the forest ranges located in divisions (excluding national parks and sanctuaries) having forests with a crown cover density of 40% or above. This matrix will be used to get information from knowledgeable people, both in the government and outside, on the biodiversity value of each range/division.

(4) To preliminarily prioritise forest divisions (excluding national parks and sanctuaries) on the basis of information collected through the matrix mentioned above to ascertain the relative biodiversity richness of forest areas.

(5) To discuss the prioritised sites thus identified with forest officers and others, state by state, through a series of meetings.

(6) To assess consumptive as well as non-consumptive use values of the prioritised forest divisions, through a study of working plans and discussions with officers and others and through sample field visits.

(7) On this basis, to develop a final set of priorities.

After the completion of state-level forest cover maps showing dense forests having a crown cover density of 40% or above, these were sent to all the state governments for demarcating the boundaries of forest divisions as well as national parks and sanctuaries in each state. In addition, the matrix shown at annexure – A was also despatched to all the states. However, due to a lack of adequate response from the states, there was a further deviation in the methodology outlined above. Instead of using the matrix attached at annexure – A, and also to see whether the maps which had been developed were useful or not, it was decided to analyse the level of disturbance in forest areas through a perusal of the working plans of two forest divisions in North Bengal viz; the Darjeeling and the Kalimpong Forest Divisions. This was primarily done by looking at the compartment history as well as other information like stock maps etc. given in the working plans for each forest compartment of the above mentioned forest divisions. A table, similar to the matrix given at Annexure – A, was constructed for each forest division. Those blocks, which were found to be less disturbed than the other blocks, and also not having any plantations were identified on the maps of the two forest

divisions. These block level maps were then overlayed on the blowups of the forest cover map of West Bengal to mark out the boundaries of the divisions and the less disturbed ranges, blocks etc. to identify biodiversity rich forest areas. In each case it was found that the biodiversity rich forest blocks were contained within the areas that had a crown cover density of 40% or above.

However, when an effort was made to use this method for other states and divisions, another problem surfaced. One found that there was no single source from where the required working plans could be procured. The largest collection of working plans was found to be available in the Central Library, Indian Council for Forestry Research and Education, Dehradun. Even here though, the volumes of the working plans containing maps and compartment histories were not available.

Therefore, another method which is being detailed below, has been used to do a preliminary prioritisation of forests in a few Indian states:

(1) Took up state-level maps developed by the IGCMC, WWF-India, for the BCPP, showing forest areas having a crown cover density below and above 40%.
(2) Overlayed the boundaries of protected areas (PAs) that were available for each state on the forest cover maps mentioned above.
(3) Marked out possible priority forest sites for biodiversity conservation in each state on the basis of the following criteria:
   (a) All isolated forest patches having a crown cover density of 40% or above.
   (b) All forest patches, preferably those having a crown cover density of 40% or above, adjoining PAs.
   (c) All forest patches, preferable those having a crown cover density of 40% or above, which connect two or more PAs with each other.
   (d) Relatively undisturbed patches of forests with a crown cover density of 40 or above, located within relatively large, unprotected, forest tracts.

The results of the above mentioned exercise for a few Indian states are shown below. It must, however, be emphasised that the priority sites identified are very tenuous and need to be discussed with a larger group. In addition, additional field level information needs to be collected to verify and support the results of this exercise.

ANNEXURE A

Matrix for Determining the Level of Disturbance of Forest Ranges

In order to assess the biodiversity profile of forest ranges having forest crown cover of 40% or above, it is important to document the management activities and other pressures that might have led to changes in its natural species composotion The matrix given below helps in doing so:

Name of the Range	*Area of the Range (sq. km)*	*Percentage of forest cover in the range which is*[1]				*Principle cause of disturbances*[2]
		Category A (Completely undisturbed)	*Category B (Slightly disturbed)*	*Category C (Heavily disturbed)*	*Category D (Plantations)*	

[1]The categories A, B, C, and D are defined as follows:

A Those forest ranges which are completely undisturbed as they have not been subjected to any forestry operations and human pressures including non-forestry land use like mining and quarrying, habitation, or some other developmental activities, biotic pressures like grazing, NTFP collection etc., and habitat related factors like forest fires or floods and retain their natural species composition

B. Those forest ranges which are subject to some disturbance and show a slight change in their natural species composition

C. Those forest ranges which are heavily distrubed and where there is a significant alteration of their natural species composition

D Those forest ranges which have either been clear felled and planted, or where the predominant vegetation cover is planted.

[2]Please list here the principle causes of disturbances in the range you are responding about and reasons for the same.

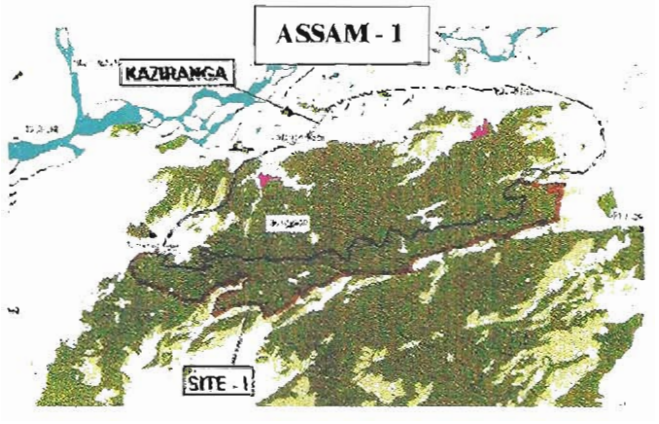
PRIORITISED FOREST AREAS IN ASSAM

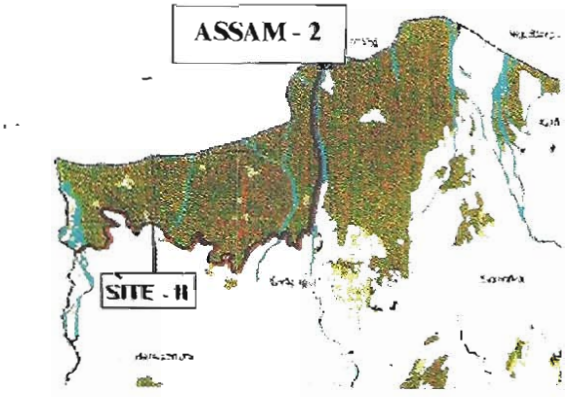
The prioritised forest areas of Assam are being shown below. The justification of their selection is as follows:

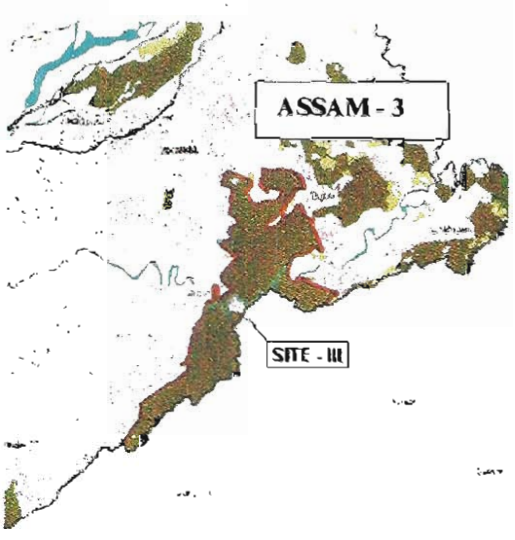
Site I: Forest patch adjoining the Kaziranga National Park along its southern boundary. The area of this site is approximately 387 sq. km.

Site II: Forest corridor between Manas Tiger reserve and the Buxa Tiger Reserve in West Bengal. The area of this site is approximately 548 sq. km.

Site III: Isolated patch of forest in North Eastern Assam. The area of this site is approximately 467 sq. km.

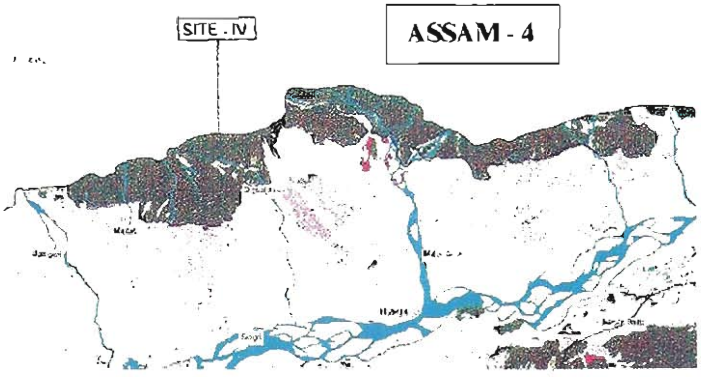


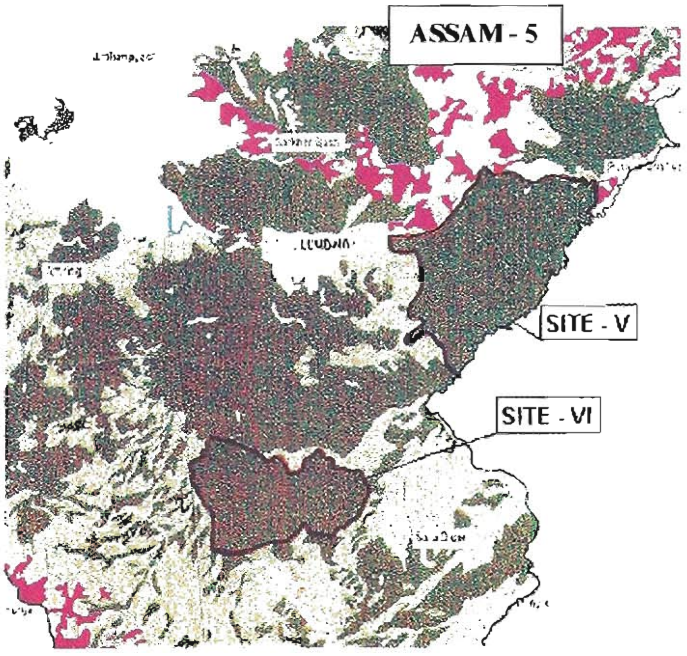




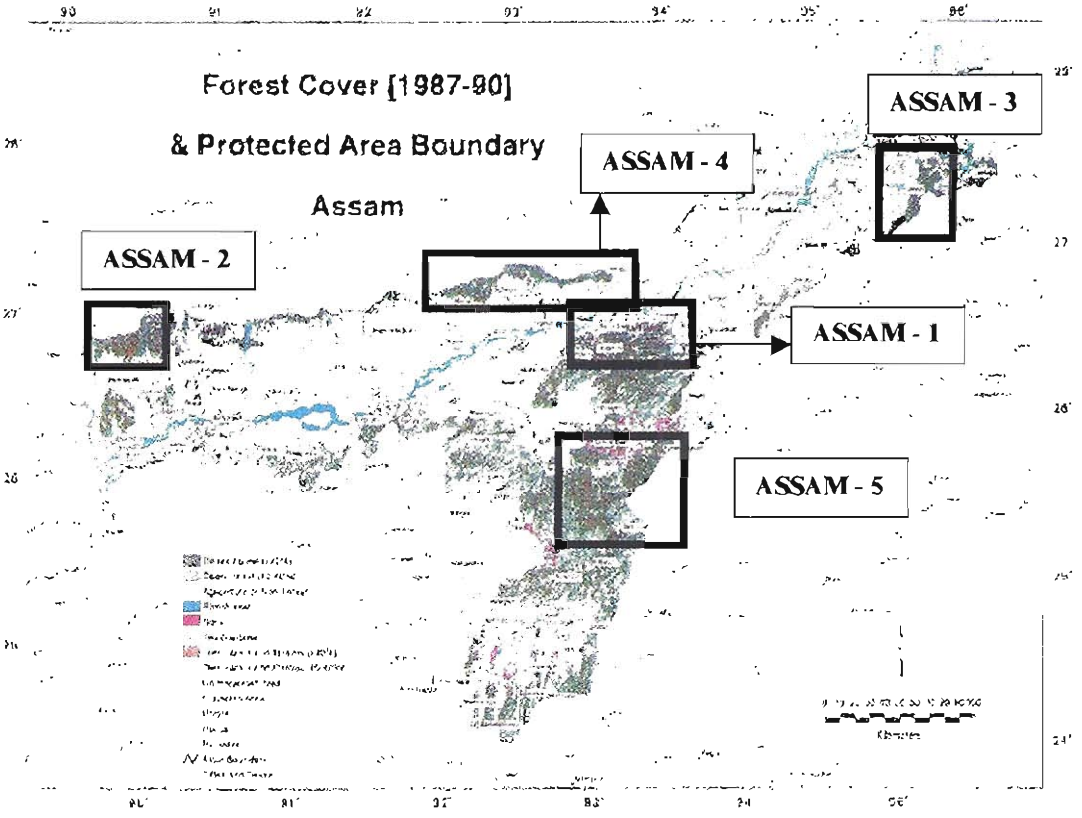
Site IV: Isolated patch of forest in North Assam. The area of this site is approximately 213 sq. km.

Sites V and VI: Relatively undisturbed patches of forest in south Assam. An area which does not have any protected areas. The area if site V is approximately 442 sq. km, while the area of site VI is approximately 289 sq. km.





The broad overview of the prioritised forest sites in Assam is being shown below:-

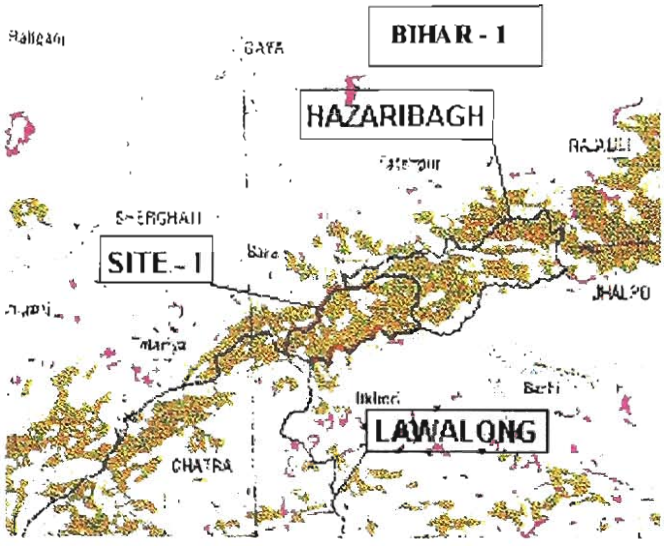


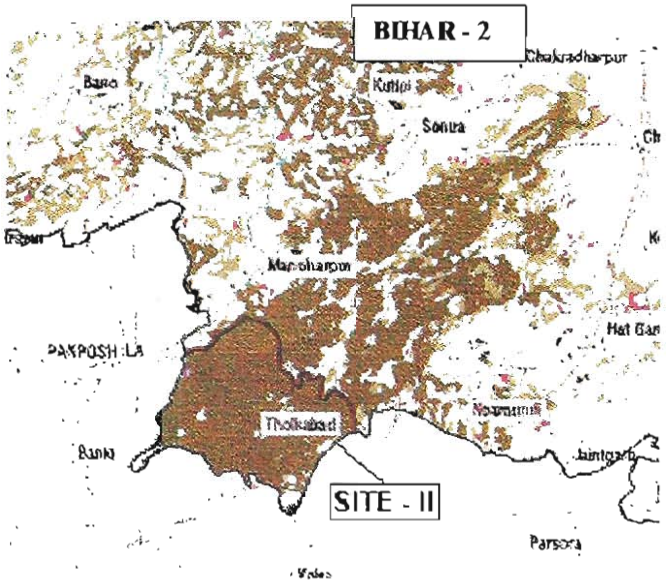
PRIORITISED FOREST AREAS IN BIHAR

The prioritised forest areas of Bihar are being shown below. The justification of their selection is as follows:

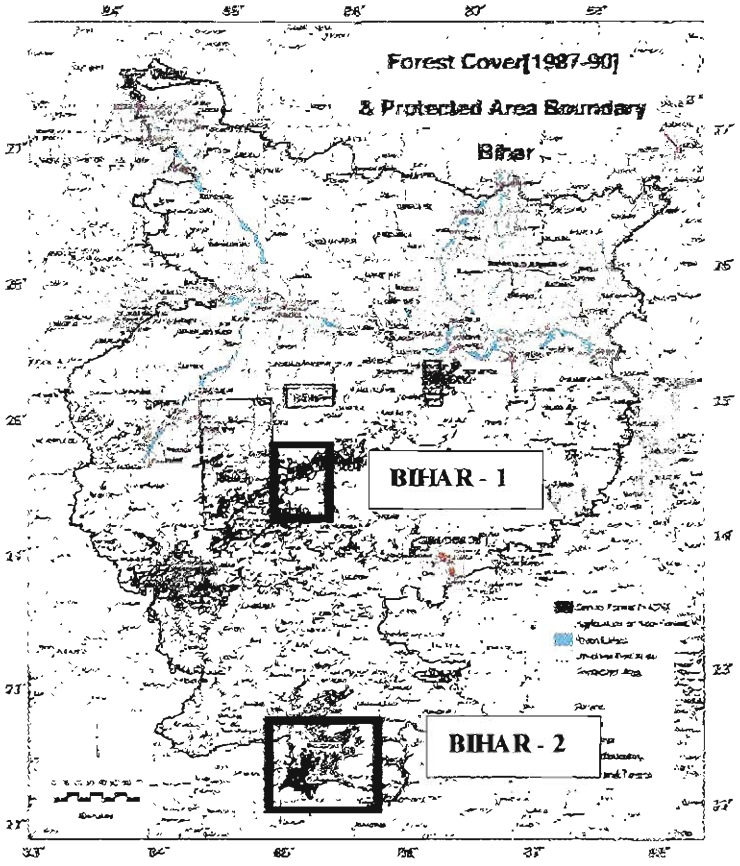
Site I: Connecting patch of forest between Hazaribagh and Lawalong sanctuaries. The approximate area of this site is 113 sq. km.

Site II: Relatively undisturbed patch of forest in south Bihar. The approximate area of this site is 280 sq. km.





The broad overview of the priotised forest sites in Bihar is being shown below:



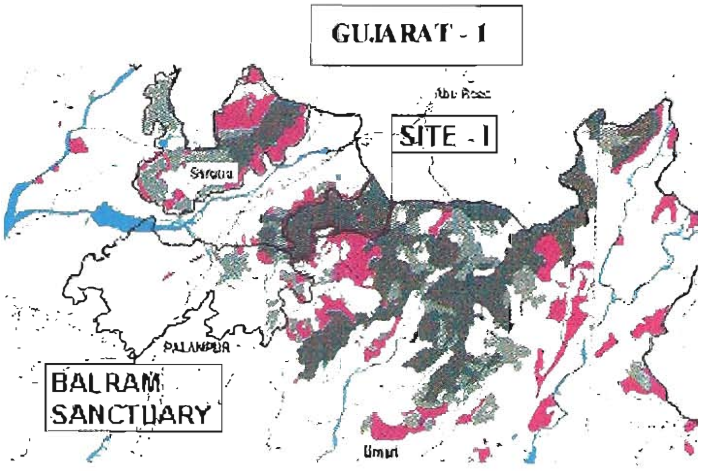
PRIORITISED FOREST AREAS IN GUJARAT

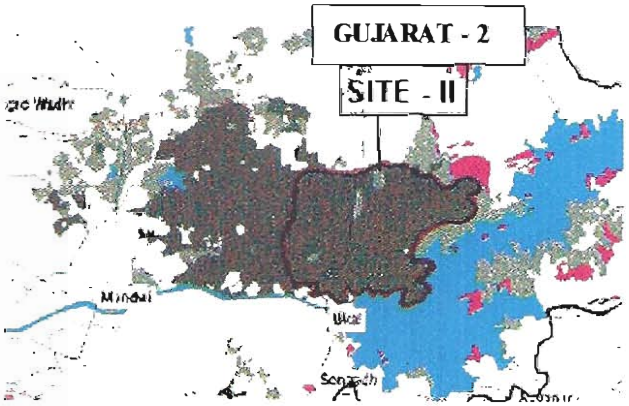
The prioritised forest areas of Gujarat are being shown below. The justification of their selection is as follows:

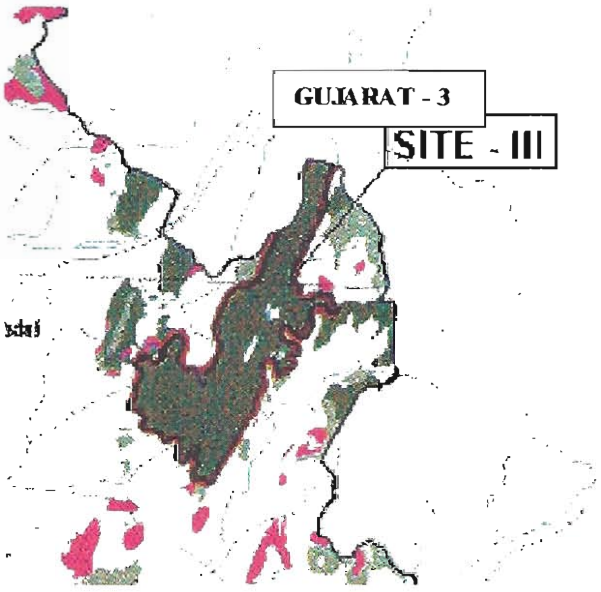
Site I: Forest patch adjoining Balram Sanctuary in north Gujarat. The approximate area of this site is 86 sq. km.

Site II: Isolated and unprotected forest patch in east Gujarat. The approximate area of this site is 400 sq. km.

Site III: Isolated and unprotected forest patch in north eastern Gujarat. The approximate area of this site is 353 sq. km.

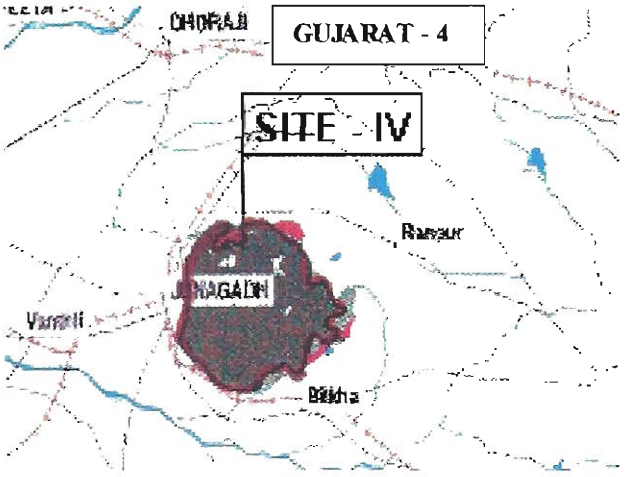


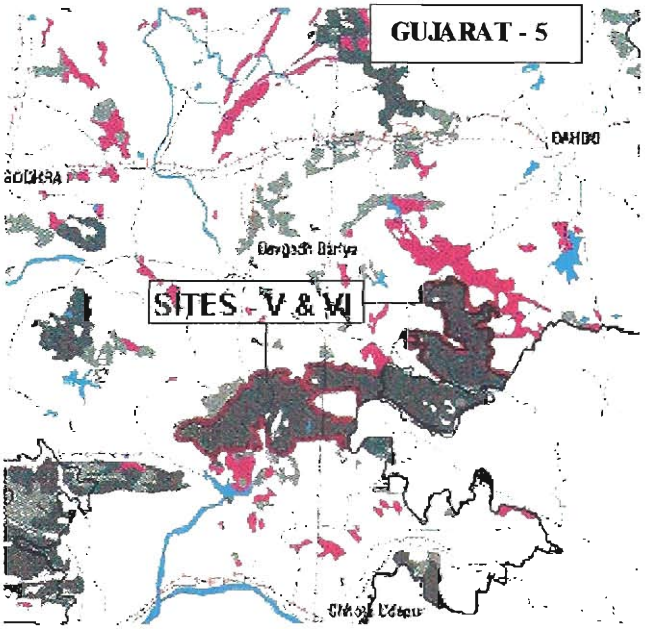




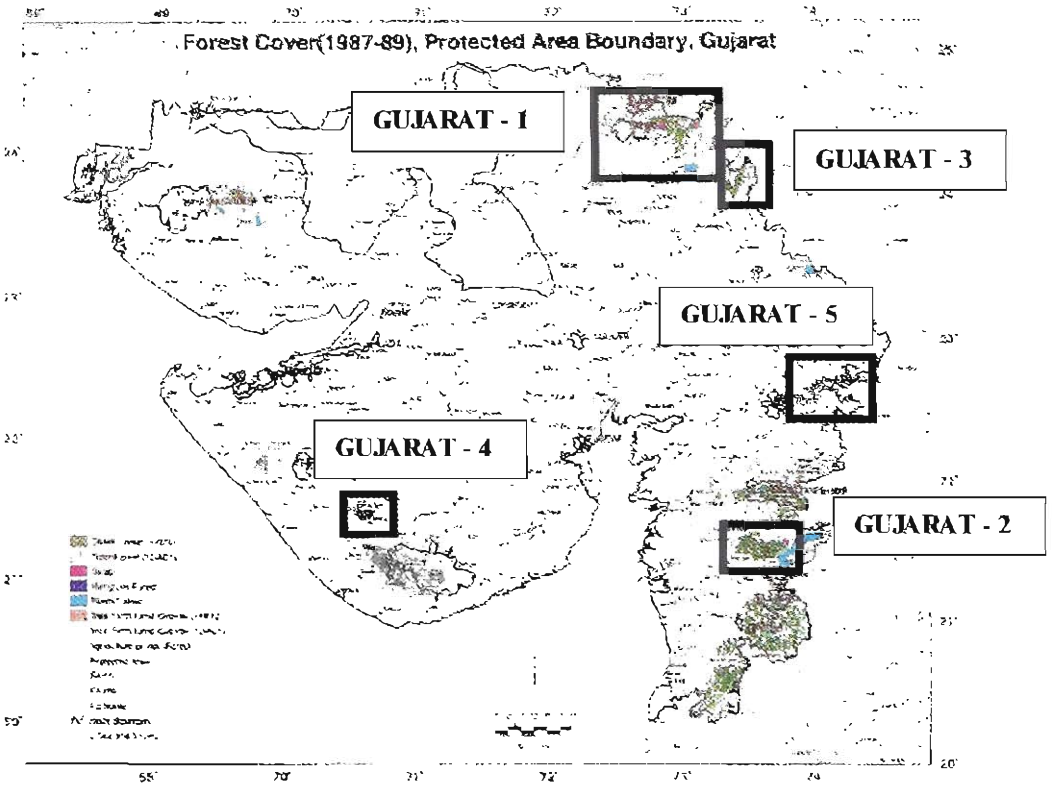
Site IV: Isolated patch of forest around Junagadh town. The approximate area of this patch is 394 sq. km.

Sites V and VI: Forest patches adjoining the Ratanmahal Sanctuary in east Gujarat. The approximate area of site V is 97 sq. km. while that of site VI is 64 sq. km.





A broad overview of the prioritised sites in Gujarat is being given below:



PRIORITISED FOREST AREAS IN JAMMU AND KASHMIR

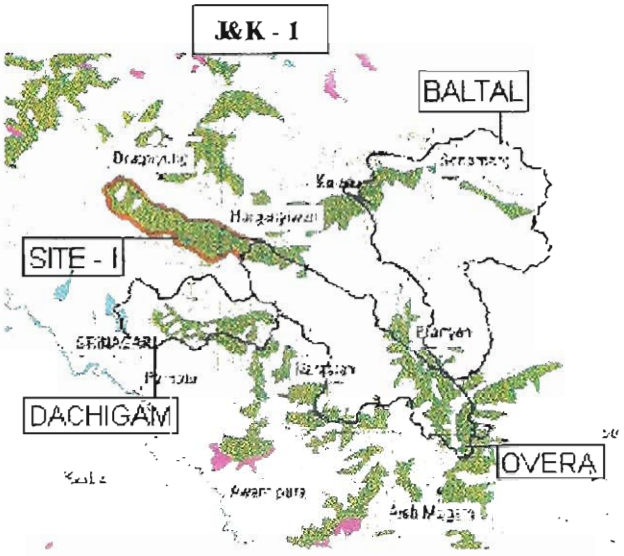
The prioritised forest areas of Jammu and Kashmir are being shown below. The justification of their selection is as follows:

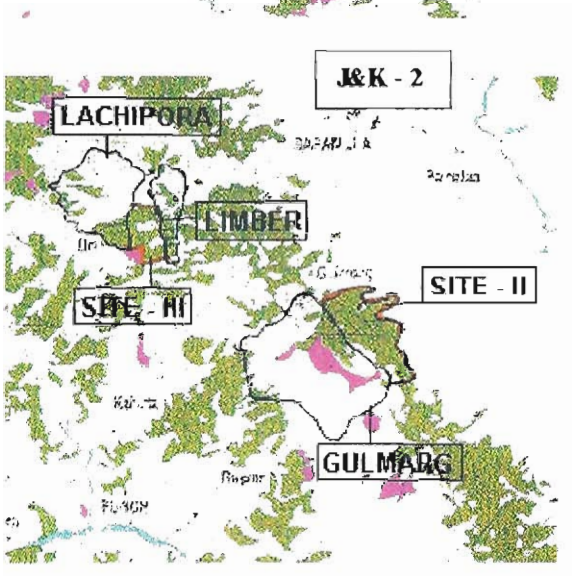
Site I: Relatively undisturbed forest patch to the west of Overa Sanctuary. The approximate area of the site is 50 sq. km.

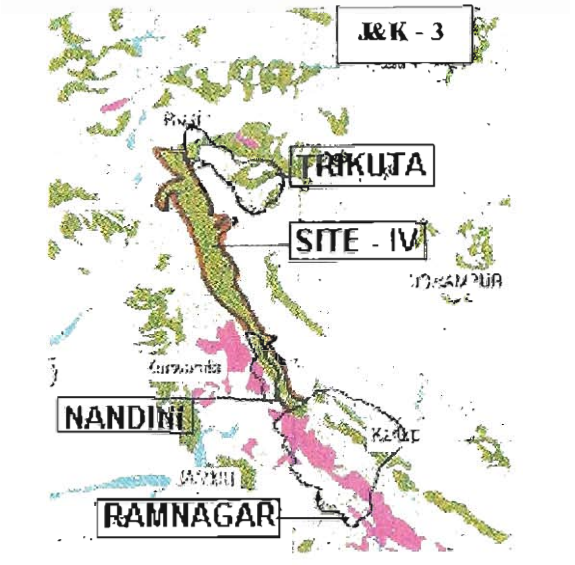
Site II: Contiguous patch of forest to the east of Gulmarg Sanctuary. The approximate area of this site is 87 sq. km.

Site III: Forest corridor connecting Lachipora and Limber sanctuaries. The approximate area of this site is 29 sq. km.

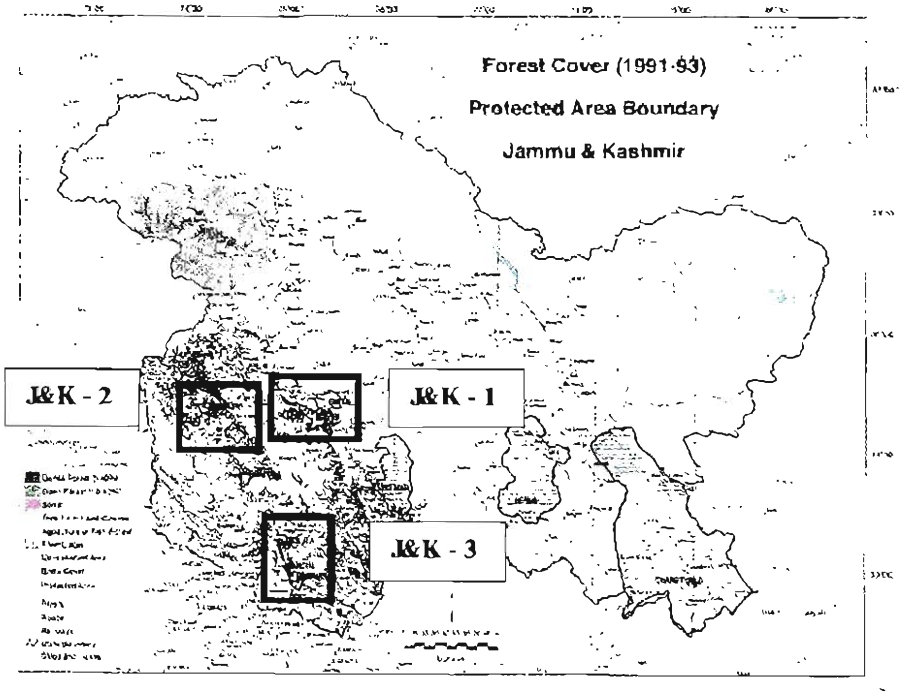
Site IV: Forest corridor connecting Trikuta, Nandini and Ramnagar sanctuaries. The approximate area of this site is 97 sq. km.







The broad overview of the prioritised sites in Jammu and Kashmir is being shown below:



PRIORITISED FOREST AREAS IN KARNATAKA

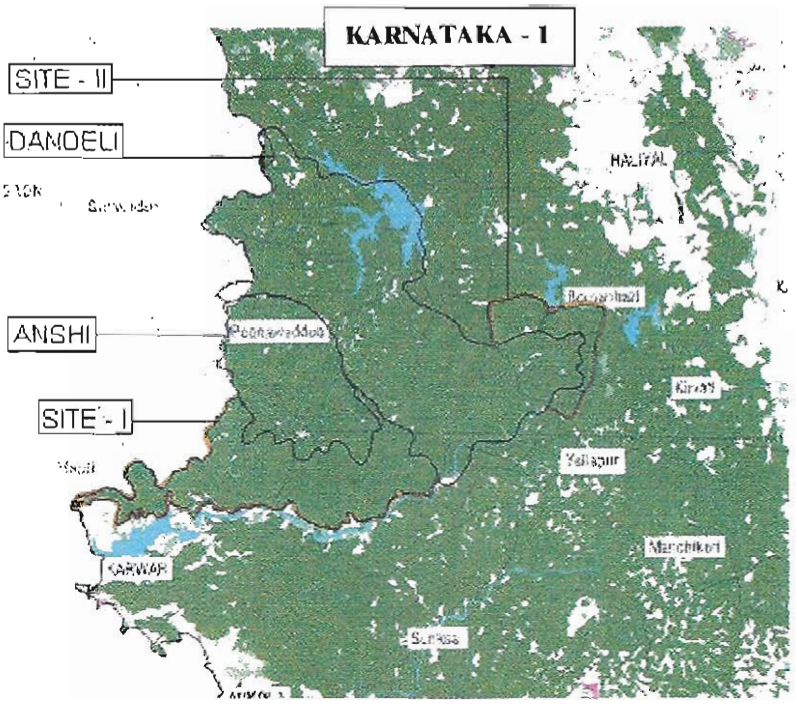
The prioritised forest areas of Karnataka are being shown below. The justification of their selection is as follows:

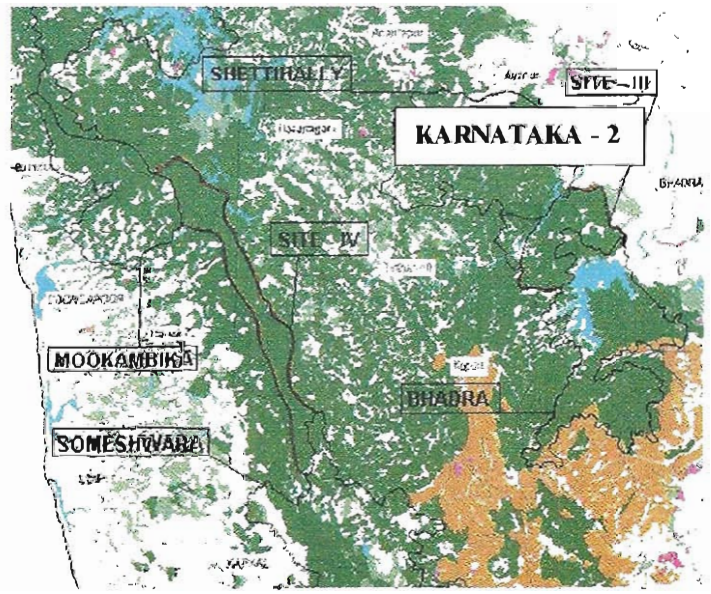
Site I: Relatively undisturbed patch of forest to the south of Anshi National Park. The approximate area of the site is 363 sq. km.

Site II: Relatively undisturbed patch of forest to the east of Dandeli Sanctuary. The approximate area of this site is 101 sq. km.

Site III: Connecting forest corridor between the Shettihally and Bhadra sanctuaries. The approximate area of this site is 177 sq. km.

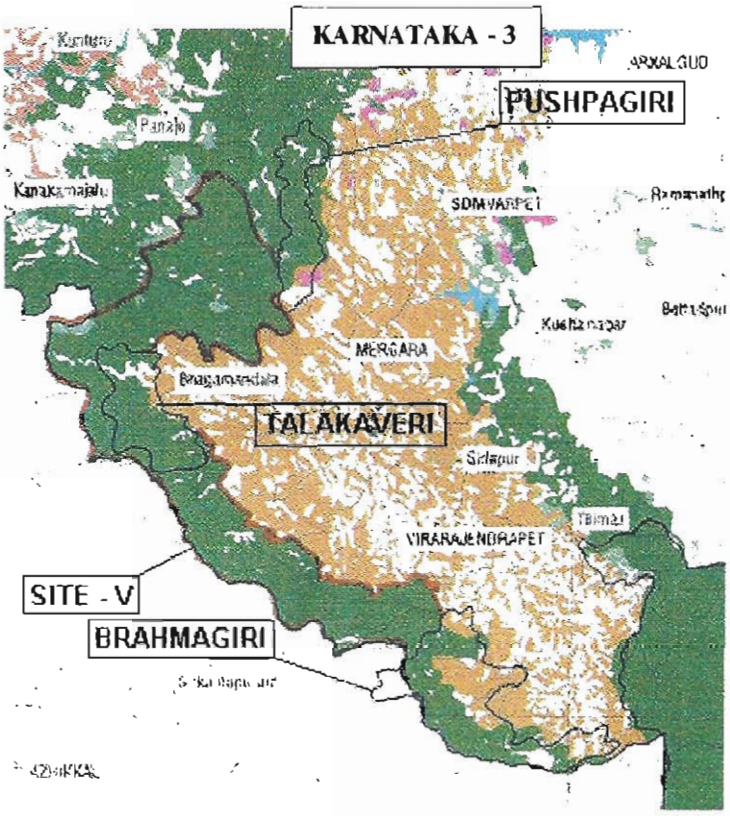
Site IV: Connecting forest corridor between the Mookambika and Someshwara sanctuaries. The approximate area of this site is 257 sq. km.

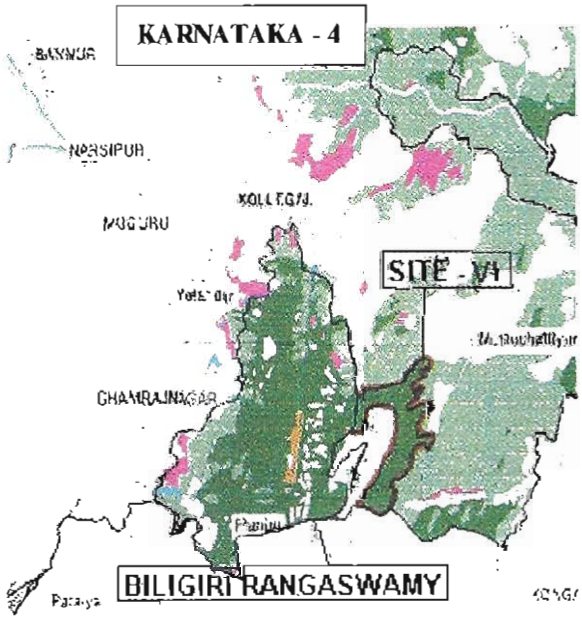




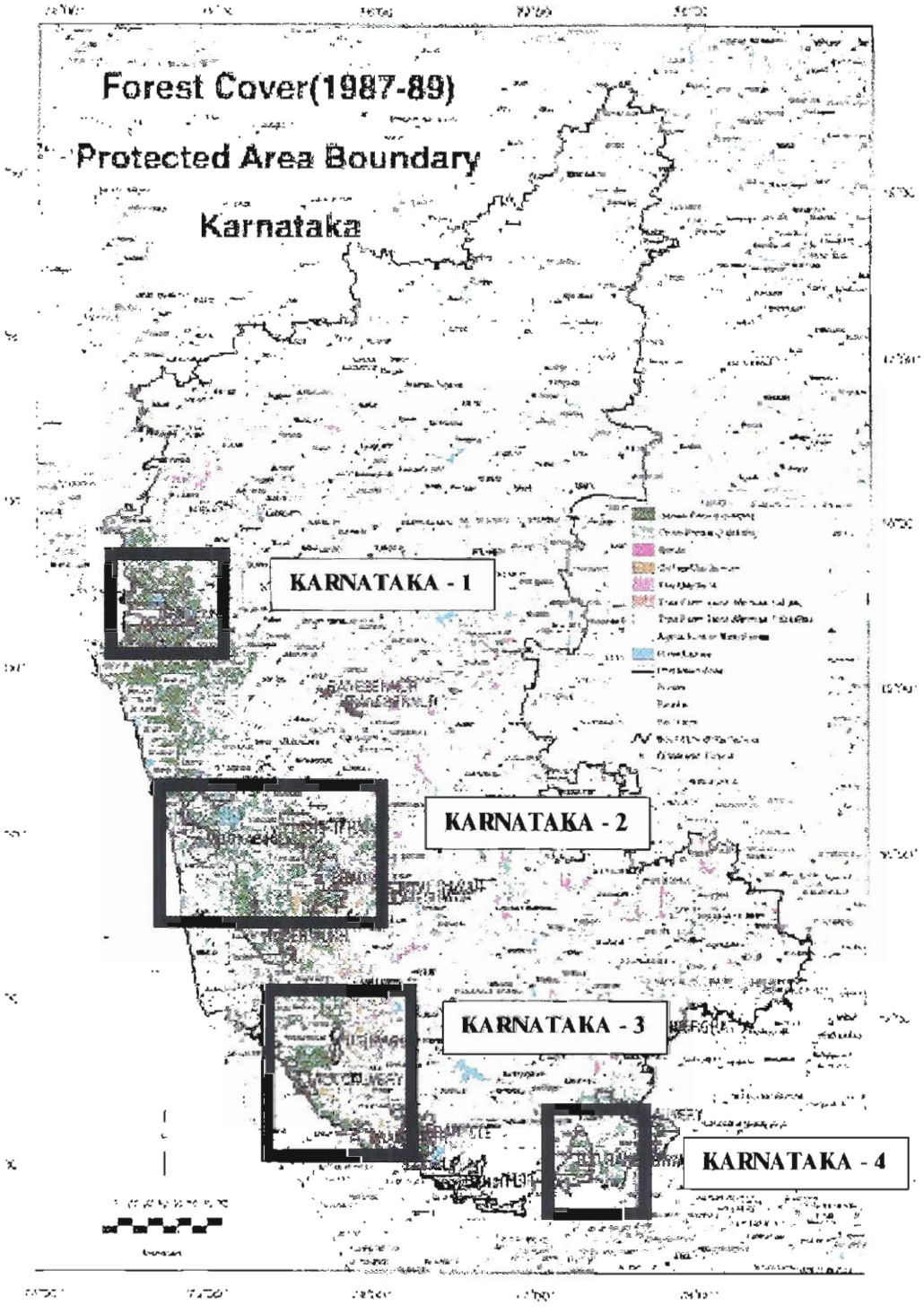
Site V: Contiguous patch of forest connecting Pushpagiri, Talakaveri and Brahmagiri sanctuaries. The approximate area of this site is 658 sq. km.

Site VI: Forest patch adjoining the Biligiri Rangaswamy Temple Sanctuary. The approximate area of this site is 77 sq. km.





A broad overview of the prioritised forest areas of Karnataka is being given below:

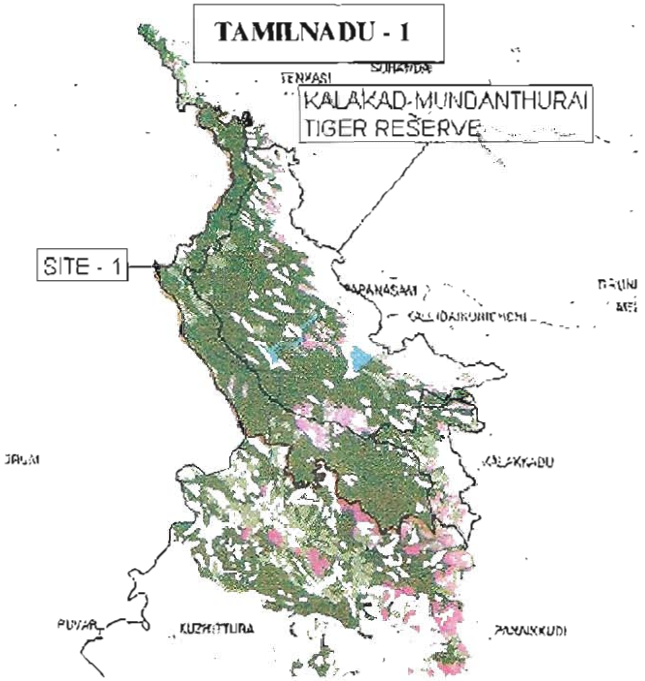


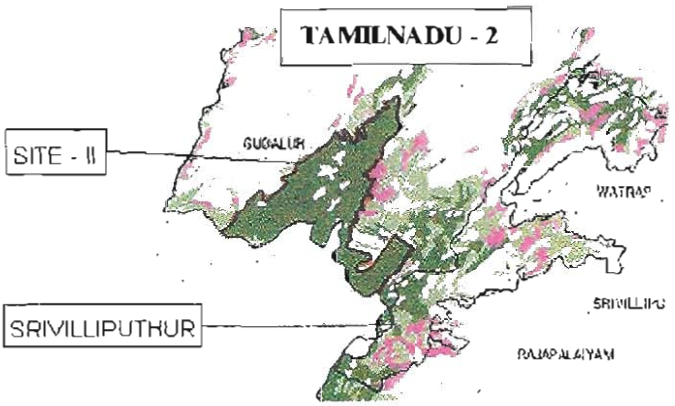
PRIORITISED FOREST AREAS IN TAMIL NADU

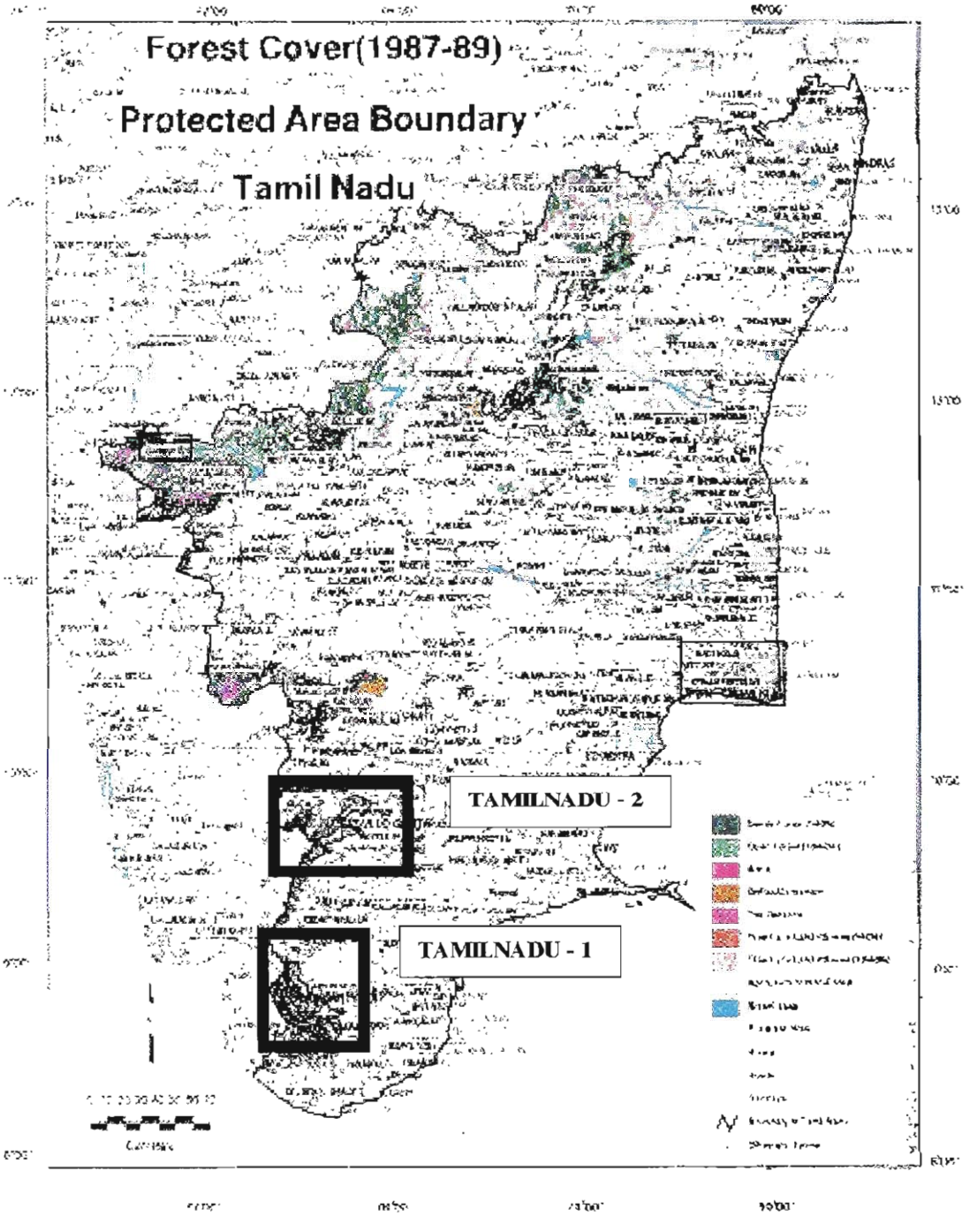
The prioritised forest areas of Tamil Nadu are being shown below. The justification of their selection is as follows:

Site I: Forest patch adjoining the western boundary of the kalakad-Mundanthurai Tiger Reserve. Also connects with the Neyyar Sanctuary in Kerala. The approximate area of this site is 187 sq. km.

Site II: Forest patch adjoining the Srivilliputhur Sanctuary in Tamil Nadu. Also connects to the Periyar Tiger Reserve, Kerala. The approximate area of this site is 376 sq. km.



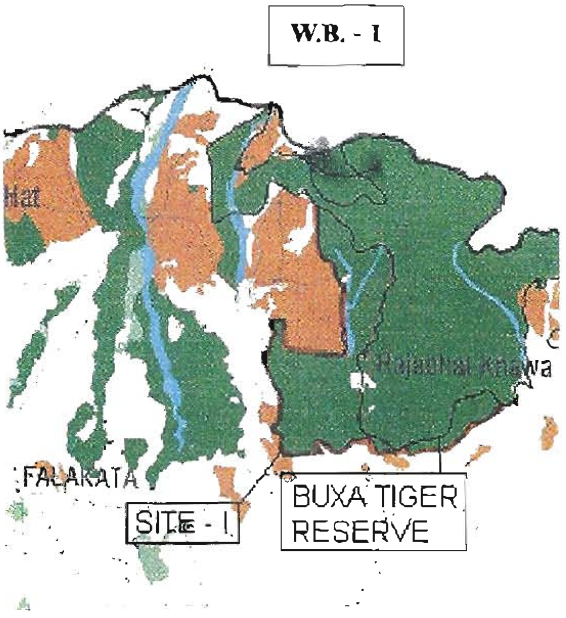


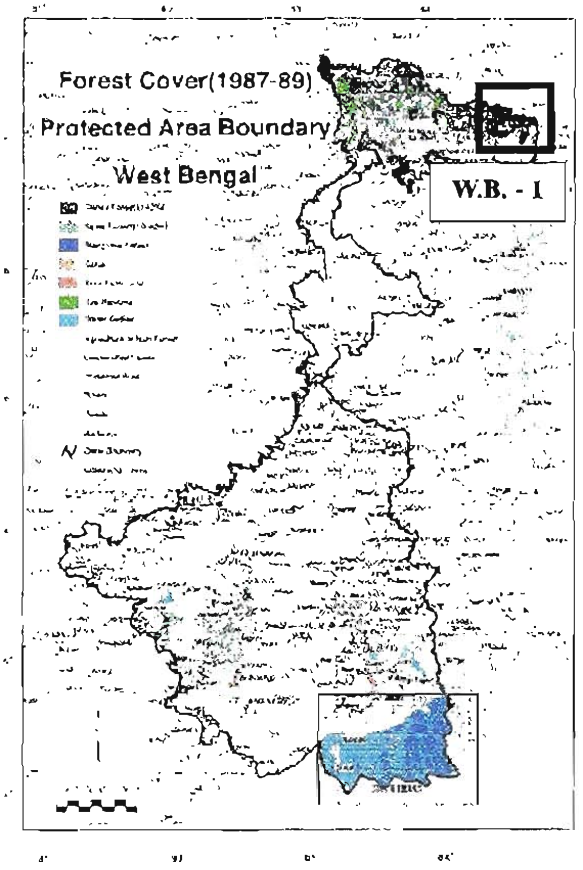

Forest Cover(1987-89)
Protected Area Boundary
Tamil Nadu
TAMILNADU - 2
TAMILNADU - 1

PRIORITISED FOREST AREAS IN WEST BENGAL

The prioritised forest areas of West Bengal are being shown below. The justification of their selection is as follows:

Site I: Forest patch adjoining the Buxa Tiger Reserve in North Bengal. The approximate area of this site is 84 sq. km.





Preliminary Prioritisation of National Parks and Sanctuaries

Raman Mehta

Introduction

The Biodiversity Conservation Prioritisation Project (BCPP) sought to prioritise species, sites and strategies across the country. There were various subcomponents of the BCPP, one of which dealt with the prioritisation of national parks and sanctuaries in India. It was recognised at the outset that national parks and sanctuaries are in themselves a priority because these protected areas (PAs) are among the last repositories of India's wild biodiversity. Much of India's vast faunal and floral wealth is now contained only within PAs which offer, arguably, the only viable strategy for *in-situ* conservation of most wild species. As such, we would like to assume that the biodiversity occurring in all PAs needs to be conserved with the same degree of efficacy and urgency. However, this may not be possible for the following reasons:

1. The resources available for conservation are scarce, and can not be used to protect the entire PA network of the country with the same level of effectiveness and efficiency.
2. There are certain PAs that harbour species or communities which are rare or threatened. It is necessary to identify these and take steps for their conservation before taking up other sites for conservation. While efforts have been made by the government to do this through initiatives like the Project Tiger, there are many more sites which need to be prioritised, and action taken for their immediate conservation.
3. There are also certain PAs which face a high level of threats or pressures. These PAs, especially the ones which harbour rare or threatened species or communities, need to be identified so that the necessary steps can be taken for their conservation.

It is for all these reasons that it was felt that a prioritisation exercise for PAs is needed. An added benefit of carrying out a prioritisation exercise is that it helps in making an assessment of the information needed for prioritisation. This in turn is helpful in making an assessment of the gaps which exist in information about PAs. Once these gaps are identified, action can be taken to collect information to try and fill them, so that the correct priorities for conservation can be identified.

Methodology

According to a list made available by the Ministry of Environment and Forests, Government of India, there were over 525 PAs in the country. Of these, 100 are located in the Andaman and Nicobar Islands. This preliminary prioritisation exercise was undertaken for 253 PAs located in the Indian Mainland. These PAs were picked up for the prioritisation exercise because data was already available with the Indian Institute of Public Administration (IIPA) for these sites. Meanwhile, as a part of the PAs prioritisation exercise under the BCPP, questionnaires were sent out to all the PAs for updating the existing database. Around 50 of these questionnaires were filled and returned. We hope that data for more PAs will come in soon and will help us in updating the information for the 253 PAs for which a database exists, and also allow for the inclusion of the remaining PAs into the prioritisation exercise.

Apart from the 253 PAs for which data was available with the IIPA, an additional 20 PAs were included in this exercise and have been listed as having a very high value, which means that they are priority sites, because they harbour a rare or threatened species or community. Of the 253 PAs for which data was available with the IIPA, there were 15 for which an accurate evaluation could not be made due to lack of sufficient data. However, these sites too, have been listed as having a very high value, since they too, harbour a rare or threatened species or community. These 35 PAs are being listed separately in annexure C along with a justification of why they are being categorised as very high value sites.

PAs located in the Andaman and Nicobar, and Lakshadweep Islands were not taken up because they are ecologically very different from the Indian Mainland, and need to be looked at separately. An exercise for the prioritisation of biodiversity rich sites in the Islands was done separately under the BCPP and many of the prioritised sites are already notified PAs.

The PAs were prioritised on the basis of their:

1. **Biological Value:** This was ascertained through identifying the diversity of forest types and subtypes occurring in the PA and looking at whether any of them are rare or threatened, the species occurring in the PA and whether any of them are endemic, rare, or threatened, the size of the PA, its proximity or connectivity to other PAs, whether the PA is located in a biogeographic province which does not have an adequate area under protection or whether it is located in a biogeographic province where the total number of PAs is inadequate etc. The details are given in Annexure A
2. **Pressures or threats** on the PA due to consumptive human use by local and other people and/or institutions. A large number of different types of pressures or threats were evaluated. These are detailed in Annexure A.
3. **Management and legal status** of the PA. The details are given in Annexure A

A detailed explanation of the above is being given in the proposed valuation framework attached at annexure A. The valuation framework was applied to the 253 PAs for which data was available, and a table of the values resulting from the application of the valuation framework was constructed. The biological values were added to get the overall biodiversity value of the PA. The values mentioned above have been further subdivided in order to categorise PAs. These categories are:

1. In terms of the value of a PA, each area has been subclassified as
   (a) Either a Very High Value PA, or
   (b) A High Value PA.
2. In terms of pressures or threats on the PA, each area has been subclassified as:
   (a) Either a High Pressure PA, or
   (b) A Low Pressure PA.
3. In terms of the legal and management status of a PA, each area has been subclassified as
   (a) Either a Low Legal and Management Status PA, or
   (b) A High Legal and Management Status PA

On the basis of the categories outlined above, PAs have been classified within each biogeographic province. It would be reasonable to assume that all the PAs which fall into the category of very high value PAs would be the priority areas for conservation. However, those among the very high value PAs which also have a high level of pressures being exerted on them would have a priority greater than those with a lower level of pressures. Further, if a very high value and high pressure PA also has a low legal and management status, efforts for its conservation would have to be taken up before the others. This is because the same level of pressures or threats being exerted on a certain PA would have a greater impact on it if the management and legal status was low and a lesser impact if the management and legal status was high.

Therefore, the highest priority would be those PAs which have a very high value, are threatened due to a high level of pressures, and where the legal and management status is low. Conversely, the lowest priority would be given to those PAs which have a high value and low level of pressures coupled with a high legal and management status. For the purpose of this report, the following is being assumed to be the order of priority of PAs:-

1. Very High Biodiversity + High Pressure + Low Legal and Management Status
2. Very High Biodiversity + High Pressure + High Legal and Management Status
3. Very High Biodiversity + Low Pressure + Low Legal and Management Status
4. Very High Biodiversity + Low Pressure + High Legal and Management Status
5. High Biodiversity + High Pressure + Low Legal and Management Status
6. High Biodiversity + High Pressure + High Legal and Management Status
7. High Biodiversity + Low Pressure + Low Legal and Management Status
8. High Biodiversity + Low Pressure + High Legal and Management Status

To distinguish between Very High Value and High Value PAs, the median or the middle point was taken as a cutoff from the column of overall value of the PA. All PAs which had an overall value of 20.24 (the median) or more were identified as very high value sites, while the others were marked as high value sites. As already mentioned, those PAs which harbour rare or threatened habitats or species and for which either the data were either inadequate or did not exist, were also identified and added to the list of very high value PAs.

A total of 162 PAs have been identified as very high value sites. The number of high value sites is 111. Atleast one PA from all the biogeographic provinces of the Indian Mainland is represented in the list of very high value sites. The only state which is not represented in the list of very high priority PAs is Tripura. The number of very high value sites for each state and biogeographic province as well as their order of priority is as follows:

STATE	*BIOGEOGRAPHIC PROVINCE*	*ORDER OF PRIORITY*	*NUMBER OF PAs*
Andhra Pradesh	Deccan Plateau (6A)	2	1
		Not Determined*	3
	Central Plateau (6B)	1	1
		2	4
		4	1
	Eastern Plateau (6C)	1	1
	East Coast (10B)	4	1
		Not Determined	1
	Number of Very High Value PAs in State		**13**
Arunachal Pradesh	East Himalaya (2D)	2	1
		4	4
		Not Determined	3
	Number of Very High Value PAs in State		**8**
Assam	Brahmaputra Valley (8A)	2	1
		3	1
		4	2
		Not Determined	1
	Number of Very High Value PAs in State		**5**
Bihar	Chota Nagpur Plateau (6D)	2	3
		4	1
	Lower Gangetic Plain (7B)	2	1
		Not Determined	1
	Number of Very High Value PAs in State		**6**
Goa	Western Ghats (5B)	4	1
	Number of Very High Value PAs in State		**1**
Gujarat	Kachh Desert (3A)	2	2
		Not Determined	1
	Gujarat-Rajwara (4B)	2	4
		3	1
		4	1
	West Coast (10A)	4	1
	Number of Very High Value PAs in State		**10**
Haryana	Punjab Plains (4A)	4	2
	Number of Very High Value PAs in State		**2**
Himachal Pradesh	Ladakh (1A)	3	1
	North West Himalaya (2A)	1	4
		2	4
		4	2
	Western Himalaya (2B)	1	2
		3	2
	Number of Very High Value PAs in State		**15**
Jammu & Kashmir	Ladakh (1A)	3	2
		4	1

* These are those PAs for which we did not have any data but which have been included as priority sites because they harbour rare or threatened species or communities.

Contd. . . .

STATE	*BIOGEOGRAPHIC PROVINCE*	*ORDER OF PRIORITY*	*NUMBER OF PAs*
	North West Himalaya (2A)	4	2
		Not Determined	1
	Number of Very High Value PAs in State		**6**
Karnataka	Malabar Plains (5A)	2	1
	Western Ghats (5B)	2	3
		3	1
		4	3
		Not Determined	2
Karnataka	Deccan Plateau (6A)	3	1
	Number of Very High Value PAs in State		**11**
Kerala	Western Ghats (5B)	2	4
		3	2
		4	2
	Number of Very High Value PAs in State		**8**
Madhya Pradesh	Gujarat-Rajwara (4B)	2	3
		4	2
	Eastern Highlands (6C)	2	1
		4	5
	Central Highlands (6E)	1	2
		2	2
		3	1
		4	4
	Number of Very High Value PAs in State		**20**
Maharashtra	Malabar Plains (5A)	4	1
	Western Ghats (5B)	4	1
		Not Determined	1
	Central Plateau (6B)	2	1
		3	1
	Central Highlands (6E)	2	2
		4	1
	West Coast (10A)	4	1
	Number of Very High Value PAs in State		**9**
Manipur	Assam Hills (8B)	4	1
	Number of Very High Value PAs in State		**1**
Meghalaya	Assam Hills (8B)	Not Determined	1
	Number of Very High Value PAs in State		**1**
Mizoram	Assam Hills (8B)	3	1
	Number of Very High Value PAs in State		**1**
Nagaland	Assam Hills (8B)	4	1
	Number of Very High Value PAs in State		**1**
Orissa	Eastern Plateau (6C)	2	1
	Chota Nagpur Plateau (6D)	2	1
	East Coast (10B)	1	1

Contd. . . .

STATE	*BIOGEOGRAPHIC PROVINCE*	*ORDER OF PRIORITY*	*NUMBER OF PAs*
	Number of Very High Value PAs in State		**3**
Punjab	Punjab Plains (4A)	3	2
	Number of Very High Value PAs in State		**2**
Rajasthan	Thar Desert (3B)	2	1
		4	1
	Punjab Plains (4A)	4	1
	Gujarat-Rajwara (4B)	1	3
		2	6
		4	1
	Number of Very High Value PAs in State		**13**
Sikkim	Central Himalaya (2C)	4	1
	Number of Very High Value PAs in State		**1**
Tamil Nadu	Western Ghats (5B)	1	1
		2	2
		3	1
	Deccan Plateau (6A)	Not Determined	1
	East Coast (10B)	3	1
		4	1
		Not Determined	1
	Number of Very High Value PAs in State		**8**
Uttar Pradesh	Western Himalaya (2B)	2	2
		4	2
	Gujarat-Rajwara (4B)	2	1
	Central Highlands (6E)	2	1
		4	1
	Upper Gangetic Plains (7A)	1	2
		2	1
		4	1
		Not Determined	1
	Number of Very High Value PAs in State		**12**
West Bengal	Central Himalaya (2C)	3	1
	Lower Gangetic Plains (7B)	4	1
		Not Determined	2
	East Coast (10B)	4	1
	Number of Very High Value PAs in State		**5**

biogeographic province. Each PA has been given a unique code This code provides information about the state in which it is located, and whether it is a national park or a sanctuary It has three parts. The first part of the code tells us about the state in which it is located. For example, the first name in the list, Karakoram Sanctuary, is located in the state of Jammu and Kashmir. Therefore, the state code ie: J&K appears first The next part of the code tells us whether it is a sanctuary or a national park. In case a PA is a national park, then the alphabet "N" appears next. Else, the alphabet "S" is used to show that the PA is a sanctuary. The last part of the code contains the first three letters of the name of the PA. Therefore, the code of Karakoram Sanctuary is J&K/S/KAR, while the code of Hemis National Park is J&K/N/HEM. In case the first three letters of a PA name are the same as another PA in the same state, then the first four alphabets are used in the code. For example. in Himachal Pradesh, the code of the Shimla Water Catchment Sanctuary is HP/S/SHIM, while the code of the Shilli Sanctuary is HP/S/SHIL.

Limitations of the data and this report

Information for many of the valuation parameters identified in the valuation framework is not yet available (see details attached at annexure B) However, the process of updating existing, as well as gathering new, information has already been initiated. As already mentioned above, a questionnaire has been developed and sent to all the state governments. As and when addition information comes in, the prioritisation matrix will get updated further.

As already mentioned above, this report has evaluated only 254 PAs located in the Indian mainland. Therefore, many national parks as well as sanctuaries do not figure in the matrices which have been compiled Further, the evaluation has been done according to information available in a database that is now over a decade old. Therefore, the values being ascribed to same of the PAs may not reflect reality on the ground. This may have, for example, led to a PA having a very high value being shown as one having only a high value.

Similarly many of the tiger reserves which have been formed by combining two or more PAs are still shown separately (e g. Tadoba, Bandhavgarh etc.). Also, many sanctuaries which were upgraded to national parks (e.g. Palamau, Valmiki, Manas etc.) are still shown as sanctuaries. Further, some national parks and sanctuaries have been expanded or contracted to include new, or exclude parts of the old, areas of the PAs. These problems will be looked into and sorted out when the existing database is updated.

Table 1: Priority Listing of the Very High Value PAs

CATEGORY OF THE PA	*S no*	*BIOGEOGRAPHIC PROVINCE*	*CODE*	*NAME*
High pressure+Low management and legal status	1	2A	HP/S/MAN	MANALI SANCTUARY
	2	2A	HP/S/GAM	GAMGUL SIAHBEHI SANCTUARY
	3	2A	HP/S/NAR	NARGU SANCTUARY
	4	2A	HP/S/KUG	KUGTI SANCTUARY
	5	2B	HP/S/LIP	LIPPA ASRANG SANCTUARY
	6	2B	HP/S/DAR	DARANGHATI SANCTUARY
	7	4B	RAJ/S/NAT	NATIONAL CHAMBAL SANCTUARY
	8	4B	RAJ/S/KAI	KAILA DEVI SANCTUARY
	9	4B	RAJ/S/RAM	RAMGARH SANCTUARY
	10	5B	TN/S/ANA	ANAMALAI SANCTUARY
	11	6B	AP/S/KOL	KOLLERU SANCTUARY
	12	6C	AP/S/PAP	PAPIKONDA SANCTUARY
	13	6E	MP/N/SAT	SATPURA NATIONAL PARK
	14	6E	MP/N/PAN	PANNA NATIONAL PARK
	15	7A	UP/N/RAJ	RAJAJI NATIONAL PARK (Data aggregated for Chilla, Motichur and Rajaji Sanctuaries)
	16	7A	UP/S/KIS	KISHANPUR SANCTUARY
Subtotal = 17	17	10B	ORI/S/BHI	BHITARKANIKA SANCTUARY

Contd. .

CATEGORY OF THE PA	*S.No.*	*BIOGEOGRAPHIC PROVINCE*	*CODE*	*NAME*
High pressure+High management and legal status	18	2A	HP/S/KAN	KANAWAR SANCTUARY
	19	2A	HP/S/SHIK	SHIKARI DEVI SANCTUARY
	20	2A	HP/S/PON	PONG LAKE SANCTUARY
	21	2A	HP/S/SEC	SECHU TWAN NALAH SANCTUARY
	22	2B	UP/S/KED	KEDARNATH SANCTUARY
	23	2B	UP/S/GOV	GOVIND PASHUVIHAR SANCTUARY
	24	2D	ARU/S/PAK	PAKHUI SANCTUARY
	25	3A	GUJ/S/DHR	DHRANGADHRA WILD ASS SANCTUARY
	26	3A	GUJ/S/NAR	NARAYAN SAROVAR SANCTUARY
	27	3B	RAJ/S/TAL	TAL CHHAPER SANCTUARY
	28	4B	GUJ/N/GIR	GIR NATIONAL PARK
	29	4B	UP/S/NAT	NATIONAL CHAMBAL SANCTUARY
	30	4B	RAJ/N/SAR	SARISKA NATIONAL PARK (Including Sariska Sanctuary)
	31	4B	MP/S/GHA	GHATIGAON GREAT INDIAN BUSTARD SANCTUARY
	32	4B	RAJ/S/MOU	MOUNT ABU SANCTUARY
	33	4B	GUJ/S/RAT	RATANMAHAL SANCTUARY
	34	4B	RAJ/S/KUM	KUMBALGARH SANCTUARY
	35	4B	MP/S/GAN	GANDHISAGAR SANCTUARY
	36	4B	RAJ/S/JAI	JAISAMAND SANCTUARY
	37	4B	MP/S/KAR	KARERA GREAT INDIAN BUSTARD SANCTUARY
	38	4B	RAJ/S/TOD	TODGARH-RAOLI SANCTUARY
	39	4B	GUJ/S/JES	JESSORE SANCTUARY
	40	4B	RAJ/S/SIT	SITAMATA SANCTUARY
	41	4B	GUJ/N/VEL	VELAVADAR NATIONAL PARK
	42	5A	KAR/S/MOO	MOOKAMBIKA SANCTUARY
	43	5B	TN/S/MUD	MUDUMALAI SANCTUARY
	44	5B	KER/S/PAR	PARAMBIKULAM SANCTUARY
	45	5B	TN/S/KAL	KALAKAD-MUNDANTHURAI (Data combined for Kalakad and Mundanthurai Sanctuaries which are managed as a single tiger reserve)
	46	5B	KER/N/PER	PERIYAR NATIONAL PARK (Including Periyar Sanctuary)
	47	5B	KER/S/WYN	WYNAD SANCTUARY
	48	5B	KER/S/NEY	NEYYAR SANCTUARY
	49	5B	KAR/S/SHA	SHARAVATHI VALLEY SANCTUARY
	50	5B	KAR/S/SOM	SOMESHWARA SANCTUARY
	51	5B	KAR/S/SHE	SHETTIHALLY SANCTUARY
	52	6A	AP/S/NAG	NAGARJUNASAGAR-SRISAILAM (Data combined for Nagarjunasagar and Srisailam Sanctuaries which are managed as a single tiger reserve)
	53	6B	AP/S/PAK	PAKHAL SANCTUARY

Contd. . . .

CATEGORY OF THE PA	*S.No.*	*BIOGEOGRAPHIC PROVINCE*	*CODE*	*NAME*
	54	6B	AP/S/ETU	ETURNAGARAM SANCTUARY
	55	6B	AP/S/KAW	KAWAL SANCTUARY
	56	6B	AP/S/PRA	PRANHITA SANCTUARY
	57	6B	MAH/S/GRE	GREAT INDIAN BUSTARD SANCTUARY
	58	6C	ORI/S/SAT	SATKOSIA GORGE SANCTUARY
	59	6C	MP/S/SIT	SITANADI SANCTUARY
	60	6D	ORI/N/SIM	SIMLIPAL NATIONAL PARK (Including Similipal Sanctuary)
	61	6D	BIH/S/PAL	PALAMAU SANCTUARY
	62	6D	BIH/S/HAZ	HAZARIBAGH SANCTUARY
	63	6D	BIH/S/DAL	DALMA SANCTUARY
	64	6E	MP/S/BOR	BORI SANCTUARY
	65	6E	MP/S/PAC	PACHMARHI SANCTUARY
	66	6E	UP/S/RAN	RANIPUR SANCTUARY
	67	6E	MAH/S/MEL	MELGHAT SANCTUARY
	68	6E	MAH/N/PEN	PENCH NATIONAL PARK
	69	7A	UP/N/COR	CORBETT NATIONAL PARK
	70	7B	BIH/S/VAL	VALMIKI SANCTUARY
Subtotal = 54	71	8A	ASS/S/MAN	MANAS
Low pressure+low management and legal status	72	1A	J&K/S/KAR	KARAKORAM SANCTUARY
	73	1A	HP/N/PIN	PIN VALLEY NATIONAL PARK
	74	1A	J&K/S/CHA	CHANGTHANG SANCTUARY
	75	2B	HP/S/RUP	RUPI BHABA SANCTUARY
	76	2B	HP/S/RAK	RAKCHHAM CHHITKUL SANCTUARY
	77	2C	WB/S/SEN	SENCHAL SANCTUARY
	78	4A	PUN/S/ABO	ABOHAR
	79	4A	PUN/S/HAR	HARIKE LAKE
	80	4B	GUJ/S/HIN	HINGOLGARH SANCTUARY
	81	5B	KER/N/SIL	SILENT VALLEY NATIONAL PARK
	82	5B	KER/S/CHIM	CHIMONY SANCTUARY
	83	5B	TN/S/NIL	NILGIRI TAHR (Mukurthy) SANCTUARY
	84	5B	KAR/S/BRA	BRAHMAGIRI SANCTUARY
	85	6A	KAR/S/BIL	BILIGIRI RANGASWAMY TEMPLE SANCTUARY
	86	6B	MAH/N/TAD	TADOBA NATIONAL PARK
	87	6E	MP/N/SAN	SANJAY NATIONAL PARK
	88	8A	ASS/S/BAR	BARNADI SANCTUARY
	89	8B	MIZ/S/DAM	DAMPA SANCTUARY
Subtotal = 19	90	10B	TN/S/PUL	PULICAT SANCTUARY
Low pressure+High management and legal status	91	1A	J&K/N/HEM	HEMIS HIGH ALTITUDE NATIONAL PARK
	92	2A	HP/N/GRE	GREAT HIMALAYAN NATIONAL PARK
	93	2A	J&K/N/KIS	KISHTWAR NATIONAL PARK
	94	2A	J&K/N/DAC	DACHIGAM NATIONAL PARK

Contd. . . .

CATEGORY OF THE PA	*S.No.*	*BIOGEOGRAPHIC PROVINCE*	*CODE*	*NAME*
	95	2A	HP/S/TIR	TIRTHAN SANCTUARY
	96	2B	UP/N/VAL	VALLEY OF FLOWERS NATIONAL PARK
	97	2B	UP/N/NAN	NANDA DEVI NATIONAL PARK
	98	2C	SIK/N/KHA	KHANGCHENDZONGA NATIONAL PARK
	99	2D	ARU/N/NAM	NAMDAPHA NATIONAL PARK
	100	2D	ARU/S/MEH	MEHAO SANCTUARY
	101	2D	ARU/S/ITA	ITANAGAR SANCTUARY
	102	2D	ARU/S/LAL	LALI SANCTUARY
	103	3B	RAJ/N/DES	DESERT NATIONAL PARK
	104	4A	RAJ/N/KEO	KEOLADEO GHANA NATIONAL PARK
	105	4A	HAR/S/BHI	BHINDAWAS SANCTUARY
	106	4A	HAR/N/SUL	SULTANPUR NATIONAL PARK
	107	4B	RAJ/N/RAN	RANTHAMBHORE NATIONAL PARK
	108	4B	MP/S/NAT	NATIONAL CHAMBAL SANCTUARY
	109	4B	MP/N/MAD	MADHAV NATIONAL PARK
	110	4B	GUJ/S/NAL	NAL SAROVAR SANCTUARY
	111	5A	MAH/N/SAN	SANJAY GANDHI NATIONAL PARK
	112	5B	KAR/N/NAG	NAGARAHOLE NATIONAL PARK
	113	5B	KAR/N/BAN	BANDIPUR NATIONAL PARK
	114	5B	KAR/S/BHA	BHADRA SANCTUARY
	115	5B	GOA/N/BHA	BHAGWAN MAHAVIR NATIONAL PARK (Including Bhagwan mahavir Sanctuary)
	116	5B	KER/N/ERA	ERAVIKULAM NATIONAL PARK
	117	5B	MAH/S/RAD	RADHANAGARI BISON SANCTUARY
	118	5B	KER/S/SHE	SHENDURUNY SANCTUARY
	119	6B	AP/S/KIN	KINNERASANI SANCTUARY
	120	6C	MP/N/IND	INDRAVATI NATIONAL PARK
	121	6C	MP/S/UDA	UDANTI SANCTUARY
	122	6C	MP/S/BHA	BHAIRAMGARH WILD BUFFALO SANCTUARY
	123	6C	MP/S/ACH	ACHANAKMAR SANCTUARY
	124	6C	MP/N/KANG	KANGER GHATI NATIONAL PARK
	125	6D	BIH/S/BHI	BHIMBANDH SANCTUARY
	126	6E	MP/N/PEN	PENCH NATIONAL PARK (Including Pench Sanctuary)
	127	6E	UP/S/KAI	KAIMUR SANCTUARY
	128	6E	MP/N/KAN	KANHA NATIONAL PARK
	129	6E	MP/N/BAN	BANDHAVGARH NATIONAL PARK
	130	6E	MP/S/NAU	NAURADEHI SANCTUARY
	131	6E	MAH/S/YAW	YAWAL SANCTUARY
	132	7A	UP/N/DUD	DUDHWA NATIONAL PARK
	133	7B	WB/S/JAL	JALDAPARA SANCTUARY
	134	8A	ASS/N/KAZ	KAZIRANGA NATIONAL PARK
	135	8A	ASS/S/LAO	LAOKHAWA SANCTUARY
	136	8B	MAN/N/KEI	KEIBUL LAMJAO NATIONAL PARK

Contd. . . .

CATEGORY OF THE PA	*S.No.*	*BIOGEOGRAPHIC PROVINCE*	*CODE*	*NAME*
	137	8B	NAG/S/INT	INTANKI SANCTUARY
	138	10A	GUJ/N/MAR	MARINE NATIONAL PARK
	139	10A	MAH/S/PHA	PHANSAD SANCTUARY
	140	10B	WB/N/SUN	SUNDERBANS NATIONAL PARK
	141	10B	AP/S/PUL	PULICAT SANCTUARY
Subtotal = 52	142	10B	TN/S/POI	POINT CALIMERE SANCTUARY
PAs whose priority can not be determined due to lack of data	143	2A	J&K/S/OVEA	OVERA-ARU SANCTUARY
	144	2D	ARU/S/MOU	MOULING NATIONAL PARK
	145	2D	ARU/S/DIB	DIBANG SANCTUARY
	146	2D	ARU/S/KAM	KAMLANG SANCTUARY
	147	3A	GUJ/S/KAC	KACHH DESERT SANCTUARY
	148	5B	KAR/N/KUD	KUDREMUKH NATIONAL PARK
	149	5B	KAR/S/PUS	PUSHPAGIRI SANCTUARY
	150	5B	MAH/S/KOY	KOYNA SANCTUARY
	151	6A	AP/N/SRI	SRI VENKATESHWARA NATIONAL PARK
	152	6A	AP/S/GUN	GUNDLA BRAHMESHWARAM SANCTUARY
	153	6A	AP/S/SRI	SRI LANKAMELLESWARA SANCTUARY
	154	6A	TN/S/GRI	GRIZZLED SQUIRREL (Srivilliputhur) SANCTUARY
	155	7A	UP/S/SON	SONANADI SANCTUARY
	156	7B	BIH/S/VIK	VIKRAMSHILA DOLPHIN SANCTUARY
	157	7B	WB/N/BUX	BUXA NATIONAL PARK AND SANCTUARY
	158	7B	WB/N/GOR	GORUMARA NATIONAL PARK
	159	8A	ASS/S/DIB	DIBRU SAIKHOWA SANCTUARY
	160	8B	MEG/N/BAL	BALPHAKRAM NATIONAL PARK
	161	10B	AP/S/KRI	KRISHNA SANCTUARY
Subtotal = 20	162	10B	TN/N/MAR	MARINE NATIONAL PARK (Gulf of Mannar)

Note: This table reflects the results of having used a database which was compiled over a decade ago. Consequently, there are a few surprises. For example, PAs like Dampa, Sanjay Gandhi (MAH), Radhanagari, Achanakmar, Marine N.P. (GUJ) etc. are shown as low pressure sites. However, in actual fact the biotic and "developmental" pressures on these PAs are enormous. Similarly many PAs now face pressures of organised poachers operating within their boundaries, a phenomenon which was relatively underrated at the time that the database was compiled.

Table 2: Priority Listing of the High Value PAs

CATEGORY OF THE PA	*S.No.*	*BIOGEOGRAPHIC PROVINCE*	*CODE*	*NAME*
High pressure+Low management and legal status	1	2A	HP/S/TUN	TUNDAH SANCTUARY
	2	2A	HP/S/BAN	BANDLI SANCTUARY
	3	2A	J&K/S/SUR	SURINSAR MANSAR SANCTUARY
	4	2A	HP/S/KHO	KHOKHAN SANCTUARY
	5	2B	HP/S/TAL	TALRA SANCTUARY
	6	2B	HP/S/CHA	CHAIL SANCTUARY
	7	2B	HP/S/NAI	NAINA DEVI SANCTUARY
	8	2B	HP/S/SHIL	SHILLI SANCTUARY
	9	2B	HP/S/MAJ	MAJATHAL SANCTUARY
	10	2B	HP/S/DARL	DARLAGHAT SANCTUARY
	11	4B	RAJ/S/DAR	DARRAH SANCTUARY
	12	4B	RAJ/S/SHE	SHERGARH SANCTUARY
	13	4B	RAJ/S/JAW	JAWAHAR SAGAR SANCTUARY
	14	4B	RAJ/S/PHU	PHULWARI SANCTUARY
	15	4B	MP/S/SAR	SARDARPUR SANCTUARY
	16	5B	MAH/S/BHI	BHIMASHANKAR SANCTUARY
	17	6A	KAR/N/BANN	BANNERGHATTA NATIONAL PARK
	18	6A	KAR/S/ADI	ADICHUNCHANAGIRI SANCTUARY
	19	6B	AP/S/SIW	SIWARAM SANCTUARY
	20	6B	MAH/S/PAI	PAINGANGA SANCTUARY
	21	6D	BIH/S/TOP	TOPCHANCHI SANCTUARY
	22	6E	MP/S/PHE	PHEN SANCTUARY
	23	6E	MP/S/PAN	PANPATHA SANCTUARY
	24	6E	UP/S/MAH	MAHAVIR SANCTUARY
Subtotal = 25	25	7A	UP/S/NAW	NAWABGANJ SANCTUARY
High pressure+High management and legal status	26	2A	HP/S/KAL	KALATOP KHAJJIAR SANCTUARY
	27	2A	J&K/S/NAN	NANDINI SANCTUARY
	28	2A	J&K/S/OVE	OVERA SANCTUARY
	29	4A	HP/S/REN	RENUKA SANCTUARY
	30	4A	J&K/S/JAS	JASROTA SANCTUARY
	31	4B	GUJ/S/BAR	BARDA SANCTUARY
	32	4B	RAJ/S/BHE	BHENSRODGARH SANCTUARY
	33	4B	GUJ/S/DUM	DUMKHAL SLOTH BEAR SANCTUARY
	34	4B	MP/S/PAL	PALPUR KUNO SANCTUARY
	35	4B	MP/S/NAR	NARSINGARH SANCTUARY
	36	4B	MP/S/SAI	SAILANA SANCTUARY
	37	5B	KAR/S/DAN	DANDELI SANCTUARY
	38	5B	GOA/S/BON	BONDLA SANCTUARY
	39	5B	MAH/S/TAN	TANSA SANCTUARY
	40	6A	KAR/S/BLA	BLACK BUCK SANCTUARY (RANEBENNUR)
	41	6A	TN/N/GUI	GUINDY NATIONAL PARK
	42	6B	AP/S/POC	POCHARAM SANCTUARY

Contd. . . .

CATEGORY OF THE PA	*S.No.*	*BIOGEOGRAPHIC PROVINCE*	*CODE*	*NAME*
	43	6B	MAH/N/NAW	NAWEGAON NATIONAL PARK
	44	6B	MAH/S/NAG	NAGZIRA SANCTUARY
	45	6C	MP/S/GOM	GOMARDA SANCTUARY
	46	6C	ORI/S/CHA	CHANDAKA-DAMPADA SANCTUARY
	47	6C	MP/S/BAR	BARNAWAPARA SANCTUARY
	48	6D	BIH/S/GAU	GAUTAM BUDDHA SANCTUARY
	49	6D	ORI/S/HAD	HADGARH SANCTUARY
	50	6D	MP/S/SEM	SEMARSOT SANCTUARY
	51	6D	MP/S/TAM	TAMORE PINGLA SANCTUARY
	52	6D	BIH/S/RAJ	RAJGIR SANCTUARY
	53	6D	MP/S/BAD	BADALKHOL SANCTUARY
	54	6D	BIH/S/LAW	LAWALONG SANCTUARY
	55	6D	ORI/S/NAN	NANDANKANAN SANCTUARY
	56	6E	MP/S/RAT	RATAPANI SANCTUARY
	57	6E	MP/S/SING	SINGHORI SANCTUARY
	58	6E	MP/S/BAG	BAGDARA SANCTUARY
	59	6E	MP/S/KHE	KHEONI SANCTUARY
	60	6E	MP/S/SAN	SANJAY (DUBRI) SANCTUARY
	61	6E	MAH/S/BOR	BOR SANCTUARY
	62	7A	UP/S/KAT	KATERNIAGHAT SANCTUARY
	63	7B	WB/S/BAL	BALLAVPUR SANCTUARY
Subtotal = 39	64	10B	AP/S/COR	CORINGA SANCTUARY
Low pressure+low management and legal status	65	1A	J&K/S/LUN	LUNGNAG SANCTUARY
	66	2A	HP/S/KAI	KAIS SANCTUARY
	67	2B	HP/S/GOB	GOBIND SAGAR SANCTUARY
	68	2B	HP/S/SHIM	SHIMLA WATER SUPPLY CATCHMENT SANCTUARY
	69	2C	SIK/S/FAM	FAMBUNG LHO SANCTUARY
	70	4A	PUN/S/BIRM	BIR MOTIBAGH
	71	4A	PUN/S/BIRG	BIR GURDIAL PURA
	72	4A	PUN/S/BUN	BIR BUNERHERI
	73	4B	RAJ/S/JAM	JAMVA-RAMGARH SANCTUARY
	74	5B	KER/S/CHIN	CHINNAR SANCTUARY
	75	5B	GOA/S/COT	COTIGAO SANCTUARY
	76	5B	KAR/S/NUG	NUGU SANCTUARY
	77	5B	KER/S/THA	THATTEKKAD SANCTUARY
	78	5B	KER/S/PEP	PEPPARA SANCTUARY
	79	5B	KER/S/ARA	ARALAM SANCTUARY
	80	5B	KER/S/PEE	PEECHI-VAZHANI SANCTUARY
	81	6A	KAR/S/RANG	RANGANATHITTU SANCTUARY
	82	6A	KAR/S/MEL	MELKOTE SANCTUARY
	83	6A	KAR/S/GHA	GHATAPRABHA SANCTUARY
	84	6A	TN/S/VED	VEDANTHANGAL SANCTUARY
	85	6C	ORI/S/BAI	BAISIPALLI SANCTUARY

Contd. . . .

CATEGORY OF THE PA	*S.No.*	*BIOGEOGRAPHIC PROVINCE*	*CODE*	*NAME*
	86	6E	UP/S/CHA	CHANDRAPRABHA SANCTUARY
	87	6E	MP/N/FOS	FOSSIL NATIONAL PARK
	88	8B	MAN/N/SIR	SIROY NATIONAL PARK
	89	10B	WB/S/LOT	LOTHIAN ISLAND SANCTUARY
Subtotal = 26	90	10B	ORI/S/BAL	BALUKHAND-KONARK SANCTUARY
Low pressure+High management and legal status	91	2A	J&K/S/RAM	RAMNAGAR SANCTUARY
	92	4A	CHA/S/SUK	SUKHNA SANCTUARY
	93	4A	HP/S/SIM	SIMBALBARA SANCTUARY
	94	4A	HAR/S/SAR	SARASWATI PLANTATION SANCTUARY
	95	4B	RAJ/S/VAN	VAN BIHAR SANCTUARY
	96	4B	RAJ/S/NAH	NAHARGARH SANCTUARY
	97	4B	GUJ/S/KHI	KHIJADAYA SANCTUARY
	98	5B	KER/S/IDU	IDUKKI SANCTUARY
	99	5B	MAH/S/KAL	KALSUBAI HARICHANDRAGAD SANCTUARY
	100	5B	GUJ/N/BAN	BANSDA NATIONAL PARK
	101	6A	AP/S/NEL	NELAPATTU SANCTUARY
	102	6B	MAH/S/DEU	DEULGAON SANCTUARY
	103	6B	MAH/S/NAN	NANDUR MADHMESHWAR SANCTUARY
	104	6B	AP/S/MAN	MANJIRA SANCTUARY
	105	6C	MP/S/PAM	PAMED SANCTUARY
	106	6E	MP/S/SON	SON GHARYAL SANCTUARY
	107	6E	MP/S/KEN	KEN GHARIYAL SANCTUARY
	108	6E	MP/N/VAN	VAN VIHAR NATIONAL PARK
	109	7B	WB/S/RAM	RAMNABAGAN SANCTUARY
	110	8B	MEG/S/SIJ	SIJU SANCTUARY
Subtotal = 21	111	10B	WB/S/SAJ	SAJNAKHALI SANCTUARY

ANNEXURE - A

Proposed Framework for Valuation of PAs

The following is proposed for biodiversity and other positive values.

1. Biodiversity Values:

(a) Occurrence of forest types:

(i) Occurrence of a forest sub type = 2 marks for each forest sub type [source. Questionnaire 1A]

(ii) Occurrence of more than one forest type = 5 marks

(iii) Occurrence of a rare forest type/sub type = 5 marks [source: Rodgers and Panwar]

(b) Occurrence of an under represented biome apart from a forest type e.g deserts, wetlands etc. = 5 marks [source. Rodgers and Panwar & Forest Survey of India]

(c) Occurrence of a species of flora or fauna listed in schedule - I of the Wildlife (Protection) Act, 1972, in a PA which does not occur in any other PA = 10 marks [source. Questionnaire 1A, WII Database & Rodgers and Panwar]

(d) Occurrence of a species of flora or fauna listed in schedule - I of the Wildlife (Protection) Act, 1972, which is found in more than 1 PA and less than or equal to 5 PAs = 8 marks [source: Questionnaire 1A, WII Database & Rodgers and Panwar]

(e) Occurrence of a species of flora or fauna listed in schedule-I of the Wildlife (Protection) Act, 1972, which is found in more than 5 PA s and less than or equal to 10 PAs = 5 marks [source: Questionnaire 1A, WII Database & Rodgers and Panwar]

(f) Occurrence of a species of flora or fauna listed in schedule- I of the Wildlife (Protection) Act, 1972, which is found in more than 10 PAs and less than or equal to 15 PAs = 3 marks [source: Questionnaire 1A, WII Database & Rodgers and Panwar]

(g) Occurrence of a species of flora or fauna listed in schedule-I of the Wildlife (Protection) Act, 1972, which do not fall in categories c). d), e), and f) above = 1 mark per species [source Questionnaire 1A, WII Database]

(h) Value for the size of the PA = Area of the PA(sq km.)/100 upto a maximum of 10 marks

(i) PA adjoining other PAs or linked through corridors to other PAs = Area of the PA/PAs (sq. km.)/100 upto a maximum of 10 marks [source: Rodgers and Panwar, IIPA Database]

(j) PA situated within a biogeographic province where total area covered by PAs is less than or equal to 1% = 10 marks [source. Rodgers and Panwar, List of PAs (MoEF)]

(k) PA situated within a biogeographic province where total area covered by PAs is greater than 1% and less than or equal to 2% =7 marks [source. Rodgers and Panwar, List of PAs (MoEF)]

(l) PA situated within a biogeographic province where total area covered by PAs is greater than 2% and less than or equal to 4% = 4 marks [source: Rodgers and Panwar. List of PAs (MoEF)]

(m) PA situated within a biogeographic province where total number of PAs is less than or equal to 5 = 10 marks [source: Rodgers and Panwar, List of PAs (MoEF)]

(n) PA situated within a biogeographic province where total number of PAs is greater than 5 and less than or equal to 10 = 7 marks [source: Rodgers and Panwar. List of PAs (MoEF)]

(o) PA situated within a biogeographic province where total number of PAs is greater than 10 and less than or equal to 15 = 4 marks [source. Rodgers and Panwar, List of PAs (MoEF)]

The following is proposed for looking at Legal Status and Management Values:

1. Legal Status:

(a) Intended Sanctuary (if notified after the 1991 amendment of the Wildlife (Protection) Act, 1972) = 0.5 marks [source: Questionnaire 1A]

(b) Intended Sanctuary having a legal status of a Reserve Forest = 1 mark [source: Questionnaire 1A]

(c) Intended Sanctuary having no rights within = 1.5 marks [source: Questionnaire 1A]

(d) Intended National Park = 2 marks [source: Questionnaire 1A]

(e) Intended National Park having a legal status of a

Reserve Forest = 2.5 marks [source: Questionnaire 1A]

(f) Intended National Park having no rights within = 3 marks [source Questionnaire 1A]

(g) Sanctuary notified before the 1991 amendment of the Wildlife (Protection) Act, 1972, but not fully set up = 3.5 marks [source: Questionnaire 1A]

(h) Sanctuary not fully set up but having a legal status of a Reserve Forest = 4 marks [source Questionnaire 1A]

(i) Sanctuary not fully set up but having no rights within = 4.5 marks [source: Questionnaire 1A]

(j) Sanctuary fully set up = 5 marks [source Questionnaire 1A]

(k) Sanctuary fully set up and an Intended National Park = 5.5 marks [source: Questionnaire 1A]

(l) Sanctuary fully set up and an Intended National Park as well as having a legal status of a Reserve Forest = 6 marks [source. Questionnaire 1A]

(m) Sanctuary fully set up and an Intended National Park having no rights within = 6.5 marks [source. Questionnaire 1A]

(n) Fully notified National Park = 7 marks [source: Questionnaire 1A]

2. **Management Parameters:**

(a) PAs which have a management plan = 1 mark [source IIPA database, Questionnaire 1A & WII database]

(b) PAs which have a separate budget = 1 mark [source: IIPA database, Questionnaire 1A & WII database]

(c) PAs which have zoning = 1 mark [source. IIPA database, Questionnaire 1A & WII database]

The following is proposed for valuation of pressures or negative values

1. **Biotic Pressures [source IIPA database & Questionnaire 1A] Please note that an absence of any of the pressures will result in the PA getting no marks for those pressures which do not exist. In the case of a PA having no pressures at all, its negative value will be equal to zero.**

(a) Dam for an irrigation or hydel power project:

(i) Area of the reservoir less than or equal to 5% of the PA = 1 mark

(ii) Area of the reservoir more than 5% or equal to 10% of the PA = 2 marks

(iii) Area of the reservoir more than 10% of the PA = 3 marks

(b) Tourism.

(i) Area occupied by the tourism project less than or equal to 5% of the PA = 1 mark

(ii) Area occupied by the tourism project more than 5% and equal to 10% of the PA = 2 marks

(iii) Area occupied by the tourism project more than 10% of the PA = 3 marks

(iv) Density of tourists visiting the PA annually below or equal to the 33 percentile class density of tourists visiting all other PAs annually = 1 mark

(v) Density tourists visiting the PA annually more than 33 or equal to 66 percentile class density of tourists visiting all other PAs annually = 2 marks

(vi) Density of tourists visiting the PA annually more than 66 percentile class density of tourists visiting all other Pas annually = 3 marks

(c) Mining/Quarrying

(i) Area occupied by the mining/quarrying project less than or equal to 5% of the PA = 1 mark

(ii) Area occupied by the mining/quarrying project more than 5% and equal to 10% of the PA = 2 marks

(iii) Area occupied by the mining/quarrying project more than 10% of the PA = 3 marks

(d) Plantations.

(i) Area of the PA used for plantations less than or equal to 5% of the PA = 1 mark

(ii) Area of the PA used for plantations more than 5% and equal to 10% of the PA = 2 marks

(iii) Area of the PA used for plantations more than 10% of the PA = 3 marks

(e) Electrical cables/transmission lines

(i) Electrical cables transmission lines within the PA = 2 mark

(f) PWD Roads/Highways

(i) PWD Roads/Highways within the PA = 2 marks

(g) Habitation.

(i) Area of habitation less than or equal to 5% of the PA = 1 mark

(ii) Area of habitation more than 5% or equal to 10% of the PA = 2 marks

(iii) Area of cultivation greater than 10% of the PA = 3 marks

(iv) Density of population less than or equal to 33% of the density of population of the district(s) in which the PA is located = 1 mark

(v) Density of population more than 33% and less than or equal to 66% of the density of population of the district(s) in which the PA is located = 2 marks

(vi) Density of population more than 66% of the density of population of the district(s) in which the PA is located = 3 marks

(h) Cultivation:

(i) Area of cultivation less than or equal to 5% of the PA = 1 mark

(ii) Area of cultivation more than 5% or equal to 10% of the PA = 2 marks

(iii) Area of cultivation greater than 10% of the PA = 3 marks

(i) Pilgrimage:

(i) Area of pilgrimage spot(s) less than or equal to 5% of the PA = 1 mark

(ii) Area of pilgrimage spot(s) more than 5% or equal to 10% of the PA = 2 marks

(iii) Area of pilgrimage spot(s) greater than 10% of the PA = 3 marks

(iv) Density of pilgrims visiting the PA annually less than or equal to the 33 percentile class or pilgrims visiting all other PAs annually = 1 mark

(v) Density of pilgrims visiting the PA annually more than 33 percentile or equal to 66 percentile class of pilgrims visiting all other PAs annually = 2 marks

(vi) Density of pilgrims visiting the PA annually more than 66 percentile class of pilgrims visiting all other PAs annually = 3 marks

(j) Fishing:

(i) Area impacted by fishing less than or equal to 5% of the PA = 1 mark

(ii) Area impacted by fishing more than 5% or equal to 10% of the PA = 2 marks

(iii) Area impacted by fishing greater than 10% of the PA = 3 marks

(iv) Quantum of extraction per sq. km. of fish less than or equal to the 33 percentile class of the per sq. km. extraction of fish from PAs = 1 mark

(v) Quantum of extraction per sq. km of fish more than 33 or equal to 66 percentile class of the per sq km. extraction of fish from PAs = 2 marks

(vi) Quantum of extraction per sq. km. of fish more than 66 percentile class of the per sq. km extraction of fish from PAs = 3 marks

(k) Timber Extraction.

(i) Area impacted by timber extraction less than or equal to 5% of the PA = 1 mark

(ii) Area impacted by timber extraction more than 5% or equal to 10% of the PA = 2 marks

(iii) Area impacted by timber extraction greater than 10% of the PA = 3 marks

(iv) Quantum of extraction per sq. km. of timber less than or equal to 33 percentile class of the per sq. km. extraction of timber from PAs = 1 mark

(v) Quantum of extraction per sq. km. of timber more than 33 percentile or equal to 66 percentile class of the per sq. km. extraction of timber from PAs = 2 marks

(vi) Quantum of extraction per sq. km. of timber more than 66 percentile class of the per sq. km. extraction of timber from PAs = 3 marks

(l) Fuelwood Extraction.

(i) Area impacted by fuelwood extraction less than or equal to 5% of the PA = 1 mark

(ii) Area impacted by fuelwood extraction more than 5% or equal to 10% of the PA = 2 marks

(iii) Area impacted by fuel wood extraction greater than 10% of the PA = 3 marks

(iv) Quantum of extraction per sq. km. of fuelwood less than or equal to 33 percentile class of the per sq km. extraction of fuelwood from PAs = 1 marks

(v) Quantum of extraction per sq km. of fuelwood more than 33 percentile or equal to 66 percentile class of the per sq. km. extraction of fuelwood from PAs = 2 marks

(vi) Quantum of extraction per sq km. of fuelwood more than 66 percentile class of the per sq. km. extraction of fuelwood from PAs = 3 marks

(m) NWFP Extraction:

(i) Area impacted by NWFP extraction less than or equal to 5% of the PA = 1 mark

(ii) Area impacted by NWFP extraction more than 5% or equal to 10% of the PA = 2 marks

(iii) Area impacted by NWFP extraction greater than 10% of the PA = 3 marks

(iv) Quantum of extraction per sq. km. of NWFP less than or equal to 33 percentile class of the per sq. km. extraction of NWFP from PAs = 1 marks

(v) Quantum of extraction per sq km of NWFP more than 33 percentile or equal to 66 percentile class of the per sq. km. extraction of NWFP from PAs = 2 marks

(vi) Quantum of extraction per sq. km of NWFP more than 66 percentile class of the per sq. km extraction of NWFP from PAs = 3 marks

(n) Fodder Extraction:

(i) Area impacted by fodder extraction less than or equal to 5% of the PA = 1 mark

(ii) Area impacted by fodder extraction more than 5% or equal to 10% of the PA = 2 marks

(iii) Area impacted by fodder extraction greater than 10% of the PA = 3 marks

(iv) Quantum of extraction per sq. km of fodder less than or equal to 33 percentile class of the per sq. km. extraction of fodder from PAs = 1 mark

(v) Quantum of extraction per sq. km of fodder more than 33 percentile or equal to 66 percentile class of the per sq. km extraction of NWFP from PAs = 2 marks

(vi) Quantum of extraction of fodder more than 66 percentile class of the per sq. km extraction of fodder from PAs = 3 marks

(o) Grazing

(i) Area impacted by Grazing less than or equal to 5% of the PA = 1 mark

(ii) Area impacted by grazing more than 5% or equal to 10% of the PA = 2marks

(iii) Area impacted by grazing greater than 10% of the PA = 3 marks

(iv) Density of cattle units grazing in the PA less than the density of cattle units in the district in which the PA is located = 1 mark

(v) Density of cattle units grazing in the PA equal to the density of cattle units in the district in which he PA is located = 2 marks

(vi) Density of cattle units grazing in the PA less more than the density of cattle units in the district in which the PA is located = 3 marks

(p) Forest Fires:

(i) Area impacted by forest fires less than or equal to 5% of the PA = 1 mark

(ii) Area impacted by forest fires more than 5% or equal to 10% of the PA =2 marks

(iii0 Area impacted by forest fires greater than 10% of the PA = 3 marks

(q) Weed infestation:

(i) Area impacted by weed infestation less than or equal to 5% of the PA = 1 mark

(ii) Area impacted by weed infestation more than 5% or equal to 10% of the PA = 2 marks

(iii) Area impacted by weed infestation greater than 10% of the PA = 3 marks

2. **Poaching**

(a) Existence of Poaching of animals = 2 marks

(b) Existence of illegal cutting of trees = 2 marks

(c) Poaching or illegal cutting of trees being done by organised gangs of poachers = 3 marks

ANNEXURE – B

Information which is needed for Prioritisation of protected areas but is either not yet incorporated or is not yet available

Data for many of the parameters which have been identified in annexure A for the valuation of protected areas are either still not available or not yet incorporated. The details for these are given below

- Data for occurrence of schedule-I species of the of the Wildlife (Protection) Act, 1972, are not incorporated except for mammals (page 18 para 1 e to para 1g, of the framework for valuation of PAs). This is because we were unable to find a comprehensive listing of reptiles, amphibians, fish, birds, and plants for PAs in India
- Data for some of the parameters identified to evaluate pilgrimage is not yet available (page 21-22, para 1i(iv) to para 1i(vi)) Information regarding these parameters will be collected from the state governments
- Data for some of the parameters identified to evaluate fishing is not yet available (page 22, para 1j(iv) to para 1j(vi)) Information regarding these parameters will be collected from the state governments
- Data for some of the parameters identified to evaluate timber extraction is not yet available (page 22, para 1k(iv) to para 1k(vi)). Information regarding these parameters will be collected from the state governments.
- Data for some of the parameters identified to evaluate fuelwood extraction is not yet available (page 23, para 1l(iv) to para 1l(vi)). Information regarding these parameters will be collected from the state governments.
- Data for some of the parameters identified to evaluate NWFP extraction is not yet available (page 23, para 1m(iv) to para 1m(vi)). Information regarding these parameters will be collected from the state governments
- Data for some of the parameters identified to evaluate fodder extraction is not yet available (page 23, para 1n(iv) to para 1n(vi)). Information regarding these parameters will be collected from the state governments.
- Data on poaching is not available (page 24, para 2) Information regarding these parameters will be collected from the state governments.

An attempt was made to try and gather data for evaluating PAs for their non-use socio economic values or ecological functions Scanty data on carbon sequestration was available from a few sources. However, it was not enough to be able to use it for evaluation of ecological functions of PAs. A secondary literature search is still being done to try and see if any detailed information is available on ecological functions like carbon sequestration, maintenance of hydrological cycles, enrichment of soils etc

ANNEXURE-C

LIST OF HIGH PRIORITY PAs WHICH HAVE NOT BEEN EVALUATED DUE TO LACK OF DETAILED DATA SETS

S.No.	*Code*	*BIO-GEOGRAPHIC PROVINCE*	*NAME OF THE PA*	*AREA OF THE PA (hectares)*	*JUSTIFICATION*
1	AP/N/SRIV	6A	SRI VENKATESWARA NATIONAL PARK	35262.00	ONE OF THE ONLY TWO LOCATIONS IN INDIA FROM WHERE THE GOLDEN GECKO IS REPORTED [PERS. COMM., AJITH KUMAR, RODGERS AND PANWAR]
2	AP/S/GUN	6A	GUNDLA BRAHMESHWARAM SANCTUARY	119400.00	CONTAINS THE RARE ALBIZIA-HARDWICKIA MIXED DECIDUOUS FOREST COMMUNITIES [RODGERS AND PANWAR]
3	AP/S/KRI	10B	KRISHNA SANCTUARY	19481.00	NOTIFIED FOR THE PROTECTION OF KRISHNA DELTA MANGROVES [RODGERS AND PANWAR]
4	AP/S/SRIL	6A	SRI LANKAMALLESWARA SANCTUARY	46442.00	HOME TO THE JERDON'S COURSER [RODGERS AND PANWAR]
5	ARU/N/MOU	2D	MOULING NATIONAL PARK	48300.00	HAS RARE FAUNA LIKE WHITE WINGED WOOD DUCK, CLOUDED LEOPARD, RED PANDA, LINSANG. [RODGERS AND PANWAR]
6	ARU/SDIB	2D	DIBANG	414900.00	ONE OF THE FEW SITED FROM WHERE THE EXTREMELY RARE TEMMINCK'S TRAGOPAN IS REPORTED [ALI AND RIPLEY]
7	ARU/S/KAM	2D	KAMLANG	78300.00	ONE OF THE FEW LOCATIONS FROM WHERE THE EXTREMELY RARE SCLATER'S MONAL IS REPORTED [ALI AND RIPLEY]
8	ASS/S/DIB	8A	DIBRU SAIKHOWA SANCTUARY	64000.00	CONTAINS A WETLAND IMPORTANT FOR MIGRATORY WATER FOWL AS WELL AS WILD BUFFALO, ELEPHANT, TIGER [RODGERS AND PANWAR]
9	BIH/S/DAL	6D	DALMA SANCTUARY	19322.10	IMPORTANT NON USE SOCIO ECONOMIC VALUES FOR THE CITY OF JAMSHEDPUR. ALSO HAS SIGNIFICANT ELEPHANT POPULATION AND IS REPRESENTATIVE OF THE *SHOREA-CLEISTANTHUS CROTON* VEGETATION TYPE [RODGERS AND PANWAR]
10	BIH/S/VIK	7B	VIKRAMSHILA DOLPHIN SANCTUARY	5000.00	FOR THE PROTECTION OF THE THREATENED GANGETIC DOLPHIN
11	GUJ/S/KAC	3A	KACHCHH DESERT SANCTUARY	750622.00	CONTAINS SEVERAL BREEDING SITES FOR THE FLAMINGO [RODGERS AND PANWAR]
12	HAR/N/SUL	4A	SULTANPUR NATIONAL PARK	117.37	WATERFOWL VALUES OF NATIONAL IMPORTANCE [RODGERS AND PANWAR]
13	HAR/S/BHI	4A	BHINDAWAS SANCTUARY	406.00	IMPORTANT WATERFOWL VALUES [RODGERS AND PANWAR]
14	HP/S/SEC	2A	SECHU TUAN NALA SANCTUARY	10295.00	BORDERS LADAKH AND HAS SNOW LEOPARD, BROWN BEAR, HIMALAYAN TAHR, BHARAL, IBEX [RODGERS AND PANWAR]

Contd. . . .

S.No.	*Code*	*BIO-GEOGRAPHIC PROVINCE*	*NAME OF THE PA*	*AREA OF THE PA (hectares)*	*JUSTIFICATION*
15	J&K/S/OVEA	2A	OVERA-ARU SANCTUARY	42500.00	CONTAINS A POPULATION OF MARKHOR [RODGERS AND PANWAR]
16	KAR/N/KUD	5B	KUDREMUKH NATIONAL PARK	60032.00	THE EXTREMELY RARE MALABAR CIVET FOUND IN THE PA. IMPORTANT POPULATION OF THE LION TAILED MACAQUE. NORTHERN EXTENT OF THE SHOLA FORESTS. [PERS. COMM. AJITH KUMAR, RODGERS AND PANWAR]
17	KAR/S/BRA	5B	BRAHMAGIRI SANCTUARY	18129.00	ONE OF THE ONLY TWO LOCATIONS IN INDIA FROM WHERE THE TOAD ANSORIA ORNATAIS REPORTED [PERS. COMM., AJITH KUMAR]
18	KAR/S/PUS	5B	PUSHPAGIRI SANCTUARY	10292.00	ONE OF THE ONLY TWO LOCATIONS IN INDIA FROM WHERE THE TOAD *ANSORIA ORNATA* IS REPORTED [PERS. COMM., AJITH KUMAR]
19	MAH/S/GRE	6B	GREAT INDIAN BUSTARD SANCTUARY	781847.00	AS IS EVIDENT, IT IS ONE OF THE FEW PAs WHICH IS HOME TO THE GREAT INDIAN BUSTARD
20	MAH/S/KOY	5B	KOYNA SANCTUARY	42305.00	CONTAINS IMPORTANT EXAMPLES OF NORTHERN EVERGREEN AND SEMI-EVERGREEN FOREST COMMUNITIES. ONE OF THE ONLY TWO LOCATIONS IN INDIA FROM WHERE THE TOAD *BUFO KOYAENENSIS* IS REPORTED [RODGERS AND PANWAR, PERS. COMM., AJITH KUMAR]
21	MAH/S/PHA	5A& 10A	PHANSAD SANCTUARY	5387.00	STRADDLES TWO BIOGEOGRAPHIC PROVINCES. CONTAINS RARE MALABAR PLAINS HABITAT [RODGERS AND PANWAR]
22	MEG/N/BAL	8B	BALPHAKRAM NATIONAL PARK	39922.00	POSSIBLE OCCURRENCE OF THE MALAYAN SUN BEAR AND HOME TO THE BUSHTAILED PORCUPINE [RODGERS AND PANWAR, PERS. COMM., AJITH KUMAR]
23	MIZ/S/DAM	8B	DAMPA SANCTUARY	68100.00	IMPORTANT FOR THE CONSERVATION OF BIOLOGICAL VALUES OF THE STATE [RODGERS AND PANWAR]. HAS ALSO BEEN NOTIFIED AS A TIGER RESERVE.
24	NAG/S/INT	8B	INTANKI SANCTUARY	20220.00	IMPORTANT FOR THE CONSERVATION F BIOLOGICAL VALUES OF THE STATE [RODGERS AND PANWAR]
25	ORI/N/BHI	10B	BHITARKANIKA (GAHIRMATHA) NATIONAL PARK AND SANCTUARY	53700.00	WORLD'S MOST IMPORTANT NESTING SITE FOR THE OLIVE RIDLEY TURTLES [RODGERS AND PANWAR]
26	PUN/S/HAR	4A	HARIKE LAKE	8600.00	WATERFOWL VALUES OF NATIONAL IMPORTANCE [RODGERS AND PANWAR]
27	RAJ/S/RAM	4B	RAMGARH SANCTUARY	30700.00	NATURAL GRASSLAND WITH A VIABLE GREAT INDIAN BUSTARD POPULATION [RODGERS AND PANWAR]

Contd. . . .

S.No	*Code*	*BIO-GEOGRAPHIC PROVINCE*	*NAME OF THE PA*	*AREA OF THE PA (hectares)*	*JUSTIFICATION*
28	TN/N/MAR	10B	GULF OF MANNAR MARINE NATIONAL PARK	623.00	IMPORTANT FOR THE GREEN SEA TURTLE AND DUGONG AND DOLPHIN POPULATION [RODGERS AND PANWAR, DANIEL, J.C.]
29	TN/S/GRI	6A	GRIZZLED SQUIRREL (SRIVILLIPUTHUR) SANCTUARY	48520.00	IMPORTANT POPULATIONS OF THE GRIZZLED GIANT SQUIRREL AND NILGIRI TAHR [PERS. COMM., AJITH KUMAR]
30	TN/S/POI	10B	POINT CALIMERE SANCTUARY	1728.76	HAS BLACKBUCK, WATERFOWL, MANGROVE, SALT MARSH, MUD FLATS, DRY EVERGREEN FOREST VALUES [RODGERS AND PANWAR]
31	UP/N/GOV	2B	GOVIND PASHU VIHAR (National Park and Sanctuary)	142520.00	A VALUABLE AREA REPRESENTING THE WESTERN HIMALAYAN BIO-GEOGRAPHIC PROVINCE [RODGERS AND PANWAR]
32	UP/S/SON	7A	SONANADI SANCTUARY	30176.00	PART OF THE ONLY REMAINING HABITAT OF THE ELEPHANT IN NORTH INDIA. ADJOINS CORBETT NATIONAL PARK AND IS A PART OF THE RAJAJI CORBETT ELEPHANT CORRIDOR. [RODGERS AND PANWAR]
33	WB/N/BUX	7B	BUXA NATIONAL PARK AND SANCTUARY (TIGER RESERVE)	36899.00	EGG EATING SNAKE, TIGER, RHINOCEROS AND ELEPHANT [PERS. COMM., AJITH KUMAR]
34	WB/N/GOR	7B	GORUMARA NATIONAL PARK AND SANCTUARY	8818 00	LARGE POPULATION OF RHINOS
35	WB/S/SEN	2C	SENCHAL SANCTUARY	3860.00	THE ONLY LOCATION FROM WHERE THE FROG *RANA SENCHALENSIS* IS REPORTED [PERS. COMM., AJITH KUMAR]

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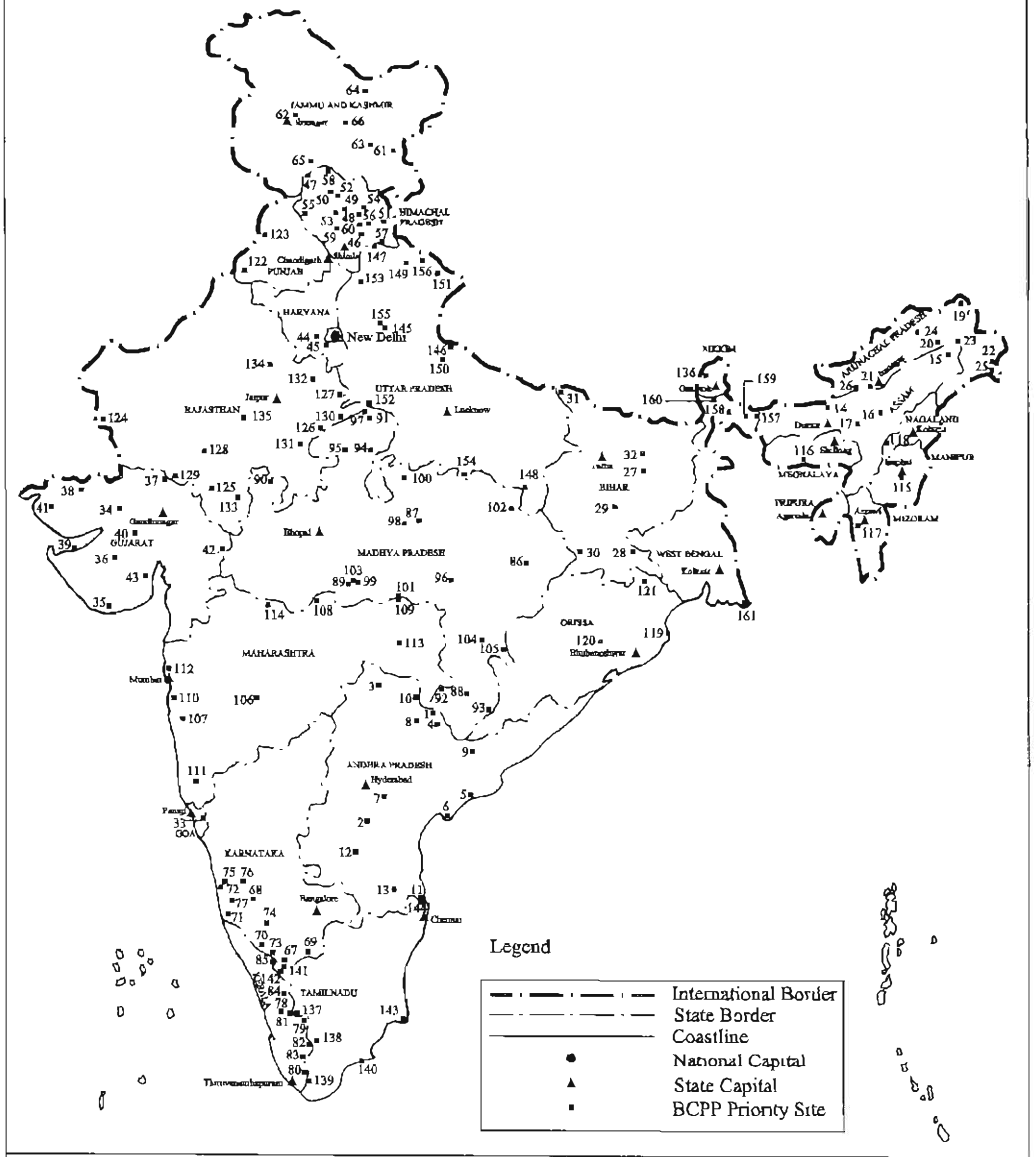
(National Parks and Sanctuaries)



ANDHRA PRADESH
1 - Eturunagaram Sanctuary
2 - Gundla Brahmeshwaram Sanctuary
3 - Kawal Sanctuary
4 - Kinnerasani Sanctuary
5 - Kolleru Sanctuary
6 - Krishna Sanctuary
7 - Nagarjunasagar-Srisailam Tiger Reserve
8 - Pakhal Sanctuary
9 - Papikonda Sanctuary
10 - Pranahita Sanctuary
11 - Pulicat Sanctuary
12 - Sri Lankamalleswara Sanctuary
13 - Sri Venkateshwara National Park
ASSAM
14 - Barnadi Sanctuary
15 - Dibru-Saikhowa Sanctuary
16 - Kaziranga National Park
17 - Laokhowa Sanctuary
18 - Manas National Park
ARUNACHAL PRADESH
19 - Dibang Sanctuary
20 - D'Ering (Lali) Sanctuary
21 - Itanagar Sanctuary
22 - Kamlang Sanctuary
23 - Mehao Sanctuary
24 - Mouling National Park
25 - Namdapha National Park
26 - Pakhal Sanctuary
BIHAR
27 - Bhimbandh Sanctuary
28 - Dalma Sanctuary
29 - Hazaribagh Sanctuary
30 - Palamau Sanctuary
31 - Valmiki Tiger Reserve
32 - Vikramshila Gangetic Dolphin Sanctuary
GOA
33 - Bhagwan Mahaveer National Park and Sanctuary
GUJARAT
34 - Dhrangadhra (Wild Ass) Sanctuary
35 - Gir National Park
36 - Hingolgarh Sanctuary
37 - Jessore Sanctuary
38 - Kachchh Desert Sanctuary
39 - Marine National Park and Sanctuary
40 - Nal Sarovar Sanctuary
41 - Narayan Sarovar Sanctuary
42 - Rasnnahal Sanctuary
43 - Velavadar National Park
HARYANA
44 - Bhindawas Sanctuary
45 - Sultanpur National Park
HIMACHAL PRADESH
46 - Darangdori Sanctuary
47 - Gamgul Siabehi Sanctuary
48 - Great Himalayan National Park
49 - Kanawar Sanctuary
50 - Kugti Sanctuary
51 - Lippa Asrang Sanctuary
52 - Manali Sanctuary
53 - Nargu Sanctuary
54 - Pin Valley National Park
55 - Pong Lake Sanctuary
56 - Rupi Bhaba Sanctuary
57 - Sangla Sanctuary
58 - Sechu Tuan Nalah Sanctuary
59 - Shikari Devi Sanctuary
60 - Tirthan Sanctuary
JAMMU AND KASHMIR
61 - Changthang Sanctuary
62 - Dachigam National Park
63 - Hemis National Park
64 - Karakoram Sanctuary
65 - Kishtwar National Park
66 - Overa-Aru Sanctuary
KARNATAKA
67 - Bandipur National Park
68 - Bhadra Sanctuary
69 - Biligiri Rangaswamy Temple Sanctuary
70 - Brahmagiri Sanctuary
71 - Kudremukh National Park
72 - Mookambika Sanctuary
73 - Nagarahole National Park
74 - Pushpagiri Sanctuary
75 - Sharavathi Valley Sanctuary
76 - Shettihally Sanctuary
77 - Someshwara Sanctuary
KERALA
78 - Chimony Sanctuary
79 - Eravikulam National Park
80 - Neyyar Sanctuary
81 - Parambikulam Sanctuary
82 - Periyar National Park and Sanctuary
83 - Shendurney Sanctuary
84 - Silent Valley National Park
85 - Wayanad Sanctuary
MADHYA PRADESH
86 - Achanakmar Sanctuary
87 - Bandhavgarh National Park
88 - Bhoramgarh Wild Buffalo Sanctuary
89 - Bori Sanctuary
90 - Gandhi Sagar Sanctuary
91 - Ghatigaon Great Indian Bustard Sanctuary
92 - Indravati National Park
93 - Kanger Ghati National Park
94 - Karera Great Indian Bustard Sanctuary
95 - Madhav National Park
96 - Kanha National Park
97 - National Chambal Sanctuary
98 - Noradehi Sanctuary
99 - Pachmarhi Sanctuary
100 - Panna National Park
101 - Pench National Park and Sanctuary
102 - Sanjay National Park
103 - Satpura National Park
104 - Sitanadi Sanctuary
105 - Udanti Sanctuary
MAHARASHTRA
106 - Great Indian Bustard Sanctuary
107 - Koyna Sanctuary
108 - Melghat Sanctuary
109 - Pench National Park
110 - Phansad Sanctuary
111 - Radhanagari Bison Sanctuary
112 - Sanjay Gandhi National Park
113 - Tadoba National Park
114 - Yawal Sanctuary
MANIPUR
115 - Keibul Lamjao National Park
MEGHALAYA
116 - Balphakram National Park
MIZORAM
117 - Dampa Sanctuary
NAGALAND
118 - Intanki National Park
ORISSA
119 - Bhitarkanika Sanctuary
120 - Satkosia Gorge Sanctuary
121 - Similipal National Park and Sanctuary
PUNJAB
122 - Abohar Sanctuary
123 - Harike Lake Sanctuary
RAJASTHAN
124 - Desert National Park
125 - Jaisamand Sanctuary
126 - Kaila Devi Sanctuary
127 - Keoladeo Ghana National Park
128 - Mount Abu Sanctuary
129 - Nahargarh Sanctuary
130 - National Chambal Sanctuary
131 - Ranthambhore National Park
132 - Sariska National Park and Sanctuary
133 - Sita Mata Sanctuary
134 - Tal Chhapper Sanctuary
135 - Todgarh Raok Sanctuary
SIKKIM
136 - Khangchendzonga National Park
TAMILNADU
137 - Anamalai Sanctuary
138 - Gravelled Spurred Sanctuary
139 - Kalakad Mundanthurai Tiger Reserve
140 - Mannar Marine Park
141 - Mudumalai Sanctuary
142 - Mukurthi National Park
143 - Point Calimere Sanctuary
144 - Pulicat Lake Sanctuary
UTTAR PRADESH
145 - Corbett National Park
146 - Dudhwa National Park
147 - Govind Pashuvihar Sanctuary
148 - Kishan Sanctuary
149 - Kudrahah Sanctuary
150 - Kishanpur Sanctuary
151 - Nanda Devi National Park
152 - Nawabganj Sanctuary
153 - Rajaji National Park
154 - Rampur Sanctuary
155 - Samaspur Sanctuary
156 - Valley of Flowers National Park
WEST BENGAL
157 - Buxa National Park and Sanctuary
158 - Gorumara National Park
159 - Jaldapara Sanctuary
160 - Singalila Sanctuary
161 - Sundarban National Park

Map Prepared by the Indian Institute of Public Administration

Prioritisation of Biodiversity Rich Sites in the State of Tripura

A.K. Gupta

Introduction

General

The State of Tripura (22°56' - 24°32' N and 91°10' - 92°21' E, with the tropic of cancer passing through it), with a geographical area of 10,490 km² is smallest of the seven North-eastern States in India. It is predominantly hilly and is surrounded on the north, west and south by the deltic basin of Bangladesh (a total of 837 km long international border) and on the east by two other northeast Indian states of Assam (Cachar district) and Mizoram. The maximum length from north to south is 183.5 km, and the maximum breadth from east to west is 112.7 km.

Tripura, a former princely state, was integrated with the Indian Union in 1949, as a part 'C' State and subsequently given the status of a fully-fledged State in 1972. Four districts (North, Dhalai, West and South) and 14 Sub-divisions have about 3626 villages. Human population in the state is about 2.6 million (Census of Tripura, 1992), including 19 tribal communities making up about 30% of the State's population. Tripuri, Chakma, Reang, Halam, Jamatia, Mog, Noatia, Garo and Lushai are some of the prominent tribal communities. The other 70% of the population are Hindu *Bengalis*

Physiography

The area represents the western fringe of typical 'Ridge and Valley (structural) Province' of the late Tertiary fold mountain belt, commonly known as the Indo-Burman Ranges (Purbanchal Range). Physiographically, the State has three distinct zones: (i) hill ranges, (ii) undulating high lands of narrow and broken plateau and (iii) lowlands and river flats (Nandy *et al.* 1983).

Climate

Tripura falls within the tropical zone and is characterised by a warm and humid climate with three distinct seasons: summer; winter; and monsoon. Winter is short followed by a brief spell of spring. During the winter season, temperature varies between 22.5°C and 10.4°C. The period from March to May is the summer season, during which the temperature ranges between a maximum and minimum of 35.6°C and 21°C. The highest temperature recorded so far at Agartala is 41.1°C (in May 1968), and the lowest is 5.2°C (in February 1968). The maximum rainfall is received in the months of June and July, and the average annual rainfall in the State is about 2100.7 mm (82.07"). During the summer, the rainfall is generally accompanied by thunder storms. Humidity is about 50% to 75% during the summer months, but it is generally over 85% during the monsoon months.

Geology and Soil

The rock formations in the State range in age from lower Tertiary (40 million years) to Recent (1 million). The north of the State is characterised by sedimentary rocks, which are grouped into three (i) the Surma Group (further sub-divided into the Bhuban and Bokabali formations); (ii) Tipam Group, and (iii) Dupi-Tila Group. The soil and bed rocks in Tripura are subject to severe chemical weathering and rapid erosion due to high rainfall in the State. The humid monsoon climate in the State has given rise to five broad groups of soil, namely (i) reddish yellow brown sandy soil, (ii) red loam and sandy soil, (iii) older alluvial soil, (iv) younger alluvial soil, and (v) lateritic soil (Gupta 1996). On the basis of topography, the soil is divided into two main types (i) soils of high land, and (ii) soils of lowland.

Forest types in Tripura

Forests cover more than 60% of the total geographical area of Tripura. Based on climate and altitude, the forests of Tripura are classified as tropical forests. Based on the classification system of Champion and Seth (1968). Deb (1981) has classified the forest types in Tripura into four

major types, each with several sub-types:

1. Climatic types
   - 1.1 evergreen forests
   - 1.2 moist deciduous forests
     - (a) sal forest
     - (b) moist deciduous mixed forest
2. Seral types
   - 2.1 swamp vegetation
3. Subsidiary edaphic types
   - 3.1 bamboo forests
   - 3.2 cane brakes
   - 3.3 garjan (Dipterocarpus) forests
   - 3.4 savannah
   - 3.5 grassland vegetation

The evergreen forests covered most of the State in the past, but now exist only in patches on steep slopes, rocky and river banks and localities which are thinly populated and are unsuitable for human use.

The moist-deciduous forests are characterised by the presence or absence of sal (*Shorea robusta*) Swamps, locally called lunga, occupy a very large area all over the State. It is mostly composed of herbaceous species, some are woody shrubs and a few scattered trees.

About 26 species of bamboo have resulted from repeated biotic influence (shifting cultivation, fire, grazing, soil erosion, and so forth).Cane stands are impregnable thorny thickets that occur in evergreen and moist deciduous forests and appear to be conspicuous where soil is fine clay and very rich in humus.Garjan (Dipterocarpus) forests, which were once found abundantly all over the State, are now restricted to fewer areas in North, South and West districts (Sonamura).Savannahs (with less than 20 stems per hectare) are the result of destruction of forests due to repeated annual fire, heavy grazing and shifting cultivation All the scattered grasslands present in the State are of recent origin, following large-scale destruction of natural forests mainly due to non-traditional shifting cultivation.Plantation forests of different timber species are being raised in the State since 1932-33, but systematic large scale commercial plantations of various species were started only in the early sixties.

Fauna Diversity in Tripura

Based on the collections made by F Skipwith, A Gorbe and J Barbe in the middle of 19th century, Blyth (1844, 1847), Sclater (1891), Pocock (1939) and Khajuria (1954, 1955) have described the past faunal diversity in Tripura. Singha (1897) also reported large populations of rhinoceros, elephant, tiger, leopard, langurs and monkeys in Tripura.

The first scientific survey was by Aggarwal and Bhattacharjee in 1977, in which 31 species and sub-species of mammalian fauna were documented in the State. Bhattacharjee and Chakraborty (1986) recorded 56 mammalian species belonging to 9 Order and 20 Families. The latest estimate by Gupta and Mukherjee (1994) put the number of land-mammal species at 90, from 65 genera and 10 orders. These make up about 19, 48, and 100% of the total species, genera, and order of land-mammals in India (Table 1). Of a total of 15 species of non-human primates in India, 7 (46.7%) are documented from Tripura (Gupta and Kumar 1994, Gupta 1994). These also include some of the highly rare, endemic and endangered species: Hoolock gibbon, slow loris, capped langur, Phayre's langur, stump-tailed macaque and pig-tailed macaque.

The total number of orders, families, genera, and species of mammalian fauna in Tripura, which are included into Schedule I of the Wildlife (Protection) Act (India), are 5 (50%), 12(41%), 14(22%), and 18(20%) respectively. Similarly, 4 (40%) orders, 9(31%) families, 10(15%) genera, and 14(15%) species of land mammals in Tripura also form a part of Appendix I of CITES.

Apart from the rich diversity of mammalian species, Tripura could be regarded as one of the unique habitats for a large number of varied bird species, reptilians, amphibians, fishes, and invertebrates very similar to the entire Northeastern Region.

Statement of Objectives

The project was envisaged with the following **objectives**.

- To develop a participatory methodology for setting biodiversity conservation priorities for Tripura, across disciplines and levels.
- To prepare, in a participatory manner, a document describing priority sites, species and strategies for biodiversity conservation.
- To develop, in a participatory manner site specific biodiversity conservation plans, for a few priority sites.
- To assist in strengthening the capacity of multiple stakeholders to do a science based independent assessment of the processes of setting priorities, developing site specific conservation plans, and channelling funds for biodiversity conservation.

Statement of the Process and Methodology

1. A territorial forest division was selected as a unit for identification and finalisation of selection of conservation hot-spots all over the State, based on the convenience of

working given the available administrative support machinery.

2. The concepts and ideas behind identification and prioritisation of conservation hot-spots was discussed with the field level staff and major emphasis was given on establishing the need of this exercise in view of the limited administrative and financial resources at their disposal

3. Different values and sub-values, based on which each identified area was to be assessed, were identified, discussed and finalised. These were mostly based on the description by Singh and Taneja (1996) in their paper 'Prioritisation for Biodiversity Conservation· Values and Criteria`

4 A seminar was organised at the district level with participation from different NGO groups, members of the public, members of various functional Joint Forestry Management (JFM) Committees, to tentatively identify and select conservation hot-spots spread over the Southern Forestry Circle (SFC). A maximum of four hot-spots from each forest division under SFC were identified and finalised.

There was a clear polarisation in the approach and criteria for the selection of the type of areas as hot-spots among forest officials and the other three categories of participants. While the main concern of the forest officials was to impart total protective cover to varied flora and fauna, the main concern of other categories of participants was for the socio-economic benefits for the local human populations inhabiting the hot-spot areas. Involvement of local NGOs in the symposium greatly helped in opening up another line of action.

5. A State level workshop was organised in November 1997, with participation from forest officials, NGO groups, local public representatives, members of functional JFM Committees, and academicians from colleges and from Tripura University.

A total of 36 hot-spots were identified and selected for further assessment and prioritisation. List of resource persons was finalised to carry out the assessment work on the selected conservation hot-spots and recommend necessary changes in the methods and approaches for the on-going assessment exercise, if so required.

6. The assessment exercise was completed in about 20 days. Out of a total of 36 sites initially chosen as hot-spots for assessment, only 30 could be so assessed while the remaining six sites could not be approached due to prevailing law and order situation in the State.

7. The location of each of the selected and assessed hot-spots was, however, marked on the map of Tripura. The total area and natural boundaries were also determined and noted during the assessment exercise.

8. The assessment of each of the sites was based on 4 major values, namely, Biodiversity Values, Taxa-based Values, Socio-economic Values, and Conservation Feasibility Values. Each of these Values were further sub-divided for the purpose of assessment into different Sub-values (**Table 2**) There are 6 sub-values under Biodiversity Value; 11 under Taxa-based Values; 12 under Socio-economic Values, and only 4 under Conservation Feasibility Values.

9 Each site was assessed for each of its sub-values, based on a ranking score as Nil, Poor, Fair, Good, and Excellent Each of these ranks was given a scoring starting from '0' for 'Nil', '1' for 'poor'; '2' for 'fair'; '3' for 'good'; and '4' for 'excellent'. The total score for all sub-values, for a given site, was calculated and the percentage was also worked out from the total possible score for each of the sub-values that a given site could have possibly scored (e.g., maximum possible score for Biodiversity Values for all 30 sites could be 720, if each site scored the maximum (4) for each of the six sub-values).

10. The assessment report prepared by the field level resource persons was finalised after a thorough discussion and deliberation at the following levels:

(a) At the field, during spot checking, this was reviewed by a team consisting of forest officers, members of some NGO group, local public representative, and experts on zoology, botany and socio-economics
(b) The assessment report was submitted by the resource persons to the local forest officers (range officers, DFOs and CF). The report was updated by filling in any missing information pertaining to forestry and wildlife aspects and also pruned for redundancy in collected information
(c) A copy of all the assessment reports was also submitted to the experts in zoology, botany, and socio-economy for thorough assessment and finalisation.

The role of socio-economists proved very crucial in this whole exercise in updating certain sub-values under 'socio-economic value'.

11 The assessment reports were then finalised after making necessary corrections and modifications, based on the recommendations of experts as described above

12. Based on this final assessment, each of the 30 CHS was then allotted a place in a priority list which was prepared taking into consideration the scoring/ranking achieved by individual CHS first in their Biodiversity Values, followed by Taxa-based Values, Conservation Feasibility Values, the Socio-economic Values, and lastly based on the total score earned by each individual CHS for 4 different Values. A final Priority List was then prepared, taking into consideration the scoring for Biodiversity and Taxa-based Values only.

13. There were a few ties between two or more CHS for the same rank. This tie was settled by taking into

consideration the total score earned by the CHS involved in the tie. The CHS with a higher total score was given priority over those having lower total scores

Results and Discussion

1 A total of 30 (thirty)* Conservation Hot Spots (CHS) were located, selected and assessed for their values from all over the state (the remaining 6 CHS from the initial target of 36 CHS could not be assessed due to inaccessibility of those areas). Of these 30 CHS, 11 are from South District, 5 CHS from West District, 6 from Dhalai District, and remaining 8 CHS are from North District (Map 1) Similarly 11 CHS fall within Southern Forest Circle (having 3 forest divisions), 14 within Northern Forest Circle (having 4 forest divisions), and only 5 CHS fall within West Forestry Circle (from 2 forest divisions).

2. The area of these CHS ranged between a minimum of 2 sq km. to a maximum of 15 sq km. Except CHS, which were less than 10 sq. km in size, all other CHS were above 10 sq km in size.

3. Except one CHS (Harijala in South District), all other CHS formed parts of some Reserved Forest (RF) in the State. Harijala consisted of a mix of Protected Forest and Revenue Land. Remaining 29 CHS were located in 18 different Reserved Forests all over the State. The maximum number of CHS (7) were from Baramura-Deotamura RF, followed by 6 CHS from Atharamura-Kalajhari RF. The remaining RFs contained mostly one or two CHS.

4. Out of a total of 30 CHS, 23 belonged to only one Gram Panchayat each, 3 CHS belonged to 2 Panchayats each, and remaining 4 CHS belonged to 4 to 6 Panchayats each (Table 3).

5. Number of villages surrounding each of these CHS varied from a minimum of 1 to a maximum of 22 villages. Only 5 CHS, however, were surrounded by 10 or more villages, while in case of the remaining 25 CHS, the number of surrounding villages was less than 10 each.

6 Human population in all the villages surrounding each of the identified CHS ranged from a minimum of 250 individuals to a maximum of about 4500 individuals.

7. Except in the case of two CHS, which were surrounded by a total of 17 villages having a majority of Bengali population, all other villages around the remaining CHS were inhabited mostly by Tribal communities. The major tribal communities were Tripuri, Jamatia, Chakma, Reang, Debbarma, Noatia, Lushai, Halam, Darlong, and Rangkhal.

8. Main occupations of human population around the CHS were *jhooming* (shifting cultivation), collection of minor forest produce, settled agriculture, wage labour, handloom and handicrafts making, animal husbandry, government jobs, and private business. *Jhumming* is noted to be the most common mode of earning livelihood by people and was seen prevalent in villages surrounding 22 out of a total of 30 CHS. Next to jhooming is collection of minor forest products. Only in a few villages incomes from animal husbandry, fisheries etc., were being earned by the villagers (Table 3).

9. The assessment of each of CHS was based on the ranking and corresponding scoring made for each of the sub-values under 4 major values. The score earned by each of the CHS for different sub-values under 4 major values is presented in Table 4.

10. Salient features for each of the assessed CHS were also noted, based on actual observations made by the surveyor, information collected by interviewing local people, forestry staff, and other knowledgeable persons and records available in different government offices (Table 5).

11 The maximum (79%) score for all the 30 CHS was for biodiversity values and Sub-values. This was followed by conservation feasibility value (75%), socio-economic values (66%), and lastly the taxa-based values (65%) It is evident from the above that all the CHS selected and assessed are rich in their biodiversity values. Similarly, all CHS are also rich in their conservation feasibility values.

Biodiversity values: Excellent ranking (score = 4) was obtained by almost 46% of the total CHS and, together with good ranking (score = 3), the number of total CHS rose to more than 78%. Only about 6% of the total CHS scored nil ranking (score = 0). It suggests that a majority of the selected CHS in Tripura are good to excellent in their biodiversity values.

Taxa-based values: For these values also the maximum number of CHS (38%) ranked excellent, and an equal number of CHS ranked fair to good. The percentage of CHS ranking nil to poor was also substantially high at about 23%. The unique feature in this category of values was the presence of highly rare and endangered flora and fauna in each of the selected CHS.

Socio-economic values: All the CHS proved very important for their socio-economic values. This is amply reflected in that about 60% of the total CHS ranked good to excellent. The remaining 40% ranked nil to fair.

Conservation feasibility values: In spite of the fact that most of the CHS were affected by the problem of militancy, yet, most of them were quite conveniently placed to be able to undertake/ initiate various conservation oriented programmes, if so required. This is reflected in the results that about 66% of the total CHS ranked good to excellent in their conservation feasibility values.

13. All CHS were further assessed for their priority ranking based on score-types for each of the sub-values under 4 major Values.

*For location of theses sites, please refer to the State map of Tripura.

Recommendations and Future Strategies

1 Once the identification and prioritisation of conservation hot-spots is completed, the recommended future strategy is to develop, in a participatory manner, site specific biodiversity conservation plans for each of these priority sites.

2. A detailed analyses of stakeholders and their problems is required to be carried out independently for each selected site. It is needed as a pre-requisite to the preparation of microplans, in a participatory manner, for each of the sites.

Microplans could be prepared using participatory/rapid rural appraisal (PRA/RRA) techniques These techniques would include: feedback from the people and collection of base-line data for preparing microplans. To mobilise all stakeholders/communities and to compensate for the loss of some of their traditional rights to forest products, certain *entry point and other relevant promotional activities* are proposed to be taken up. The main objective of the entry point and other promotional activities is to elicit the willing participation of the communities.

3 Inclusion of entry point and other promotional activities in the microplans calls for an integrated approach with active participation from other developmental departments in the state, viz., Animal Resource Department, Horticulture Department, Agriculture Department, Fisheries Department, and so on. Forest Department may act as the nodal department for the purpose of identification and execution of specific area-based non-forestry activities on non-forest lands by the other line departments

4. Participation of Non-Governmental Organisations (NGOs) in this exercise, as agents of change; for creating awareness, and for encouraging restoration of common/ degraded lands through various forestry-based activities, must be encouraged. In Tripura, sufficient financial aid to the concerned NGO groups is a must for their active participation.

5. Regular monitoring should form an integral part of the programme (microplans) for effecting necessary changes in the methods and approaches.

6. It was also recognised during this study that active involvement of the Panchayati Raj Institutions (PRI) in the state will be very crucial to achieveing the goals of conservation and management of hot-spots. This participation and involvement of the PRI must be at all its three levels (village, district and state level).

Conclusion

This study demonstrates that Tripura, although geographically a very small state, can still be ranked as a biodiversity rich state The richness of its floral and faunal components could be attributed to its unique bio-geographical location and zoo-geographical position. Drastic changes in its demography over the past 3-4 decades, however, have taken a heavy toll on its bio-resources.

As is clearly reflected in this study, in almost all the conservation hot-spot sites biotic pressure constitutes the main concern. It is, therefore, concluded that for upholding the existing conservation status and excellent biological values and sub-values of most of the identified conservation hot-spots, the socio-ecological dependency of the local human inhabitants are required to be reduced to the minimum level possible, mainly through an integrated approach involving many development departments in the state and in conformity with the existing Panchayati Raj set-up.

Table 1: Land Mammal Genera of Tripura Compared with India

Sl. No.	*Order / Family*	*India*	*Tripura*	
		Genus	*Genus*	*Species*
1.	INSECTIVORA			
	Tupaiidae	2	1	1
	Talpidae	1	1	1
	Soricidae	6	2	2
	Erinaceidae	2	-	-
2.	CHIROPTERA			
	Pteropidae	3	3	3
	Emballonuridae	1	1	1
	Megadermatidae	1	1	1
	Rhinolophidae	4	1	1
	Molossidae	2	-	-
	Vespertilionidae	16	2	3
3.	PRIMATES			
	Lorisidae	2	1	1
	Cercopithecidae	2	2	6
	Pongidae	1	1	1
4.	PHOLIDOTA			
	Manidae	1	1	1
5.	CARNIVORA			
	Canidae	3	3	4
	Hyaenidae	1	1	1
	Ursidae	3	3	3
	Procyonidae	1	-	-
	Mustelidae	7	6	9
	Viverridae	8	5	7
	Felidae	3	2	7
6.	PROBOSCIDAE			
	Elephantidae	1	1	1
7	PERRISODACTYLA			
	Rhinocerotidae	1	1	1
	Equidae	1	-	-

Contd. . . .

Sl. No.	*Order / Family*	*India*	*Tripura*	
		Genus	*Genus*	*Species*
8.	ARTIODACTYLA			
	Suiidae	1	1	1
	Bovidae	15	5	5
	Tragulidae	1	-	-
	Cervidae	4	3	4
9.	LAGOMORPHA			
	Leporidae	2	1	1
	Ochotonidae	1	-	-
10.	RODENTIA			
	Sciuridae	10	4	8
	Hustrocodae	2	1	1
	Muscardinidae	1	-	-
	Phizomyidae	2	1	1
	Muridae	22	9	14

Table 2: Values and Sub-values used for Assessment of Conservation Hot-spots

Values	*Sub-values*
1. Biodiversity	Representativeness
	Vulnerability
	Ecosystem Diversity
	Landscape Complexity
	Conservation Threat
	Conservation Opportunity
2. Taxa-based Values	Species Richness
	Endemism
	Threat
	Complimentarity
	Irreplaceability
	Redundancy
	Critical Habitat
	National Importance
	International Importance
	Important Species
	Potential
3. Socio-economic Values	Direct
	Indirect
	Optional
	Cultural
	Scientific
	Demonstrative
	Tourism
	Landscape
	Recreation
	Research
	Monitoring
	Awareness
4. Conservation Feasibility Value	Protection Status
	Level of Threats
	Management Capabilities
	Size

Table 3: Basic Information on 30 conservation hotspots in Tripura

S. No.	*Site*	*Area (km^2)*	*Location*	*Status(RF)*	*Panch*	*Villages*	*Populn*	*Community*	*Occupation*
1	Harbatali	12	SOUTH	Tekka-tulsi	4	20	4500	Tripuri	jh, wage, agr, mfp, an hus
2	Baishnabpur	4	SOUTH	Bara-Deota	2	12	1909	Tripuri, Chakma	jh,mfp,agr
3	Malumbari	4	SOUTH	Tekka-tulsi	2	22	3219	Tripuri	jh, wage, agr, mfp, an hus
4	Kalshi	9	SOUTH	Bara-Deota	2	8	2018	Tripuri	jh, wage, agr, mfp, an hus
5	Garjee	12	SOUTH	Garjee	6	16	3200	Jamatia	wages, agr, govt. jobs, buisn
6	Harijala	10	SOUTH	PF, Khas land	5	9	1200	Bengalis	mfp(s), timber, fishing, agri
7	Kalapania	5	WEST	Melaghar PRF	4	8	11700	Bengalis	wages, job, buisness, mfp(sale), jh(p)
8	Maharani	8	SOUTH	Bara-Deota(N)	1	1	325	Jamatia, Malsum	jh, mfp(self), agri, ani. husb.,
9	Latmachhara	12	SOUTH	Bara-Deota(S)	1	4	981	Reang	mfp, jh, wages
10	Paharpur	9	SOUTH	Atharamura(S)	1	3	500	Reang	handloom, jh, an hus, wage
11	Debbari	8	SOUTH	Bara-Deota	1	2	750	Jamatia, Bengali	wage, govt jobs, jh, agr
12	Killa	10	SOUTH	Bara-Deota(N)	1	3	600	Jamatia	mfp, wages, horti, jh
13	Harbang	2	WEST	Baramura	1	4	752	Debbarma	jh, mfp(self), timber
14	Simulchhara	8	WEST	Atharamura(N)	1	1	162	Tripuri	wages, jh, handloom, craft
15	Tulashika	15	WEST	Atharamura(N)	1	7	2130	Reang, D'Barma	jh, agri, wages
16	Bidyabill	6	WEST	Atharamura(N)	1	6	1293	Debbarma	jh, agri, wages, bamb craft
17	Kamlachhara	4	DHALAI	Kulai-Kalajhari	1	1	500	Rankhal	agr, wages, husb, jh, mfp, craft
18	Chhotosarma	7	DHALAI	Longtharai	1	3	919	D'Barma, Bengali	agr, wages, craft, mfp, husb
19	Kiran Para	2	DHALAI	Kulai	1	1	250	Reang	govt jobs, agr
20	Joychandra	5	DHALAI	Long-Chandrai	1	4	1200	Chakma, Noatia	jh, wages, mfp(sale), agri
21	Thalchara	11	DHALAI	Central Catchment	1	6	850	Chakma, Noatia	jh(F), mfp(sale), job, buisness
22	Lalchara	5	DHALAI	Manu-Chailgta	1	4	982	Reang, Chakma	Agr, jh(P), fishing, wages, mfp(self)
23	Satnala	6	NORTH	Manu-Chailagta	1	1	265	Reang	wages, agr, mfp, jobs, loom, craft, shops
24	Jampui	8	NORTH	Jampui	1	1	951	Lushai, Mizos	craft, self-employ, orange cult, jobs
25	Bhrupara	3	NORTH	Ujjan-Machmara	1	1	225	Reang	craft, jh, wages, jobs, mfp, hort, husb
26	Bangsul	10	NORTH	Damchara, Juri	1	6	1020	Halam (Kuki)	jh, wages, mfp, occupy forest land
27	Kacharichhara	2	NORTH	Deo	1	1	1090	Chakma	wages, jh, mfp, bamboo sale
28	Satarmia Howr	3	NORTH	Samrao-Hali	1	2	2311	Tribals, Bengalis	agr, jobs, wages, buis
29	Unnakoti	5	NORTH	Unnakoti	1	6	1750	Darlong, Muslims	jh, betel cult, agri
30	Juri	8	NORTH	Juri-Churaibari	1	10	1214	Halam(Kuki)	Jh, Orange & Betel, mfp

Table 4: Assessment Score of 30 CHS for different Sub-values

VALUES	*H'tali*	*B'Pur*	*M'bari*	*Kalshi*	*G'jee*	*H'jala*	*K'ania*	*M'ani*	*L'chara*	*P'pur*
Representativeness	3	3	4	4	4	4	4	4	3	4
Vulnerability	3	2	3	4	3	4	3	3	3	3
Ecosystem diversity	3	3	3	3	3	2	4	4	3	2
Landscape complexity	3	3	2	2	3	2	4	4	3	2
Conservation threat	2	3	4	4	4	4	4	4	4	4
Cons. opportunity	2	4	2	4	4	4	4	4	3	3
Species richness	3	3	2	2	3	2	4	3	4	4
Endemism	3	1	4	4	4	2	4	3	4	4
Threat	2	2	4	4	3	4	3	4	4	4
Complimentarity	3	2	2	2	2	4	2	4	3	2
Irreplaceability	0	0	0	2	2	2	2	1	1	2
Redundancy	3	0	0	2	2	2	3	1	1	2
Critical habitat	3	2	4	4	4	4	4	4	4	2
National importance	4	4	3	2	4	4	4	3	4	4
International importance	4	4	2	4	2	2	1	2	4	4
Important species	4	0	3	4	4	3	4	4	4	4
Potential	3	0	2	2	3	4	4	3	4	4
Direct socio-economic	4	4	4	3	4	4	4	4	4	4
Indirect socio-economic	4	4	4	2	4	3	3	4	4	3
Optional	3	2	2	1	2	4	2	2	3	4
Cultural	3	1	1	4	2	1	4	4	2	0
Scientific	4	4	4	4	4	4	4	2	4	2
Demonstrative	3	1	4	3	4	2	4	1	4	2
Tourism	0	1	3	0	2	1	1	1	1	1
Landscape	3	1	4	2	4	3	4	3	2	2
Recreation	3	1	3	2	1	1	1	1	1	2
Research	3	4	3	4	4	4	4	4	4	3
Monitoring	2	0	1	4	3	2	2	3	2	2
Awareness	1	2	4	4	1	2	3	2	4	2
Protection status	1	2	2	4	2	2	1	1	3	2
Level of threats	4	3	4	4	4	4	4	4	4	3
Management capability	4	2	4	2	4	4	3	2	4	2
Size	4	1	2	3	4	3	4	3	4	3
GRAND TOTAL	94	69	93	99	103	97	106	96	106	91

Table 4: Continued . . .

VALUES	*D'bari*	*Killa*	*H'bang*	*S'chara*	*T'kha*	*B'bill*	*Kamla*	*C'ma*	*K'para*	*J'para*
Representativeness	4	4	4	3	3	2	4	4	3	4
Vulnerability	3	3	3	3	3	1	3	3	2	1
Ecosystem diversity	3	4	4	3	1	2	4	1	2	3
Landscape complexity	3	4	4	3	1	2	4	3	2	3
Conservation threat	4	4	2	4	4	3	1	3	4	1
Cons. opportunity	4	4	4	1	3	3	4	4	3	4
Species richness	3	4	3	3	3	1	4	2	2	4
Endemism	4	4	3	3	3	1	3	2	3	4
Threat	4	2	1	4	4	3	2	3	1	2
Complimentarity	3	4	4	1	1	1	1	0	2	4
Irreplaceability	1	2	4	1	1	3	1	4	1	1
Redundancy	1	2	4	2	1	0	0	0	1	3
Critical habitat	1	4	4	4	4	0	4	4	4	4
National importance	4	4	4	3	2	0	4	3	2	3
International importance	3	4	2	0	0	0	0	0	0	2
Important species	1	4	3	4	4	3	4	3	4	4
Potential	4	3	3	4	4	4	2	3	3	4
Direct socio-economic	4	4	4	4	4	4	4	4	4	4
Indirect socio-economic	4	4	2	3	3	4	3	3	3	2
Optional	4	2	4	2	1	2	2	2	4	4
Cultural	4	4	4	1	2	0	0	1	2	1
Scientific	4	4	3	4	4	2	4	2	1	4
Demonstrative	4	4	4	2	2	2	4	4	1	4
Tourism	4	1	4	1	1	2	0	1	1	0
Landscape	3	4	4	2	2	3	2	1	0	3
Recreation	4	1	4	1	1	1	4	1	0	0
Research	3	4	3	4	4	4	4	2	4	4
Monitoring	2	2	3	2	4	2	1	2	3	0
Awareness	2	4	3	2	2	3	4	2	2	1
Protection status	3	4	4	2	2	2	3	1	2	1
Level of threats	3	2	1	4	4	4	2	4	2	4
Management capability	3	4	3	4	4	4	3	3	3	1
Size	3	4	4	3	4	4	4	4	4	2
GRAND TOTAL	104	112	110	87	86	72	89	79	75	86

Table 4: Continued . . .

VALUES	*T'hara*	*L'hara*	*S'nala*	*J'pui*	*Bhru*	*K'ari*	*B'sul*	*S'war*	*U'koti*	*Juri*	*Total*
Representativeness	4	4	2	4	1	4	4	3	4	4	95
Vulnerability	4	4	3	4	4	4	2	4	2	3	82
Ecosystem diversity	4	3	2	4	1	3	3	1	1	4	75
Landscape complexity	4	3	2	4	2	4	3	1	3	4	77
Conservation threat	4	4	4	2	0	4	3	4	4	3	90
Cons. opportunity	3	4	4	4	2	4	3	4	4	4	94
Species richness	4	4	3	4	1	4	3	1	2	3	80
Endemism	4	4	3	4	2	4	4	1	2	2	86
Threat	4	4	4	4	2	4	3	4	4	3	87
Complimentarity	2	2	3	3	1	0	3	4	2	3	62
Irreplaceability	1	2	0	0	2	2	2	1	2	2	41
Redundancy	1	2	0	0	0	0	0	0	3	0	30
Critical habitat	4	4	3	4	2	4	4	4	4	3	94
National importance	2	4	0	4	0	4	4	0	4	2	79
International importance	1	2	0	0	0	0	2	0	3	0	41
Important species	4	4	3	4	0	4	4	1	4	3	88
Potential	4	4	3	4	0	4	3	4	4	3	86
Direct socio-economic	4	4	4	4	4	4	3	4	4	4	106
Indirect socio-economic	2	3	3	4	2	4	2	3	2	3	85
Optional	2	3	1	4	3	3	4	4	4	4	73
Cultural	1	1	3	4	0	3	1	0	4	4	51
Scientific	4	4	3	4	3	4	4	1	2	4	91
Demonstrative	0	4	3	4	0	4	0	4	1	3	75
Tourism	4	1	3	4	0	4	0	0	4	2	42
Landscape	4	3	3	4	0	1	3	3	4	3	70
Recreation	2	1	3	4	0	1	0	0	3	3	41
Research	3	4	3	4	0	3	4	1	2	4	92
Monitoring	2	3	3	4	2	4	2	4	2	3	64
Awareness	1	4	3	4	2	3	2	0	3	3	68
Protection status	1	1	2	4	2	4	2	1	1	1	60
Level of threats	4	4	4	2	4	4	3	4	4	3	93
Management capability	3	4	3	4	4	4	2	4	3	3	87
Size	2	3	3	4	3	3	2	2	4	2	85
GRAND TOTAL	93	105	86	115	49	106	84	72	99	95	2470

Table 5: Salient Features of Conservation Hot Spots in Tripura

Site	*Salient Features*
Harbatali	Hoolock, deer
Baishnabpur	Elephant migration, JFM, orange cultivation
Malumbari	Medicinal plants, landscape, tourists, JFM
Kalshi	Bamboo area, elephant corridor, Natural Kanak, 'Banya Nageshwar' a rare plant, militancy, Phayre's, rhesus, pig-tailed
Garjee	Sal area, buffer WLsanc, fire wood collection and illicit felling due to heavy demand
Harijala	Phayre's from Trishna WLS, whistling teal, totalwater area 25 years ago, 26 drains, draw-down agri
Kalapania	Turtles, python, snakes, primates, best wetland area
Maharani	Elephant migratory corridor, dense natural forests, langurs, bear, wild dogs, python, bamboo/cane, high militancy
Latmachhara	Elephants, Phayre's, hoolock, wild boars, wild goats
Paharpur	Elephant habitat, wild dogs, migratory birds, porcupine, hoolock, loris, Torenia macronulata-endemic flora, militancy
Debbari	Historical'Chhabimura', Phayre's langurs, medicinal plants
Killa	Bamboo area, elephant corridor, Many areas protected by tribals themselves, JFM
Harbang	Rich landscape, python, langurs, gibbon, leopard, bear, deer, wild dogs, about 100 types of medicinal plants, Bambusa tulda, JFM, cane/mutra
Simulchhara	Wild goat, Phayre's, elephant, Dhup trees, militancy
Tulashika	Wildlife species, militancy, endemic flora(Holigarna caustica)
Bidyabill	Militancy, endemic flora (Wallichia caryotoides), Phayre's, hoolock, bamboo area, elephant, leopard
Kamlachhara	JFM, economically sound, area of previous militancy
Chhotosarma	Garja/sal area in North, highly degraded due to human pressure
Kiran Para	Phayre's, python, deer, wild dogs, leopard, wild cats, bear, deer, bamboo/cane
Joychandra	Wild dog, elephant, Hornbill, Natural forest, Militancy, high hill area adding to landscape
Thalchara	Elephant, wild dog, sambar, primates, wild goat, bear, bison, Hornbill, high production of mustard & tobacco, militancy, excellent landscape
Lalchara	JFM, High landscape, Gibbon, deer, leopard, elephant, bear, Medicinal, Mutra
Satnala	Wild boar, snakes, Phayre's, hoolock, deer, wild dog, good landscape, militancy, bamboo, canes
Jampui	Hoolock, bear, Phayre's, mostly own lands, Mizo commu, economy sound
Bhrupara	wild boar, wildl dog, leopard, gibbon, python, porcupine, pheasants, Bhrang raj, militancy, 'Brue' is name of one tribal cultural group
Bangsul	Rich landscape, Wild boar, snakes, Phayre's, hoolock, slow loris, deer, wild dog, a langur reported could be golden langur
Kacharichhara	Hoolock, Phayre's, rhesus, pig-tailed, deer, bear, python, bamboo and canes
Satarmia Howr	Large water body turned into paddy, migratory birds, degraded forest allaround due to heavy human needs
Unnakoti	Clouded leopard, white bear, wild dogs, langurs and monkeys, gibbon, loris, tourist place, Begonia sarculigera-an endemic plant, militancy
Juri	Water fountain, coal quarring, religious festival 'Sita Kund', hoolock, wild dog, boar, bear, python, langurs and monkeys

Table 6: Final Priority List of Conservation Hot-spots

Rank	*Site*	*Score for Different Values*				
		Bio	*Taxa*	*Socio*	*Feasibility*	*Total*
1	Killa	23	37	37	14	112
2	Kalapania	23	35	36	12	106
3	Lalchhara	22	36	35	12	105
4	Harbang	21	35	42	12	110
5	Latmachhara	19	37	35	15	106
6	Maharani	23	32	31	10	96
7	Garjee	21	33	35	14	103
8	Thalchhara	23	31	29	10	93
9	Paharpur	18	36	27	10	91
10	Jampui	22	31	48	14	115
11	Kacharichhara	23	30	38	15	106
12	Kalshi	21	32	33	13	99
13	Harijala	20	33	31	13	97
14	Unnakoti	18	34	35	12	99
15	Joychandrapara	16	35	27	8	86
16	Debbari	21	29	42	12	104
17	Bangshul	18	32	25	9	84
18	Harbatali	16	32	33	13	94
19	Juri	22	24	40	9	95
20	Simulchhara	17	29	28	13	87
21	Kamlachhara	20	25	32	12	89
22	Malumbari	18	26	37	12	93
23	Tulashikha	15	27	30	14	86
24	Chhotosurma	18	24	25	12	79
25	Satnala	17	22	35	12	86
26	Kiranpara	16	23	25	11	75
27	Satarmia Howr	17	20	24	11	72
28	Baishnabpur	18	18	25	8	69
29	Bidyabill	13	16	29	14	72
30	Bhrupara	10	10	16	13	49

Prioritisation of Biodiversity Rich Sites in the State of Meghalaya

Debjani Roy and Sangita Choudhury

Introduction

The northeast is one of the most important areas in the Indian subcontinent for developing a comprehensive conservation network. Of all the zones in India, it is perhaps the richest in communities, in species and in endemics. Northeast India with its highly humid tropical climate is very remarkable for biodiversity. The region represents the transition zone between India, Malayan and Indo-Chinese biogeographic regions, as well as a meeting place of Himalayan Mountains with that of Peninsular India. Therefore, this region acts as a biogeographic gateway. Most of the species contributing to the biological diversity of northeast India are either restricted to the region as a whole or even to smaller localities, as in the Khasi and Jaintia Hills, a set of twin hills in Meghalaya, which are perhaps the richest botanical habitats in entire Asia. The climate within the biogeographic region is highly variable - warm subtropical in the foothills, moderate in the mid slopes, cool and temperate in the high hills. The varied climate and altitude have greatly influenced the rich diversity of vegetation, flora and fauna in this region. The state of Meghalaya, covering an area of 22,549 sq km, comprising of the Khasi, Garo and Jaintia hills districts, and lying between 25.47 - 20.10 N and 89 45 - 92 47 E in northeast India, is one of the richest and most interesting regions from the biodiversity point of view. It has long been recognized as an important area of biological diversity and endemicity, whilst close to 40% of the land is classed as ecological forest.

Despite its initial botanical fame, as early as 1854, Meghalaya is also rich in faunal values not found anywhere else in the world. Meghalaya has one of the largest, and densest, elephant populations of India - a population that is poorly protected, and that is causing increasing damage to life and property. Other large mammals of significance include wild buffalo, gour, serow, goral, bear, tiger lessercats, and gibbon. Bird values, including hornbills, is exceptionally rich.

Meghalaya's altitude ranges from 30 to 2000m asl, and from 1200 mm of rain to the wettest place on earth with some 11,00 mm p.a. Habitats range form tropical evergreen and moist deciduous forest to distinctive pine and temperate Oak Forest. The area has a very high and localised level of endemism in trees, shrubs, herbs and especially orchids. Hooker (1854), while exploring this region, stated "Orchidaceae are perhaps, the largest natural order in the Khasi hills, where 250 species of orchids grow, chiefly on trees and rocks, but many are terrestrial, inhabiting damp woods and grassy slopes. Most of these values are concentrated in the evergreen forests in the south and southeast and the temperate forests of the high plateaus. The region experiences a tropical monsoonic climate and receives both northeast and southeast monsoons".

Flora of the Khasi Hills in Meghalaya is quite interesting. It has an affinity with the flora of Nagaland as well as that of Manipur. Some of the Burmese elements like *Eulalia Manipurensis, Germainia Khasiana, Spodiopogon lacei, Themeda caudata, T.subsericans* are found mainly in Khasi hills and Manipur. *Eulalia pallens* has a discontinuous distribution and is found in Khasi hills, India and China. Some Indo-Malayan, Burmese and Sikkim species were reported from Nongpoh area. Several Sikkim species are found in Khasi hills at much lower altitude. Similarly, there is a distribution of grasses common to Nagaland, but appearing at greater heights, like - *Centotheca lappacea, Calamagrostis seabrescens, Phyllostachys mannii, Thamnocalamus Pranii, Schizostachyum dullooa* etc. *Apocopis purpurea* of South India is also reported from the Khasi hills.

Existing Conservation Inputs

Whilst 40% of Meghalaya is classified as ecological forest, at present it has 2 national parks and 3 sanctuaries conserving just 1.4% of the State.

(a) Balphakram National Park of 200 sq. Km. Protects evergreen forest community on the southern border

(b) **Nokrek Ridge National Park** of some 50 sq.Km. in the Garo Hills It protects an area of exceptional genetic diversity in wild citrus varieties, as well as other forest value

(c) **Nongkhyllem WLS** of 29sq km. offers protection to moist deciduous forest on the northern slopes.

(d) **Siju WLS** of 5sq km and

(e) **Baghmara Pitcher Plant Sanctuary** of 1sq.km protects plant values in the vicinity of Balphakram.

Some protection has been given to few temperate forest patches as 'Sacred Forest Groves'. In a few places the forest status is good, e.g. in Mawsmai and Mawphlang In many cases it has greatly deteriorated in the past years e.g. Shillong Peak and Jowai Town Mention must be made of district council initiative such as the Jarain Pitcher Plant Sanctuary created by The Jaintia Hills District Council

Method for Prioritization

Prioritization of biodiversity conservation sites was done with reference to certain well-defined values that include bio-diversity and socio-economic importance of the prioritized site

(1) Discussion were held with village elders and knowledgeable persons

(2) Maps of sites and their location locations were prepared with the help of Survey of India, Shillong

(3) Depending on the available secondary data, the assessment for each site was divided in to tow major groups:

(i) Biodiversity values
(ii) socio-economic values

(4) The bio-diversity values were further sub grouped as:

(a) Richness - depending upon the number of species
(b) Uniqueness/Taxa based values- depending upon the rarity status of the species (threatened or endangered)
(c) Naturalness - sites free from human intervention
(d) Endemism - depending upon the number of endemic species
(e) Representativeness - community formations

(5) The socio-economic values were also sub grouped as direct economic values, socio-cultural values and scientific values.

(6) Each site was assessed for each of the value and the scores obtained were ranked Ranking scores of 0 to 5 were allotted to each of sub groups, depending upon the character, rarity status and other criteria, as defined above Based on the individual scores obtained, total scores for all the sub values for a given site were calculated

(7) Each of the sites was allotted a place in the priority list and accordingly given a rank based on the total score obtained. Alongwith the scores the importance of each site was also calculated with regards to the number of prioritized species, depending upon their rarity status Sites with higher scores and consisting of highly prioritized species were given the top priority for conservation.

Criteria for Prioritization

The following categories of rare species have been recognized by the IUCN, mainly based on.

(1) Present distribution.
(2) Decline in number of population in course of time.
(3) Abundance and quality of natural habitats.
(4) Biology and potential value of the species

These are defined as follows for conservation and protection.

Rare: Taxa with small world populations that are not at present endangered or vulnerable but are at risk. These taxa are usually localized within restricted geographical areas or habitats or thinly scattered over a more extensive range.

Vulnerable: Taxa believed likely to move in to the endangered category in the near future if causal factors continue operating. Included are taxa of which most or all the populations are decreasing because of over-population; extensive destruction of habitat or other environmental disturbances, taxa with populations that have seriously depleted and whose ultimate security is yet to be assured; taxa with populations that are still abundant but are under threat from serious adverse factors throughout their range

Endangered: Taxa in danger of extinction and whose survival is unlikely if the causal factors continue operating Included are taxa whose numbers have been reduced to a critical level or whose habitats have been so drastically reduced that are they deemed to be in immediate danger of extinction

We further prioritized the species for their socio-economic value based on their medicinal, economics, horticultural and botanical value According to our priortization, maximum weightage was given to endangered species, since these species need immediate protection. Among endangered species, highest priority was given to plants having medicinal value. Similarly, among rare

plants, highest priority was also given to medicinal plants and least to ornamental species.

Weightage was given to the endemics with narrow distribution range, especially if their habitat was endangered by biotic interference. The rationale is given below

Ornamental	These Plants are beautiful but their social and economic value is indeterminate.
Research value	These Plants are of interest to researchers.
Horticultural value	We have given equal weightage to rare plants having either horticulture or economic values This is because, only after the plants are grown and solid, the cultivators can earn money. Before this there is no direct benefit to the farmers
Economic and Socio-cultural	Some plants e g. bamboo, have an immense market value in the region Bamboo are used for handicrafts and also for paper industry, furniture etc..
Medicinal	These plants are important because they are used directly in the health care systems of the society. They ensure the welfare of the patients who use medicines prepared from these plants; They also ensure the welfare of traditional practitioners and facilitate the upkeep of their knowledge. These plants are also the source of their livelihood. Further, the recurring exploitation of medicinal plants from their natural habitat is resulting in the decline in the population level of these plants. Therefore, these plants have been given the highest ranking, since they are being used for medicinal preparation and at the same time are on the verge of extinction They need to be protected and propagated.

The final values were given to the various sites depending on the scores they got for the various values and sub- values, as described above As a result, 16 sites have been prioritized for Meghalaya.

Prioritized Sites of Meghalaya

16 sites were prioritized based on the prioritization of individual groups. They are listed in Table 1.

Discussion

The flora of Meghalaya is among the richest in India, both in extent and diversity of species Besides, a good number of primitive angiosperms, not reported from any other part of the country, are found in this region. An enormous number of timber, medicinal and other economically important plants are also found here.

Recently, it has been noted that increasing biotic influences, including socio-economic development and unrestrained commercial exploitation of forest wealth, have threatened the survival of the genetic resources

The alarming changes that have taken place in recent years, in the ecology and landscape, have brought about a number of changes in the native flora. Meghalaya has witnessed a heavy biological depletion mainly due to the large-scale practice of shifting agriculture

Another reason for depletion in forest cover and changes in vegetation could be due to urbanization of the area. There was hardly any industry except for coal mining in Cherrapunjee Now there is a cement factory in Cherrapunjee, a plywood factory at Burnihat, hydroelectric projects at Barapani and Garampani. All these together have their impact on the depletion of the original vegetation As a result of all these factors, a number of extremely rare species are threatened and are struggling for existence.

Looking at the status and the needs for conservation we have prepared a priority list on the basis of bio-diversity and socio-economic values, using certain criteria. Based on these criteria, the biodiversity and socio-economic values and anthropogenic stresses, sites were awarded special needs for conservation which are as follows:

(1) Rare and Endangered
(2) Rare and Endemic
(3) Endemic and Endangered
(4) Rare and Ornamental
(5) Endemic and Economic
(6) Rare and Research/Botanical
(7) Rare and Horticulture/Economic
(8) Rare and Medicinal
(9) Endangered and Medicinal

Table 1

No.	*Site*	*Place*
1.	A	Nartiang, Jowai, Umtapoh, Shangung. Raliang, Khliehriat, Sutunga, Thadlaskein, Laskein, Mynro.
2.	B	Jakrem, Mawblong, Mawsynram, Cherrapunjee, Shella, Sohrarim, Pynsursla
3.	C	Burnihat, Umling, Lailad, Nongpoh, Umtesor, Umtynagar, Nongkhlaw, Mairang.
4.	D	Umsning, Sumer, Umsaw, Umtham, Umwai, Umran, Barapani, Umshing, Shillong, Laitkor Peak, Mawphlang, Mawkdok, Nongkrem, Laitlynkot.
5.	E	Anogiri, Jengjal, Rongram, Selbalgiri, Tura, Damalgiri, Adugiri, Kherapara, Barengapara, Dalu, Thebrangiri, Assimgiri
6	F	Dawki, Muktapur.
7.	G	Songsak, Rongrenggiri, Williamnagar, Darugiri, Rongjeng, Damra, Damadubi, Manikganj, Simseng, Manda, Tasek, Dambu.
8.	H	Garampani, Kopili.
9.	I	Siju, Baghmara.
10.	J	Balpakhakram, Kanai, Mahadeo, Maheshkola.
11	K	Sonapahar, Nongstoin, Rambari.
12	L	Sonapur, Umkiang.
13	M	Mawpat.
14	N	Balat, Ranikor, Nongkhyllem.
15	O	Phulbari,Digranggiri, Duragiri. Rongsangiri.
16.	P	Garobadha.

Biodiversity Conservation Sites in Order of Priority

1. Site A: (Nartiang, Jowai, Umtapoh, Shangung, Raliang, Khliehriat, Sutunga, Thadlaskein, Laskein, Mynro.)

Orchids form a dominant element in the forests of Khasi and Jaintia Hills. 250 species grow chiefly on trees and rocks but many are terrestrial, inhabiting grassy slopes and damp places. The orchid flora has depleted mainly due to:

(a) Overcollection of ornamental species
(b) Disturbance of their habitat
(c) Deforestation resulting in the destruction of many epiphytic orchids

Several endemic and ornamental species have been exploited in large quantities resulting in the shrinkage of their population. Several terrestrial orchids are depleting in nature due to clearing of land for cultivation. The site is endowed with the maximum number of orchid species and therefore ranks highest in biological value. This site is also rich in bamboos and plants from which brooms are made and transported to other parts of India

Threatened: 11 orchids. 35 other plant species; 2 mammals

Rare: 20 plant species
Endangered: 4 plant species
Endemic: 11 orchids

Rhododendron formosum is extensively collected for its ornamental flowers and medicinal values.

Nepenthes khasiana populations have dwindled due to excessive collection by traders and students

Other: *Arundina graminifolia* is endangered. exploited for trade.

Lodes hookeriana population considerably reduced due to felling of trees. Regeneration poor. only a couple of trees left

Hylopetes alboniger alboniger is a vulnerable mammalian species of the site.

2. Site B: (Jakrem, Mawblong, Mawsynram, Cherrapunjee, Shella, Sohrarim, Pynsursla)

The extent of damage to forest ecosystem is best exemplified by extreme case of jhuming at Cherrapunjee. The tropical wet, evergreen forests of Cherrapunjee have slowly turned into grasslands due to excessive felling, heavy grazing and burning.

This site has ranked highest in naturalness and encompasses 26 sacred groves. These habitats are free from human intervention, yet several species contained in them are threatened.

Critically Endangered: 1 amphibia

Threatened species: 14 plant species, 25 orchids, 2 mammals, 1 aves, 2 reptile, 5 amphibia, 11 pisces, 1 insecta.

Myotis formosus, fa io. *Spizixos canifrens, Amphiesma xenura, Meghophyrs parva, Hyla annectens, Amolops afghamus, Rana alticola, Rana laticeps, Philatus cherrapunjee, Pericarpitermes latignathes durga* are all threatened faunal species.

Rare: 17 plant species

Endemic: 9 orchid, 10 plant species, 1 amphibia

Rhododendron formosum is an endemic, endangered, rare and ornamental species. It is extensively collected for ornamental flower and for its medicinal values Population dwindling

Philatus cherrapunjee is an endemic amphibian species.

Nepenthes Khasiana is a rare, endemic, endangered, horticultural and of economic interest. It is exploited by traders and students.

Other: *Acer laevigatum, Luvuga scandens* is an important rare medicinal plant, *Arundina graminifolia* is a rare, endangered, horticultural and of research and economic importance. It is exploited in trade and has horticultural value, Magnolia has disappeared due to the damage of forests at Sohrarim near the cement factory at Cherrapunjee.

3. Site C: (Burnihat, Umling, Lailad, Nongpoh, Umtesor, Umtynagar, Nongkhlaw, Mairang.)

Cases of burning and grazing have been reported from Nongpoh, where green forests are cleared.

Threatened: 9 plant species, 3 mammals, 1 reptilie, 3 pisces.

Hylobates hoolock, Viverra zibetha, Presbytis pileatus, Python molurus are the threatened faunal species.

Rare: 23 plant species

Endemic: 1 orchid, 2 plant species

4. Site D: (Umsning, Sumer, Umsaw, Umtham, Umwai, Umran, Barapani, Umshing, Shillong, Laitkor Peak, Mawphlang, Mawkdok, Nongkrem, Laitlynkot.)

This site ranks highest in uniqueness.

Threatened: 38 plant species, 15 orchid, 6 mammals, 4 aves, 6 reptile, 11 amphibia, 11 plsces, 4 insecta.

Nycticebus coucang bengalensis, Felis bengalensis, Mustela kathiah, Petaurista alborujus candidulus, P.manificus, Hylopetes alboniger, Bambusicola fytchii hopkinsonii, Aquila rapax nipalensis, Pluvialis dominica fulva, Spizixos conifrons, Kachuga tacta, Teratolopis fasciata, Lipoltis frenatus, Xanochrophis cerasogaster, Amphiesma khasiens, Veranus bengalensis, Scutiger skkimensis, Megophyrs parva, Hyla amnectens, Microhyla berdmori, Amolops afghamus, Rana alticola, Rana danieli, Rana laticeps, Rana mawphlangensis, Philatus andersoni, Philatus shillongensis, Captotenmes heimi, Anoplotermes shillongensis, Pericapritermes laitgnathus durga, Nasutitermes kali are all threatened and vulnerable faunal species.

Rare: 31 plant species,

Endangered: 4 plant species, 2 amphibia

2. *Leptobrachium hasseltii, Meghophrys monticola*

Endemic: 16 orchid, 14 plant species, 1 amphibia

Rhododendron formosum collected extensively for ornamental and medicinal purpose

Other: *Anthroxanthum clarkei, Carex rara* and *Philautua shillongensis* are rare and **Endangered species**. *Cycas pectinata and Dipteris Wallichi* has depleted because of the construction of the Barapani hydro-electric project.

5. Site E: (Anogiri, Jengjal, Rongram, Selbalgiri, Tura, Damalgiri, Adugiri, Kherapara, Barengapara, Dalu, Thebrangiri, Assimgiri)

Critically endangered: 2 amphibia

2. *Pedostikes kempi, Megophrys monticola*

Threatened: 10 plant species, 2 reptile, 4 amphibia

Varanus bengalensis, Amphiesma xenura, Rana alticola, Rana Laticeps, Philalatus garo, Philatus Kempii are the threatened faunal species

Rare: 9 plant species

Endemic: 3 plant species, 2 amphibia

6. Site F: (Dawki, Muktapur)

Threatened: 3 orchid, 5 plant species, 11 pisces

Endemic: 5 plant species

Others: *Arundina graminifolia* is a rare ornamental plant as well as a horticultural plant. It is endangered and exploited for trade and horticultural value

7. Site G: (Songsak, Rongrenggiri, Williamnagar, Darugiri, Rongjeng, Damra, Dainadubi, Manikganj, Simseng, Manda, Tasek, Dambu.)

Threatened: 2 mammals, 2 aves 1 amphibia, 7 pisces, 2 insecta

Petanurista petaurista lylei, P. magnificus, Plataleca leucoroidia major, Aviceda leuphotes syama, Meghophyrus parva, Captotermes heimi, Anoplotermes

shillongensis are the threatened faunal species.

Rare: 8 plant species

Endemic: 4 plant species

Artocarpus lacoocha is an endangered, endemic and economic plant. Population dwindling due to indiscriminate felling of trees. Regeneration of these trees is poor. *Melodorum rubiginosum* is endemic and endangered.

8. **Site H:** (Garampani, Kopili)

Threatened: 4 plant species, 3 orchids, 1 amphibia

Philautus andersoni is a threatened amphibian species

Rare: 3 plant species

Endemic: plant species

9. **Site I:** (Siju, Baghmara)

Threatened: 7 plant species, 1 aves, 12 pisces

Pandian haliaetes haliatus is a threatened and vulnerable species

Rare: 2 plant species

Endemic: 3 plant species

Nepenthes Khasiana is rare, endemic, endangered and of horticultural value. Population dwindled due to excessive collection by traders and students

Artocapus lacoocha is an endemic, endangered and economic plant. Population declined due to felling for timber

10. **Site J:** (Balpakhakram, Kanai, Mahadeo, Maheshkola)

Threatened: 7 plant species, 1 orchid, 1 pisces

Rare: 14 plant species

Endangered: 1 plant species

Endemic: 4 plant species

Other: *Luvunga scandens* is important as a rare and medicinal plant

11. **Site K:** (Sonapahar, Nongstoin, Rambari)

Threatened: 6 orchids, 1 mammals, 3 pisces, 1 insecta

Mustela kathiah, Acrania assamensis are threatened and vulnerable species.

Endemic: 1 plant species, 1 orchid

12. **Site L:** (Sonapur, Umkiang)

Threatened: 1 mammal

Pipistrella coromandra coromandra is a threatened mammal of this site.

13. **Site M:** (Mawpat)

Threatened: 1 amphibia

Scutiger sikkimensis is a threatened amphibian species of the site.

14. **Site N:** (Balat, Ranikor, Nongkhyllem)

Threatened: 1 reptile, 2 pisces

Lissemys punctata punctata is a threatened and vulnerable species.

Rare: 2 plant species

Endemic: 1 plant species

15. **Site O:** (Phulbari, Digranggiri, Duragiri, Rongsangiri)

Threatened: 8 pisces

16. **Site P:** (Garobadha)

Threatened: 5 pisces

Rare: 2 plant species

For preparing the priority site map and list for the state of Meghalaya we utilised secondary literature and participant observational information. These data were further corroborated with satellite data. The satellite data was provided to us by Prof. Shekhar Singh, Chairman, BCPP Steering Group and Dr. P.S. Roy, Dean, IIRS, Dehra Dun. The information has been collated and produced by the Indian Institute of remote Sensing (National Remote Sensing Agency) Department of Space, Government of India, 4 Kalidas Road Dehradun in March, 1998 in "Biodiversity Characterisation At Landscape Level using Remote Sensing and Geographic Information System" – Phase I Project Manual, Department of Biotechnology and Department of Space, Govt. Of India.

The prioritised map for the Biodiversity rich sites of Meghalaya prepared for the BCPP and the Remote Sensing maps of Forest type, Biodiversity value image, Ecosystem image, Biological richness image, Graphical presentation of important sites of phytodiversity of Meghalaya, prepared by Tomar and Roy, were used to compare and prepare the final priority site list. It is important to mention here that the sites demarcated in all these maps were the same. The final site list showing the distribution pattern is given in the Annex.

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Annex: List of Prioritised Sites for Meghalaya

Site	*Attributes of the site according to forest map*	*Attributes of the site according to biodiversity value image*	*Attributes of the site according to ecosystem image*	*Attributes of the site according to biological richness image*	*Attributes of the site according to graphical presentation of important sites of phytodiversity*
A	1. Grassland 2. Pine Forest degraded 3. Plantations 4. Agriculture/ Settlement 5. Cloud cover 6. Broad Leaved Hill forest 7. Sub Tropical Pine Forest 8. Mixed Pine Forest 9. Current Shifting Cultivation 10. Abandoned Shifting Cultivation 11. Sub Tropical Semi Evergreen Forest 12. Broom grass	1. Lowest 2. Low 3. Medium 4. Higher 5. Low	1. Highest 2. Higher 3. High 4. Medium 6. Cloud/ Water body/ Settlement	1. High 2. Higher 3. Medium	1. Endangered species 2. Flowering Plant species
B	1. Agriculture/ Settlement 2. Scrub 3. Grassland 4. Broad Leaved Hill Forest 5. Broom grass 6. Sub Tropical Semi Evergreen Forest	1. Lowest 2. Low 3. Medium 4. Highest	1. Highest 2. Medium 3. Higher 4. Low	1. Higher 2. High 3. Medium 4. Highest	1. Flowering Plant species 2. Rare species
C	1. Agriculture/ Settlement 2. Current Shifting Cultivation 3. Sub /Tropical Evergreen Forest 4. Sub Tropical Semi Evergreen Forest 5. Mixed Pine Forest 6. Abandoned Shifting Cultivation 7. Scrub	1. Lowest 2. Low 3. Medium 4. High 5. Higher	1. Highest 2. Higher 3. High 4. Medium 5. Low	1. Higher 2. Highest 3. High 4. Lowest	1. Medicinal Plants 2. Endangered species

Contd. . . .

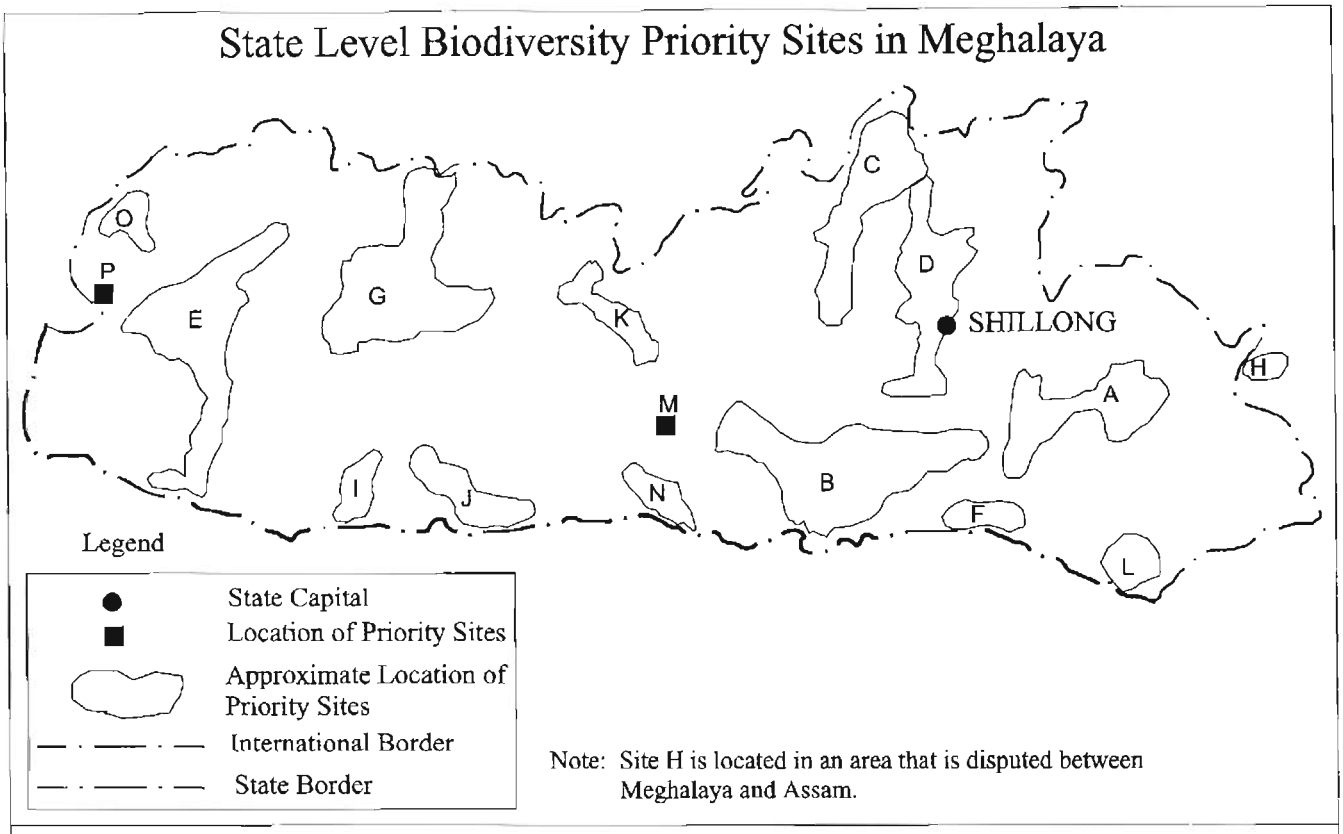
Site	*Attributes of the site according to forest map*	*Attributes of the site according to biodiversity value image*	*Attributes of the site according to ecosystem image*	*Attributes of the site according to biological richness image*	*Attributes of the site according to graphical presentation of important sites of phytodiversity*
D	1. Agriculture/ Settlement 2. Current Shifting Cultivation 3. Bamboo Breaks 4. Abandoned Shifting Cultivation 5. Water Body 6. Grassland 7. Sub Tropical Evergreen Forest 8. Sub Tropical Semi Evergreen Forest 9. Sub Tropical Pine Forest 10. Mixed Pine Forest 11. Scrub 12. Pine Forest Degraded 13. Broad Leaved Hill Forest	1. Lowest 2. Low 3. Medium 4. High 5. Higher	1. Low 2. Medium 3. High 4. Higher 5. Highest 6. Cloud/Water body/ Settlement	1. High 2. Higher 3. Highest 4. Medium 5. Lowest	1. ndemic species
E	1. Sub Tropical Evergreen Forest 2. Sub Tropical Semi Evergreen Forest 3. Agriculture/ Settlement 4. Scrub 5. Current Shifting Cultivation 6. Abandoned Shifting Cultivation	1. Lowest 2. Low 3. Medium 4. High 5. Highest	1. Low 2. Medium 3. High 4. Higher 5. Highest	1. High 2. Higher 3. Highest 4. Medium 5. Lowest	1. Citrus Plants
F	1. Sub Tropical Semi Evergreen Forest 2. Broom Grass 3. Grassland	1. Highest 2. Low 3. Lowest	1. Higher 2. Highest	1. High 2. Higher 3. Highest	
G	1. Agriculture/ Settlement 2. Bamboo Breaks 3. Current Shifting Cultivation 4. Abandoned Shifting Cultivation 5. Sal Forest 6. Sub Tropical Semi Evergreen Forest	1. Lowest 2. Low 3. Medium 4. High 5. Highest	1. Low 2. Medium 3. High 4. Higher 5. Highest 6. Water Body/ cloud/Settlement	1. Medium 2. High 3. Lowest 4. Highest	1. Endemic species 2. Medicinal Plants 3. Endangered species 4. Rare species

Contd. . . .

Site	*Attributes of the site according to forest map*	*Attributes of the site according to biodiversity value image*	*Attributes of the site according to ecosystem image*	*Attributes of the site according to biological richness image*	*Attributes of the site according to graphical presentation of important sites of phytodiversity*
H	1. Sub Tropical Semi Evergreen Forest 2. Mixed Pine Forest	1. Medium	1. Medium	1. High 2. Higher	
I	1. Sal Forest 2. Sub Tropical Semi Evergreen Forest 3. Current Shifting Cultivation 4. Plantations 5. Moist Deciduous forest 6. Agricultural/ Settlement	1. Lowest 2. Low 3. Medium	1. High 2. Higher 3. Medium 4. Low	1. High 2. Higher 3. Medium 4. Lowest	1. Flowering Plant species 2. Insectivorus Plant
J	1. Moist Deciduous Forest 2. Sal forest 3. Plantations 4. Sub Tropical Evergreen Forest 5. Sub Tropical Semi Evergreen Forest 6. Current Shifting Cultivation 7. Abandoned Shifting Cultivation	1. Lowest 2. Low 3. Medium 4. High 5. Highest	1. Low 2. High 3. Higher 4. Medium 5. Highest	1. High 2. Higher 3. Lowest	
K	1. Grassland 2. Mixed Pine Forest 3. Agriculture/ Settlement 4. Sub Tropical Pine Forest 5. Current Shifting Cultivation 6. Abandoned Shifting Cultivation	1. Medium 2. Higher 3. Low 4. Lowest	1. Medium 2. High 3. Higher 4. Low	1. High 2. Higher 3. Highest 4. Medium	
L	1. Sub Tropical Evergreen Forest 2. Sub Tropical Semi Evergreen Forest	1. Highest	1. Highest	1. Higher	
M	1. Water Body 2. Grassland 3. Sub Tropical Semi Evergreen Forest	1. Medium 2. Higher	1. Medium 2. Higher	1. High 2. Higher 3. Lowest	

Contd. . . .

Site	*Attributes of the site according to forest map*	*Attributes of the site according to biodiversity value image*	*Attributes of the site according to ecosystem image*	*Attributes of the site according to biological richness image*	*Attributes of the site according to graphical presentation of important sites of phytodiversity*
N	1. Agriculture/ Settlement 2. Broom grass 3. Grassland 4. Sub Tropical Semi Evergreen Forest 5. Abandoned Shifting Cultivation	1. Lowest 2. Low 3. Highest	1. Higher 2. Medium 3. Low	1. High 2. Higher 3. Lowest	
O	1. Agriculture/ Settlement 2. Sub Tropical Semi Evergreen Forest 3. Bamboo Breaks 4. Current Shifting Cultivation	1. Low	1. Low	1. High	
P	1. Sub Tropical Seim Evergreen Forest 2. Bamboo Breaks 3. Agriculture/ Settlement 4. Abandoned Shifting Cultivation	1. Lowest 2. Low 3. Medium 4. Higher	1. Low 2. Highest	1. High 2. Higher 3. Highest 4. Lowest	



A - Nartiang, Jowai, Jarain, Umtapoh, Shangpung, Raliang, Khliehriat, Sutunga,Thadlaskein, Laskein, Mynso

B - Jakrem, Mawblong, Mawsynram, Cherrapunjee, Shella, Sohrarim,Pynursla

C - Burnihat, Umling, Lailad, Nongpoh, Umtesor, Umtyngar, Nongkhyllem, Mairang

D - Umsning, Sumer, Umsaw, Umtham, Umwai, Umran, Barapani, Umsing, Shillong,LaitkorPeak, Mawphlang, Mawkdok, Nongkrem, Laitlynkot

E - Anogiri, Jengjal, Rongram, Selbalgiri, Tura, Damalgiri, Adugiri, Kherapara, Barengapara, Dalu, Thebrangiri, Assimgiri

F - Dawki, Muktapur

G - Songsak, Rongrenggiri, Williamnagar, Darugiri, Rongjeng, Damra, Dainadubi, Manikganj, Simseng, Manda, Tasek, Dambu

H - Garampani, Kopili

I - Siju, Baghmara

J - Balphakram, Kanai, Mahadeo, Maheshkola

K - Sonapahar, Nongstoin, Rambari

L - Sonapur, Umkiang

M - Mawpat (within and around)

N - Balat, Ranikor, Nongkhlaw

O - Phulbari, Digranggiri, Duragiri, Rongsagiri

P - Garobadha (within and around)

Map prepared by the Indian Institute of Public Administration

Prioritisation of Conservation Sites in the Middle and Lower Hills of Arunachal Pradesh

K. Haridasan

Introduction

Arunachal Pradesh, one of the seven states of northeast India lying in the eastern Himalayan has an area of 83743 sq. km. It is positioned between 26°28' and 29°30' N latitude and 91°30' and 97°30' E longitude. Physiographically the state is predominantly hilly. Ridges, valleys, plateaus and gorges are features of the land scape. Numerous rivers and rivulets drain these hills and catchments to the mighty river Brahmaputra. The wide ranging latitudinal variations support over twenty different forest types (Table 1) near sea level to over 7000m. Over 5000 flowering plants species and many species of non-flowering and animal species exist in these forests.

A predominantly indigenous tribal population comprising of over 25 tribes and nearly 100 sub-tribes, inhabits the state. As per the 1991 census the total population was over 8.5 lakhs. These people practice the age-old shifting cultivation where by sizeable chunks of forests are cleared and used for agriculture purpose in a cyclic manner. To some extent this has an ecological impact on the wild habitats. Further, there has been a spurt in the human population, with an increased demand of forest resources. The development activities which are now ongoing in this state also demand a larger proportion of forest based raw materials. All these add upto deforestation and unrestricted exploitation of plants and plant parts. Different ongoing developmental activities have resulted in habitat destruction and fragmentation.

Arunachal Pradesh is situated at the trijunction of India, China and Myanmar, forming a gateway for the floras of paleo-arctic, Indo-Malayan, Asian and Indo-Chinese realms. Biotic elements from all these regions occur in this state, making it very rich in floral and faunal resources. The state has been well recognized as a biodiversity 'hotspot'. There is a great prevalence of endemic and primitive plants, thereby enabling eminent scientists like Takhtajan call this region a cradle of flowering plants. Due to the abundance of crop relatives and cultivated plants, the region, along with the state, is also recognized as a centre of origin of at least some of our cultivated species. However, due to inadequacies in transport infrastructure and communication bottlenecks, the state's vast geographical area has not been properly explored. Under these circumstance it is not possible to determine conservation priorities for the entire state. Conservation priorities can and should be determined from among those areas that are both rich in biodiversity and currently threatened. There are other biodiversity rich areas, which are naturally protected in the states protected area network (Table 2). In Arunachal Pradesh, protected areas cover only about 11% of the geographical area. As these, however, do not cover all the various forest types, it is worthwhile identifying additional areas for conservation. Of the different agroclimatic zones and forest types, the tropical and subtropical forests or the mid hill belt are the most ravaged, on account of human and biotic pressure. As such, any attempt for conservation in this belt will have great significance and far reaching consequences.

Forest and Forest Types

The forests of Arunachal Pradesh fall under five broad forest types and four climatic categories. These are the tropical forests, subtropical forests, pine forests, temperate forests and alpine forests. These are interlaced with subtypes and secondary forests depending upon local conditions. Different people have studied the forest vegetation of Arunachal Pradesh and attempted a classification of forest types. (Rao 1972, Rao 1974, Rao and Hajra 1986, Kaul and Haridasan 1987. Champion and Seth 1978, Haridasan, Chauhan and Beniwal 1993.). Most of these works are based on species composition, altitudinal variations, agroclimatic conditions etc. However there is a general agreement in delineating these forests types. Accordingly, forests below 900 m MSL, largely covering the plains and foothills are treated as the **tropical type** which again consist of **tropical semi evergreen, tropical wet evergreen and tropical moist deciduous types.** These have a remarkable manifestation of floral diversity and unparallelly rich species composition. Detailed accounts of the floristics of these forests are found in Kaul and Haridasan (1987).

These forests are rich in many useful resources like :

Timber (*Terminalia myriocarpa, Duabanga grandiflora, Dipterocarpus macrocarpus, Shorea assamica, Gmelina arborea, Mesua ferrea, Artocarpus chaplasha, Bombax ceiba, Canarium strictum, Michelia champaca*, and many others).

Bamboos (*Bambusa pallida, Dendrocalamus hamiltonii, Pseudostachyum polymorphum*, etc).

Rattans/Canes (*Calamus tenuis, Calamus flagellum, C. floribundus, C erectus, Daemonorops jenkinsianus. Plectocomia himalayana* and more than 15 other species)

Medicinal plants (*Terminalia chebula, T bellirica, Emblica officinalis, Oroxylum indicum, Acorus calamus, Piper brachystachyum, Clerodendrum colebrookianum, Costus speciosus, Abroma augusta, Paedaria foetida* and numerous other species). (Haridasan 1995., Haridasan and Deori 1988)

Edible plants and fodder: *Spilanthes paniculata, Diplazium esculentum, Solanum nigrum, Sarcochlamys pulcherrima, Elaeocarpus floribundus, Baccaurea sapida, Garcinia pedunculata, Bauhinia purpurea*, etc. details of which are given in Haridasan, Bhuyan and Deori (1990).

Gums, resins and others: *Canarium strictum, Shorea assamica, Cordia dichotoma*, etc. for gums and resins (Shukla, Rao and Haridasan 1994).

Bark of Jigat (*Persea*) for Agarbathi manufacture, *Trema orientalis* and *Sterculia* for fibre *Imperata* for thatch, *Thysonolaena* for **broom**, *Livistona* and *Calamus erectus* for **roofing leaves**, *Phyrium pubinerve* for **leaf plates**, *Musa* etc. for leaf and fibre. These and many other useful plants for human kind grow abundantly in the tropical wilderness.

Many of these are utilised by the local dwellers to meet their day to day needs. Exploitation for domestic requirements has been going on for ages without much ill effect on the ecosystem.

Subtropical Forests

The tropical type of forest is followed by **subtropical forests** in an ascending order above 900m. MSL to 1800m., which characteristically occupy the mid hill region Details of structure and composition of this type of forests are provided in Kaul and Haridasan (1987) Due to increased moisture and climatic conditions and favourable habitat, the biodiversity is equally rich in this type of forests, though the species composition is different. These forests are the habitat for many of our useful plants as mentioned below

Trees: *Michelia spp., Magnolia sp., Castanopsis, Quercus, Photinia, Albizia*, etc.

Bamboos: *Cephalostachyum fuchsianum, Chemonobambusa callosa, Schizostachyum helferi, Phyllostachys bambusoides, Dendrocalamus sahnii*, etc.

Rattans/Canes: *Calamus innermis, Plectocomia himalayana*,

Fats, Gums and resins: *Pinus roxburghii, Madhuca butyraceoides, Lindera sp.* Etc.

Edible plants: *Zanthoxylum, Castanopsis, Solanum, Rubus*, etc.

The sub tropical pine forest in contrast to the preceeding forest has less biodiversity and has simple structure These forests are in fact successional in nature and are met with in areas of scanty rainfall. Many useful commodities are available from these forests, including pine resins, pine timber, medicinal plants like *Rubia cordifolia, Solanum, Swertia, Berberis, Rhus*, etc. Aromatic plants like *Zanthoxylum* also grow here.

Temperate Forests

Above the altitude of 1800 m MSL, in the hills of Arunachal Pradesh, luxuriantly grow the temperate forests of broad leaved or conifer type. These forests are mostly known for their medicinal plants like *Ginseng, Illicium, Codonopsis, Rubia, Valeriana, Coptis teeta, Podophyllum, Taxus, Berberis*, etc Main timber species are *Cupressus, Abies, Tsuga, oaks* and *laurels*. Some wild edible plants like *Myrica, Rubus, Prunus*, etc. are available in these forests.

Alpine Forests

Beyond 3500 m MSL in Arunachal Pradesh, the forests reduce to the level of scrubs and grasslands. These meadows are the habitat for a great variety of medicinal and aromatic plants Prominent among them are *Rhododendron anthopogon. Fritillaria, Aconitum, Hypericum Swertia, Gentiana, Helinia, Valeriana, Bergenia, Gymnadaenia, Picrorrhiza* and others. There are a few lichens and mushrooms which are also gathered by the people for different purposes

Secondary Types

In addition to these broad categories, there are a few secondary types resulting from various biotic factors. Shifting agriculture, various developmental activities, extraction of timber and other commodities lead to destruction of original vegetation and secondary types are formed The main categories under this are grasslands, bamboo breaks

or degraded forests. As expected these are with less biodiversity and with an altogether different composition from the original types. However, we have learnt to use many forms of the produce from this type of forests as well Prominent among them are bamboos, thatch, fodder and fuel

All these forests in the state are owned and occupied in patches by a variety of local people who live in close association with the forests and depend on it.

Forest Management

The effort of the state environment and forest department has been to conserve the forest and wild life, to maintain the ecological balance and to promote sustained socio-economic development of the local people. Large areas of forests have been brought under scientific management, besides associating the people in protection, development and management of forests Table 3 provides the legal status of the forests in Arunachal Pradesh. The per capita forest area in the state is about 6 ha As against the average of 0 1 ha for the rest of the country The forest management efforts seek to elicit the involvement and co-operation of the people while safeguarding their customary rights over the land. With the adoption of the idea of participatory forest management, areas outside reserved forests and government owned lands are also brought under forest management. This is more important in terms of conservation of biological diversity. Afforestation and plantation efforts are carried out on a massive scale for replenishing the depleted stock. Harvesting is done through meticulously prepared working plans and as per its guidelines. These practices ensure sustainable utilization of forest produce.

Protected Area Network

Habitat protection and wild life conservation is achieved through establishing national parks and sanctuaries. There are 11 sanctuaries and 2 national parks located in different parts of Arunachal Pradesh, spread over an area of 9245.98 Sq. km (Table 2). Within these protected areas, the bio-diversity of almost all the districts is offered shelter and refuge There is also a proposal for extending this protected area network to cover further areas.

Prospective Areas

In Arunachal Pradesh there are large forested areas which could possibly be used for creation of new protected areas. Though the higher elevations of Arunachal Pradesh have more such areas, these are comparatively free from biotic pressures. On the contrary, the mid hill and lower regions have dense vegetation and pristine forests laden with natural resources. These are much more exploited due to their accessibility and richness in utility species. In such areas, which are vulnerable, if there are a few pockets of representative forests undisturbed then they offer the priority areas which deserve conservation. In Arunachal Pradesh various areas suggest themselves. These include the Doimara Reserved Forests in West Kameng district. Pe per and vicinity above Kimin in Lower Subansiri District. Demwee-Hawa pass to Tidding in Lohit district and Deomali, Namsai and Tengapani in Tirap and Lohit districts These areas are outside the protected area network but harbour rich bio-diversity They are also surrounded by zones of increased biotic pressures. They are representative of the vegetation surrounding the area. They are also unique in that there is a preponderance of primitive flowering plants and endangered species which require conservation

Present Study

Realising the importance of conservation in areas outside protected area network, an attempt was made to explore the possibility of finding out suitable locations to prioritise for conservation This involved collection of first hand information through secondary sources, including reports, and interactions with people through interviews.

As a first step, all previous records of botanical surveys were gathered and probable locations earmarked.

After having short-listed a few locations, we made a field inspection and interviewed some people for finding out the utility aspects of the proposed sites. Four important locations could be worked out. The results are tabulated below.

Constraints

Though Arunachal Pradesh has rich forest area and has a thin population, the problems associated with forest conservation are many.

Firstly, the economy of the state revolves around forests. As such, forests are looked upon as a source of revenue Hence, total protection is not feasible.

Further, there is a general apprehension among the local people that sanctuaries, national parks and other protected areas are areas where people's rights on the forests are curtailed. There is, therefore, a tendency to resist any move to develop such protected areas, as long as they are not in the control of the people, or with peoples participation It may be mentioned that programs such as Apna-Van, Anchal forests, where the active participation of people is an important component and the land continues

to be under community control, have evoked enthusiastic support from the people

As such, whenever the people were approached for information on forests and forest products, they were sceptical and deliberately avoided parting with information. In their view, such queries were related to the establishment of sanctuaries or other protected areas, which were not welcomed by them. This posed a great difficulty in getting information.

Most of the bio-diversity rich areas are now road connected and valuable resources must have already been eroded from there. However, some good patches are still existing in areas which are comparatively inaccessible. To study such areas is obviously difficult.

There are very few people who have knowledge about such areas and particularly who are willing to share the views and help in such studies. Despite all these difficulties, the project could be implemented and the results are discussed below.

Conservation Priority Area-1 (Site-1)
Doimara and vicinity

Situation

Located in the West Kameng district of Arunachal Pradesh, this reserved forests patch extends from the foot hills in the west to Balukpong in east. This area is also adjoining the Orchid Sanctuary and Eagles Nest Wild Life Sanctuary of Arunachal Pradesh. Towards the south is Assam, where the Missamari defence cantonment is situated. The Assam area is more thickly populated The area is predominantly hilly. It is traversed by rivers and streams providing different micro climatic conditions. The forest types and compositions also vary due to these factors. The forests in general are very luxuriant and mostly undisturbed over large areas

These forests are the source of many valuable forest products and commodities like timber, bamboos, rattans/ canes, medicinal plants and other non timber forest produce. Currently, there is exploitation of these commodities in a small or large scale, depending on the produce

Our study reveals that this area has valuable timber species like *Terminalia myriocarpa, Duabanga grandiflora, Canarium strictum, Ailanthus grandis, Gmelina arborea, Altingia excelsa*, etc

Important canes (Rattans) like *Calamus flagellum, C latifolius, Plectocomia assamica*, are also seen. Among bamboos, the prominent ones are *Bambusa pallida* and *Dendrocalamus hamiltonii*. Some other useful plants are *Garcinia spp, Spondias sp.*, etc. yielding edible fruits, and other useful commodities. Some such plants are listed below

Vulnerability

The forests are normally exploited for their timber. Adjoining this forest there are as many as five wood-based industries, two in Doimara area and three in Bhalukpong area. These large saw mills, if run to full capacity, would require huge quantities of raw materials in the form of timber.

Bhalukpong is the main area for Cane furniture and processing These units derive their raw materials from the adjoining forests where our study area falls. In addition to these, Tezpur and Rangapara are centers of cane trade where the raw materials from the study area are sold. Bamboos are exploited mostly for local use. To some extent they are also being harvested to feed the requirements of the defense cantonment and the paper mills at Jagiroad.

Apart from these some barks like Jigat (*Litsea sebifera, Persea* spp., *Oroxylum indicum, Dillenia* sp) are exploited in bulk, often to the detriment of the species concerned Unscientific extraction leads to disease and death of the plants.

Much of these activities are by the people inhabiting the vicinity The danger is often through commercial interests and activities rather than through local utilization. As the people depend for their needs on such resource laden forests, it is imperative to provide adequate conservation measures so that the fruits could be utilised for posterity. This area is a priority mainly because –

- It is very rich in biological diversity
- It has many commercially important and useful products.
- It has ethnic communities surrounding it and depending on it.
- Among the flora there is representation of endangered, endemic and other threatened plants.
- Presence of wild crop relatives.
- Mounting pressure on the biota.
- Vulnerability due to increased communication facilities being developed here.

Diversity

The forests of this area fall broadly under tropical and sub tropical types. There is a prevalence of **tropical semi-evergreen forests, tropical evergreen forests, sub tropical broad leaved forests, tropical riparian forests, secondary forests, bamboo breaks** etc.

The **tropical semi evergreen forests** found here have a prevalence of dominant trees like *Terminalia myriocarpa, Duabanga grandiflora, Canarium strictum, Ailanthus grandis, Talauma hodgsonii, Castanopsis indica*, etc.

The **tropical evergreen forests** have a predominance of evergreen elements like *Altingia excelsa, Mesua ferrea, Talauma, Persea, Syzygium* etc. along with other semi evergreen elements.

Sub tropical broad leaved forests are more of evergreen types and are very dense in appearance. Being moist it has luxuriant growth of epiphytes and ground flora. Some very important species of this zone are *Altingia excelsa, Magnolia sp., Englehardia spicata, Lithocarpus, Castanopsis, Quercus*, etc. This zone is important for different forest resources, particularly canes, barks, medicinal herbs, bamboos, etc.

Other **Secondary forests** are the result of deforestation due to various reasons. They are poor in composition and structural complexity. *Macranga, Callicarpa, Maesa, Saurauia, Musa, Pandanus*, grasses and other weedy species abound in such forests. They are less productive and less useful to the people at large.

The **tropical riparian forests** are met with in river banks and flood plains. These forests sometimes briefly get inundated and need to withstand water logging. Though such areas are limited in extent, they are important in respect of soil and water conservation. Some trees like *Dillenia indica, Lagerstroemia speciosa, Bischofia javanica, Elaeocarpus aristatus* grow in such habitats.

Due to constant exploitation and ecological pressures, some of our plants become rare, endangered or threatened. Repeated surveys result in new finds and records which need detailed documentation and conservation efforts. The selected locality Doimara R.F. is one such area where some rare and endangered species like *Dipteris wallichii, Plectocomia assamica, Albizia arunachalensis, Balanophora sp, Arundina graminifolia, Cyathea spp., Angiopteris evecta* have been located.

The area is also important as a refuge for some of our wild crop relatives and economic plants. Listed below are some such important species.

Tree Species

Terminalia myriocarpa
Duabanga grandiflora
Ailanthus grandis
Altingia excelsa
Amoora wallichii
Morus laevigata
Michelia spp
Lagerstroemia minuticarpa
Kydia glabrescens
Mesua ferrea
Lagerstroemia speciosa
Bischofia javanica
Englehardia spicata
Schima wallichii
Elaeocarpus aristatus
Persea spp

Bamboos

Dendrocalamus hamiltonii
Bambusa pallida
Pseudostachyum polymorphum

Rattans/Canes

Calamus tenuis
Calamus flagellum
Calamus erectus
Plectocomia assamica

Endangered and Other Plants

Hodgsonia macrocarpa
Entada purseatha
Arundina graminifolia
Livistona jenkinsiana
Wallichia densiflora
Caryota urens
Cyathea spp.
Angiopteris evecta
Dipteris wallichii
Piper spp
Musa spp.
Pandanus sp.
Acorus calamus
Lasia spinosa
Albizia arunachalensis
Podocarpus nerifolius
Dendrobium spp.
Lycopodium sp.

In addition, there are some good representation of *Elaeocarpus, Spondias, Mangifera, Diplazium, Spilanthus, Pouzolzia, Sarcochlamys, Paedaria, Saccharum*, and other such useful genera. Full details can only be determined after conducting indepth field surveys.

Conservation Priority Area - 2 (Site-2)

Pe Per and vicinity near Kimin.

Situation

This locality is situated amidst the tropical semi evergreen forest belt in the Papum pare and Lower Subansiri district border, towards south of lower Subansiri. It is a very

pristine forest patch protected largely due to comparative inaccessibility due to the river barrier. Its more of a hill and hill slope with valley physiographically. Rainfall and temperature are high which are typical of tropical forests.

The dense vegetation in this forest consists of important and useful plants like Timber, Bamboos, Canes, Medicinal Plants and other non timber resources. The forest in general are rich in species composition and very complex in structure as is typical of tropical forests. The microclimatic conditions prevailing over here must have favourably contributed to the richness of the area.

An enquiry with the people nearby revealed that this forest is particularly rich in species of rattans, palms and wild animals.

Some of the important trees include *Duabanga grandiflora, Altingia excelsa, Canarium strictum, Amoora wallichii, Ailanthus grandis, Michelia spp. Castanopsis sp.* etc. *Calamus flagellum, Calamus tenuis, Calamus erectus, Calamus leptospadix* are some of the canes found here. While *Dendrocalamus hamiltonii, Bambusa pallida, Pseudostachym polymorphum* are some bamboos growing here.

Canarium strictum yields resin while *Terminalia chebula, Terminalia bellirica*, etc. are valued for their medicinal properties.

As of now, there is not much disturbance to his patch of forests. However, people come here for hunting and collection of non-timber forest products. Due to the spectacular diversity of species and its importance as one of the unique habitats, it is perhaps an important conservation priority.

Conservation Priority Area - 3 (Site-3)
Tropical wet evergreen forests at Deomali-Namsangmukh, Namsai, Tengapani-Madhupan and vicinity.

Situation

The area is situated in Tirap and Lohit districts of Arunachal Pradesh, lying in the south bank districts of Brahmaputra. Towards the west it is bordered by Assam and all around it is surrounded by Tropical semi evergreen forests. Kamlang Wild Life Sanctuary and Namdapha National Park are close to this place.

The topography is of the plains and low hills. Numerous streams criss-cross the area and inundate parts of the forests during the summer. There is heavy rainfall and high temperatures during the summer. The vegetation is broadly tropical wet evergreen type, dominated by Dipterocarps like *Dipterocarpus retusus* and *Shorea assamica*. The structure is very complex and the composition diverse. These are centres of rich biodiversity and unique flora. It is also a veritable store house of many important plant groups like Timber, Bamboos, Canes, Medicinal plants, other NTFP, wild edibles and crop relatives, rare and endangered plants, etc. Dipterocarps are considered to be one of the most important raw materials for plywood and wood based industries. Due to the proximity of such industries, pressure on these forests is high. Being partly in the plains, there is evidence of conversion of forest land to other land use systems like agriculture. The urban development that is taking place in the vicinity of these forests, like the Deomali township, Namsai township, Lathaw and other centres, also reduces the area of these forests.

Vulnerability

These rich forests are being exploited primarily for their timber resources. As already mentioned, the lofty trees of the dominant species Hollong (*Dipterocarpus macrocarpus*) Mekai (*Shorea assamica*) Khokon (*Duabanga grandiflora*) Jutuli (*Altingia excelsa*) Amari (*Amoora wallichii*) Sam (*Artocarpus chama*) etc. are removed by the numerous industries situated in the vicinity of such forests and also by those large units located in the adjoining state of Assam. They are converted to plywood, beams and other items. The requirements of all these industries are so large that if not scientifically exploited and managed it is only a matter of time before these forests get wiped out.

Priority

With all these pressures acting upon the vegetation, habitat degradation takes place and at least some vulnerable plants get endangered.

It may be noted that this forests type in India occurs only in this region.

These forests are the habitat of the only non-human ape, the Hoolock Gibbon, in Arunachal Pradesh.

Some other rare animals seen in such habitats are Tiger, Hornbill, Flying squirrel, etc.

This also offers habitat to some of our rare plants like *Sapria himalayana, Cyathea spp., Angiopteris evecta, Dischidia bengalensis, Beilschmedia deomalica, Picrasma javanica, Griffithia sp., Gnetum gnemon* etc.

List of some important plants in the locality are as follows.

Trees

Dipterocarpus macrocarpus
Shorea assamica
Altingia excelsa

Mesua ferrea
Sapium baccatum
Elaeocarpus sphaericus
Amoora wallichii
Duabanga grandiflora
Ailanthus grandis
Trema cannabina
Elaeocarpus rugosus
Vatica lancifolia
Manglietia sp.
Michelia sp.
Stereospermum colais
Canarium strictum
Phoebe sp.,
Turpinia sp.

Bamboos

Dendrocalamus hamiltonii
Bambusa pallida
Cephalostachyum sp.
Pseudostachyum polymorphum

Canes

Calamus nambariensis
Calamus sp.
Zalacca

Medicinal Plants

Piper sp.
Acorus sp.
Paedaria sp
Clerodendrum sp
Costus sp
Terminalia chebula
T. bellirica
Oroxylum indicum

Other Plants

Mangifera sylvatica
Gnetum gnemon
Hodgsonia macrocarpa
Spondias pinnata
Spondias axillaris
Canarium strictum
Elaeocarpus floribundus
Baccaurea sapida
Garcinia cowa
Garcinia paniculata
Zanthoxylum sp.
Dillenia indica
Syzygium spp.
Abelmoschus moschatus
Beilshmedia deomlica
Sapria himalayana
Dischidia bengalensis
Gnetum gnemon
Cyathia sp
Angiopteris evecta
Lycopodium
Entada purseatha
Griffithia sp.

Conservation Priority Area-4 (Site-4)
Demwee-Sewak pass-Tiding

Situation

The area is situated in Lohit district, some 10 km. east of Tezu, the district head quarter, along the Tezu-Hayuliang Road It lies in the tropical semievergreen belt and ascends to the sub tropical belt at Sewak pass Physiographically the area is hilly The hills are mostly steep. On both sides of the ridge. which lies more or less in a north south direction, are streams and small river valleys Climatically it experiences high temperatures in the summer Rainfall too is very heavy The road to Hayuliang bisects the proposed site. By and large the forests are undisturbed. However, there is evidence of human pressures as they are proximal to the district headquarters. There are lime stone deposits near Tidding. These are also being exploited, though currently on a limited scale.

This dense patch of forest vegetation covers the eastern ridge, 10-15 km east of Tezu, which at first rises gently from the plains but later ascents steeply on both sides. The hills are clothed with dense vegetation, typical of tropical and sub tropical zones The floristic composition and structure are as explained in Kaul & Haridasan (1987).

The dominant trees include *Duabanga grandiflora, Dalbergia sp Albizia sp., Terminalia Myriocarpa, Altingia excelsa, Michelia spp., Schima wallichii, Stereospermum colais* and many others. Timber, Cane and Bamboos are the main economic products from these forests There is increasing demand for these commodities to satisfy the needs of the growing population of the district head quarters and the surrounding area. In addition, there are many wood based industries. a few in the vicinity. but many more in Choukham and Namsai area. Even the industrial centre of Tinuskia, in Assam, is at an accessible distance All of them are looking for timber

This forest also has an abundant growth of bamboos In the lower hills there are *Dendrocalamus hamiltonii,*

Bambusa pallida and *Pseudostachyum polymorphum*, while in the higher areas there are *Chimonobambusa callosa, Phyllostachys sp , Neohousea helferii* and a very interesting species of *Cephalostachyum* nearer to *fuchsianum*, whose shoots have a fiery look with purplish sheaths

Interestingly, there is a good representation of rattans too. Mostly these belong to the *genera Calamus* like *C flagellum, C. floribundus, C erectus, Zalacca* and *Plectocomia* are also found here.

Other potential non timber forest produce include gums and resins like *Canarium* (Dhuna), medicinal plants like *Costus speciosus, Terminalia chebula, T. bellirica, Gmelina arborea, Cinnamomum spp, Litsea sp., Oroxylum sp*, etc , thatch, broom and others.

The area is also rich in wild edible plants like *Spondias, Ficus, Syzygium*, etc

Some of our rare and endangered species like *Angiopteris, Cyathea, Albizia, Arundina*, are taking refuge in this area. The botanical studies of the State Forest Research Institute have also revealed some possibly new records of *Firmiana, Pentace* etc

Apart from plants, the fauna too is rich in this area. Many wild cats, deers, snakes, monkeys, pheasants and other birds are inhabiting this wilderness.

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Comparative Assessment of the Four Selected Sites

Site	1	2	3	4
Forest Type	Tropical Semi evergreen Sub tropical broad leaved	Tropical Semi-Evergreen Subtropical broad Leaved	Tropical Wet Evergreen	Tropical Semi-Evergreen and
Physiography	Plain, Low hills and Steep hills	Low and Medium hills	Plain and low hills	Plain, Low and Steep hills
Species Diversity	***	**	****	***
Rare and Endangered Plants	****	**	****	***
Crop Relatives and Economic	***	***	***	***
Proximity to human Settlements	****	**	*****	***
Pressure on Forests	***	**	******	****
Habit condition	60	80	40	50
Regeneration	**	***	**	***
Presence of Aliens	****	*	****	**

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Table 1: General Forest Types in Arunachal Pradesh
Champion and Seth 1968

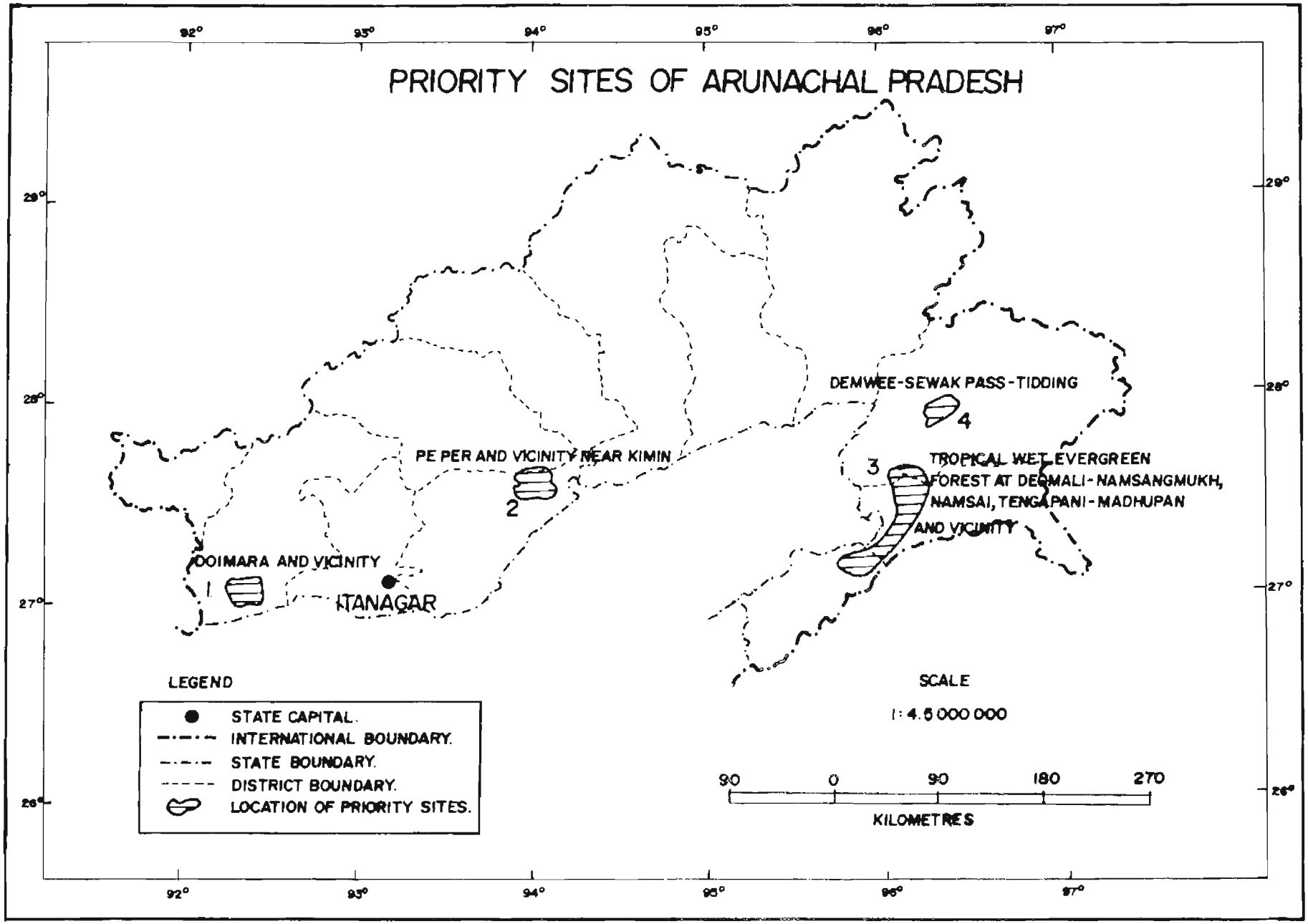
IB/C1	Assam valley tropical evergreen forests
IB/C2	Upper Assam Valley tropical evergreen forests
2B/C1a	Assam alluvial plains semi-evergreen forests
2B/C1/S1	Sub Himalayan light alluvial semi-evergreen forests
3C/C3B	East Himalayan moist deciduous forests
3/1S2	Eastern hollock forests
8B/C1	East Himalayan sub tropical forests
9/C2	Assam sub tropical pine forests
11B/C1	East Himalayan wet temperate forests
11B/C1a	Luaraceae forests
11B/C1b	Bak Oak forests
11B/C1c	High level Oak forests
11B/C2	Naga hill temperate forests
12/C3a	East Himalayan mixed coniferous forests
12/C3b	Abies delavayi forests
14/C2	East Himalayan sub-alpine birch/fir forests
15/C3	Alpine pastures
16/C1	Dry alpine scrub
16/E1	Dwarf juniper scrub

Table 2: Protected Areas in Arunachal Pradesh

National park / Sanctuaries	*District*	*Area in sq. km*	*Major animals*
National Parks			
Namdapha national Park and project Tiger	Changlang	1985.00	Hoolock Gibbon, Tiger, Clouded/Snow leopard Musk deer, Takin, Capped langur and rare Birds
Mouling National Park	Upper Siang	483.00	Takin, Serow, Red Panda Goral, Leopard, Black bear, Pheasants etc.
Wildlife Sanctuaries			
Pakhui Wildlife Sanctuary	East Kameng	861.95	Elephant, Tiger, Gaur Sambhar, Barking Deer, Binturong, Leopard, Pheasants etc.
Itanagar Wildlife Sanctuary	Papum pare	140.30	Elephant, Tiger, Leopard, Serow, Barking deer and birds
D`Ering memorial Wildlife Sanctuary	East Siang	190.00	Hog Deer, Hispid, Hare, Bengal pelican Reptiles and migratory Birds.
Mehao Wildlife Sanctuary	Dibang valley	281.50	Elephant, Tiger, Leopard Red panda, Hoolock, Gibbon, etc
Kamlang Wildlife Sanctuary	Lohit	783.00	Tiger, Takin, Leopard, Red Panda, Hoolock, Gibbon, Capped Langur

Table 3: Legal Status of the Forests in Arunachal Pradesh

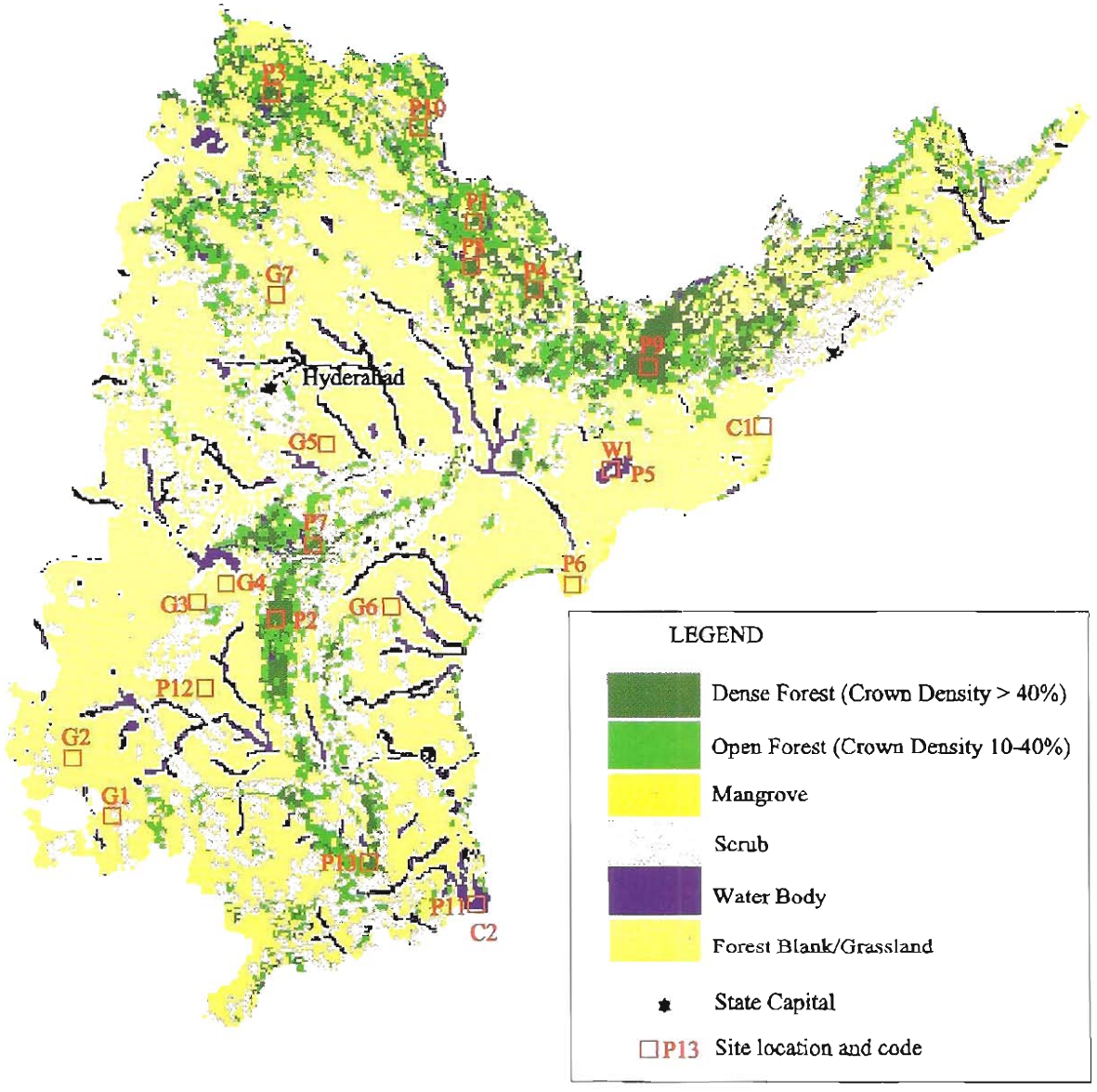
Legal status	*Area in Sq. km*	*% of total Recorded area Forest*	*% of total geographical*
Reserved forests	9815.37	19 04	11.72
Anchal & village Forest reserves	489 29	0.94	0.58
Protected Forest	7.79	0.01	0.01
Proposed reserve Forest	3820.00	7.41	4.56
National parks	2468.23	4.79	2.95
Sanctuaries	6777.75	13.14	8.09
Unclassed State forests	31981.57	62.05	38.19


PRIORITY SITES OF ARUNACHAL PRADESH
92°
93°
94°
95°
96°
97°
29°
28°
27°
26°
DEMWEE-SEWAK PASS-TIDDING
4
PE PER AND VICINITY NEAR KIMIN
2
TROPICAL WET EVERGREEN FOREST AT DEOMALI-NAMSANGMUKH, NAMSAI, TENGAPANI-MADHUPAN AND VICINITY
3
DOIMARA AND VICINITY
1
ITANAGAR
LEGEND
STATE CAPITAL.
INTERNATIONAL BOUNDARY.
STATE BOUNDARY.
DISTRICT BOUNDARY.
LOCATION OF PRIORITY SITES.
SCALE
1:4,6000 000
90 0 90 180 270
KILOMETRES

BCPP Priority Sites
Statewise Maps

Base maps prepared by Indira Gandhi Conservation Monitoring Center, WWF India
Sites plotted by Raman Mehta, Indian Institute of Public Administration, New Delhi

BCPP Priority Sites in Andhra Pradesh



PROTECTED AREAS

P1- Eturunagaram Sanctuary
P2- Gundla Brahmeshwaram Sanctuary
P3 - Kawal Sanctuary
P4 - Kinnerasani Sanctuary
P5 - Kolleru Sanctuary
P6 - Krishna Sanctuary
P7 - Nagarjunasagar-Srisailam Tiger Reserve
P8 - Pakhal Sanctuary
P9 - Papikonda Sanctuary
P10 - Pranahita Sanctuary
P11 - Pulicat Sanctuary
P12 - Sri Lankamelleshwara Sanctuary
P13 - Sri Venkateshwara National Park

GRASSLANDS

G1 - Hamireddypalli
G2 - Mudinanipalli
G3 - Nellibanda
G4 - Rollapadu Sanctuary
G5 - Shamsabad
G6 - Siruvella
G7 - Vikarabad

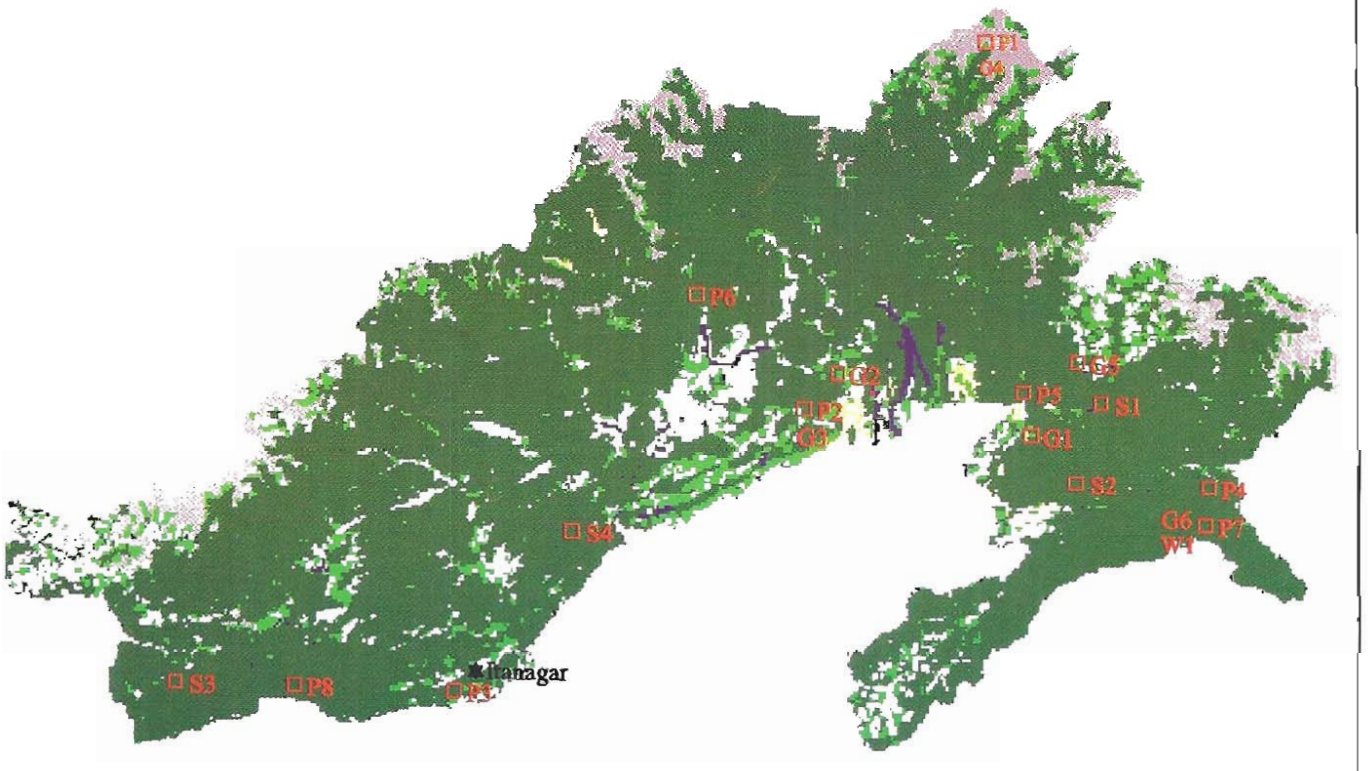
WETLAND

W1 - Kolleru Sanctuary

COASTS

C1 - Coringa
C2 - Pulicat Lake

BCPP Priority Sites in Arunachal Pradesh



LEGEND

- Dense Forest (Crown Density > 40%)
- Open Forest (Crown Density 10-40%)
- Scrub
- Tea Gardens
- Water Bodies
- Snow
- Uninterpreted Area or Cloud
- Forest Blanks/Grasslands
- State Capital
- P8 Site Location and Code

PROTECTED AREAS

P1 - Dibang Sanctuary
P2 - D'Ering (Lali) Sanctuary
P3 - Itanagar Sanctuary
P4 - Kamlang Sanctuary
P5 - Mehao Sanctuary
P6 - Mouling National Park
P7 - Namdapha National Park
P8 - Pakhui Sanctuary

GRASSLANDS

G1 - Chapories of Lohit River
G2 - Scattered grasslands between Sesseri and Sibia Rivers.
G3 - D'Ering (Lali) Sanctuary
G4 - Dibang Sanctuary
G5 - Kerun
G6 - Namdapha National Park

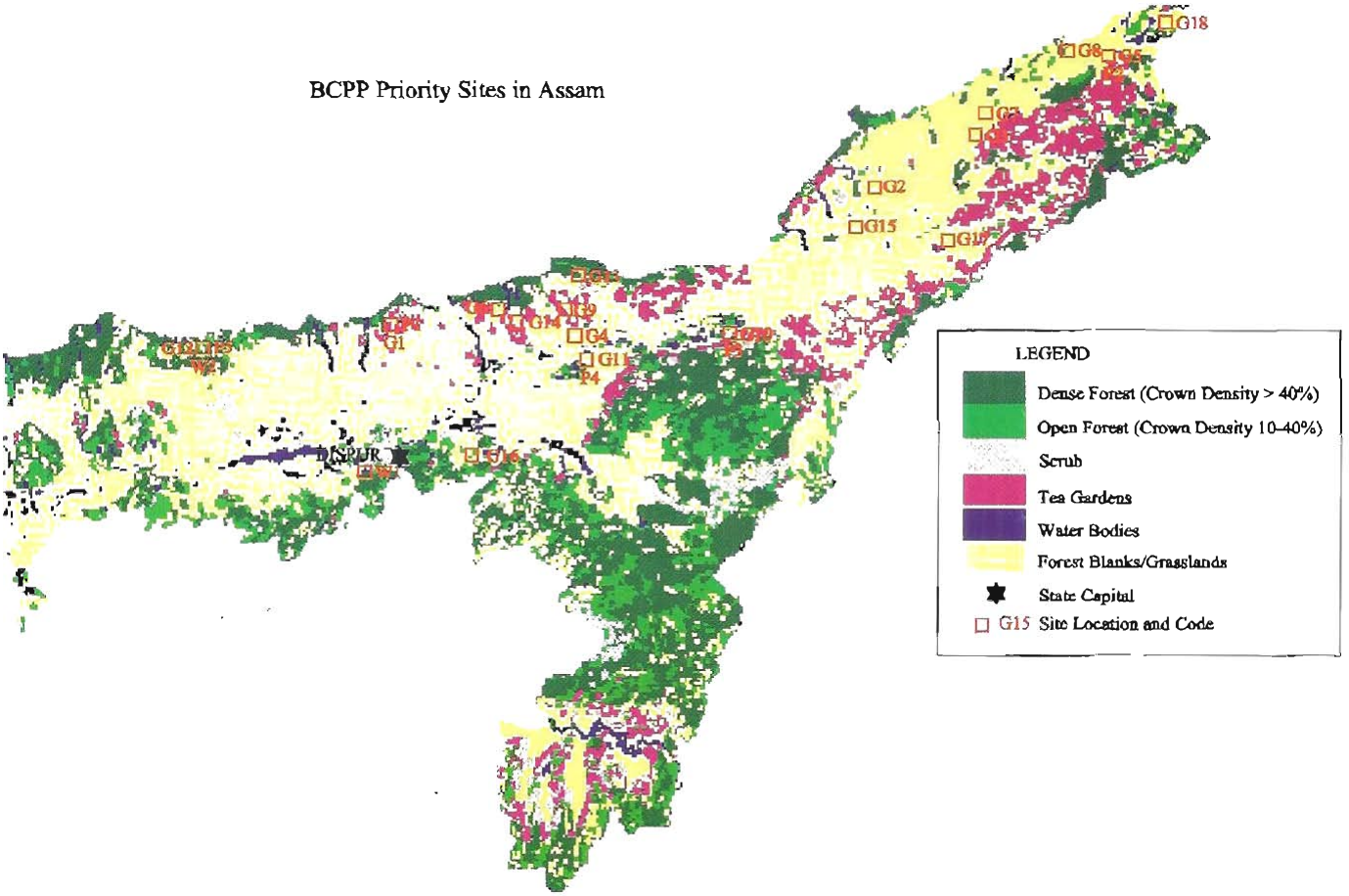
STATE LEVEL PRIORITY SITES

S1 - Demwee Sewak
S2 - Deomali Namsai
S3 - Doimara
S4 - Pe Per Kimin

WETLAND

W1 - Namdapha National Park

Note: The exact location of a wetland priority site ie; Deopani, is not available and hence not plotted. The entire trans and greater himalayan region in the state was highlighted as a priority. However, since no specific site was mentioned as a priority site, none have been plotted.



GRASSLANDS

G1 - Barnadi Sanctuary
G2 - Borchapori
G3 - Bordalani
G4 - Burhachapori Sanctuary
G5 - Dibru-Saikhowa Sanctuary
G6 - Hugrajuli
G7 - Jamjing and Sengajan
G8 - Kobo Chapori
G9 - Kochmora
G10 - Kaziranga National Park
G11 - Laokhowa Sanctuary
G12 - Manas National Park
G13 - Nameri National Park
G14 - Orang Sanctuary
G15 - Pabha
G16 - Pabitora Sanctuary
G17 - Papi-Dibing Sanctuary
G18 - Amarpur, Sibia Chapori, Sadiya Plains (Bhimchapori, Kundil Kalita R.F. and Ambikapur)

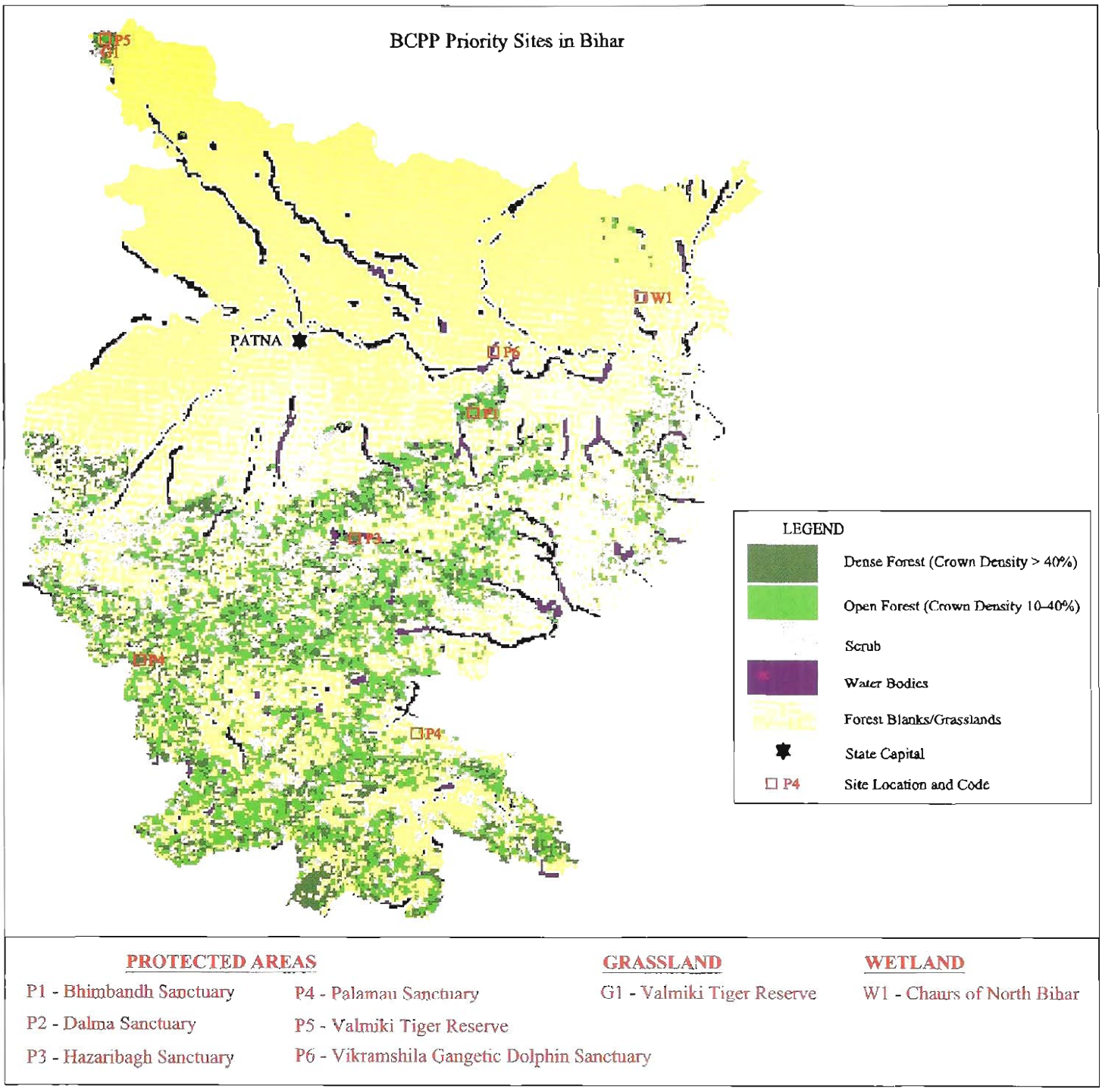
PROTECTED AREAS

P1 - Barnadi Sanctuary
P2 - Dibru-Saikhowa Sanctuary
P3 - Kaziranga National Park
P4 - Laokhowa Sanctuary
P5 - Manas National Park

WETLANDS

W1 - Dipor Beel
W2 - Manas National Park

Note: The grassland sites shown above include the sites prioritised by Dr. Asad Rahmani and Dr. Anwaruddin Choudhury.



PROTECTED AREAS

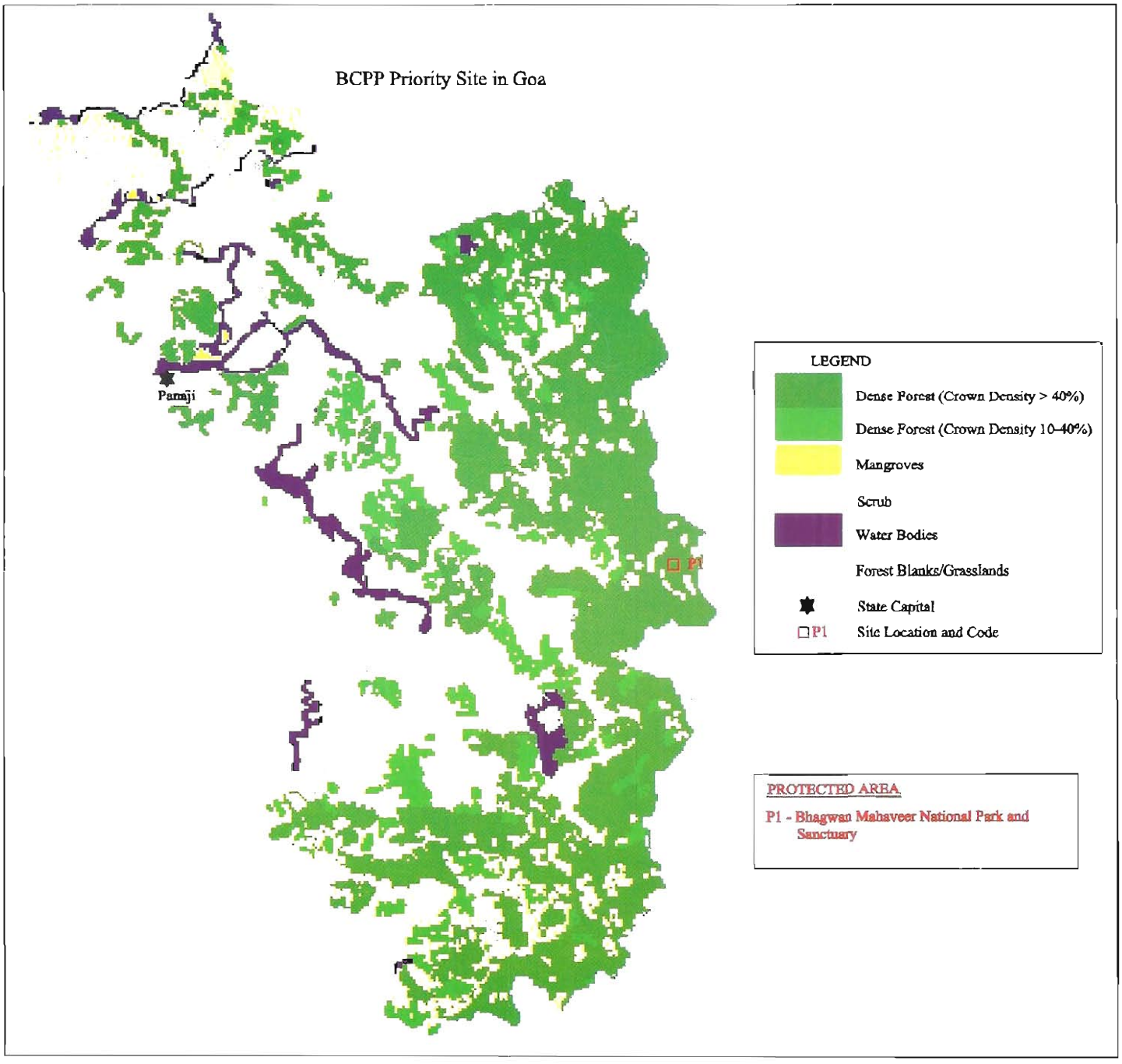
P1 - Bhimbandh Sanctuary
P2 - Dalma Sanctuary
P3 - Hazaribagh Sanctuary
P4 - Palamau Sanctuary
P5 - Valmiki Tiger Reserve
P6 - Vikramshila Gangetic Dolphin Sanctuary

GRASSLAND

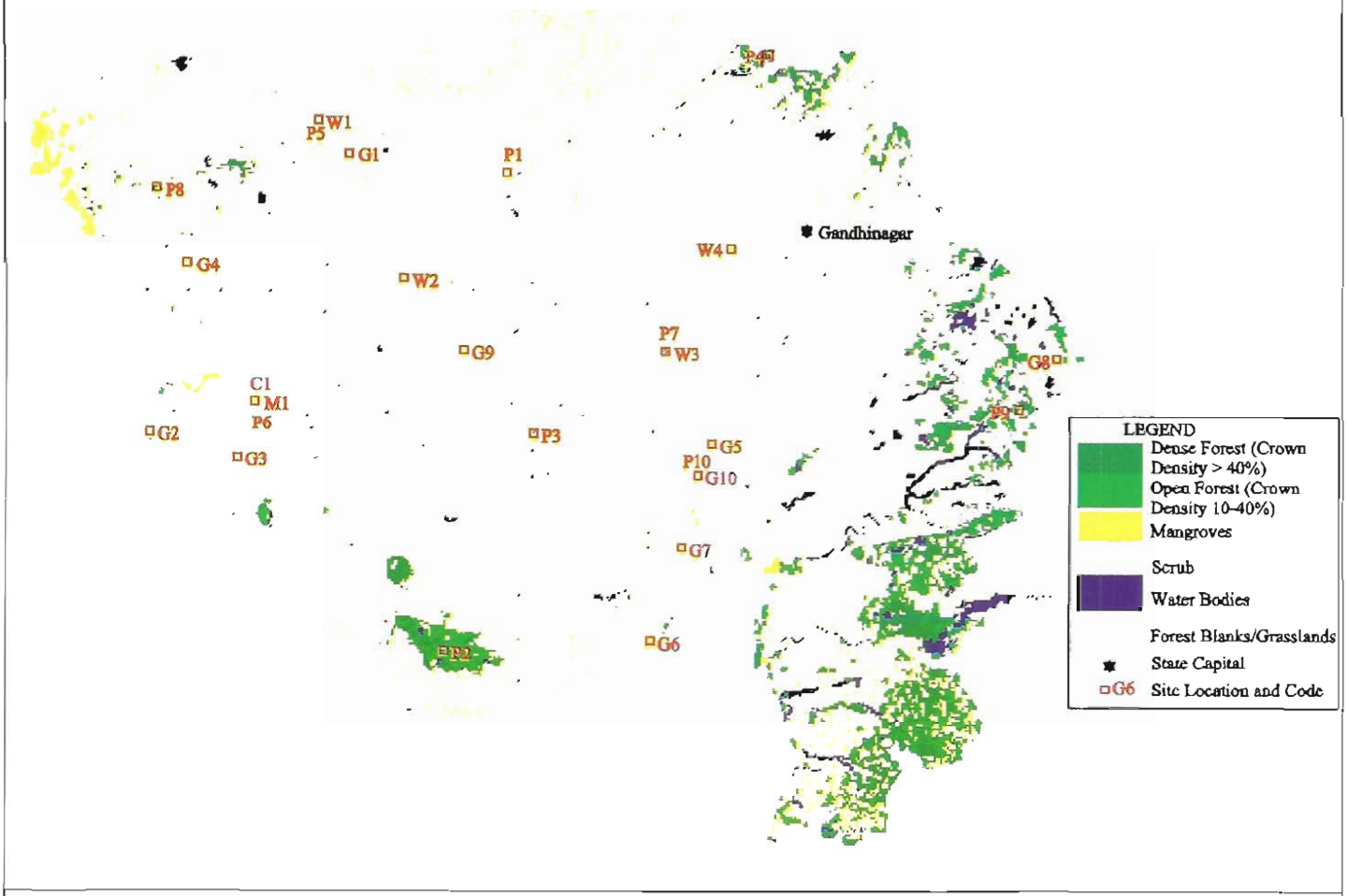
G1 - Valmiki Tiger Reserve

WETLAND

W1 - Chaurs of North Bihar


BCPP Priority Site in Goa
Panaji
P1
LEGEND
Dense Forest (Crown Density > 40%)
Dense Forest (Crown Density 10-40%)
Mangroves
Scrub
Water Bodies
Forest Blanks/Grasslands
State Capital
P1 Site Location and Code
PROTECTED AREA
P1 - Bhagwan Mahaveer National Park and Sanctuary

BCPP Priority Sites in Gujarat



PROTECTED AREAS

P1 - Dhrangadhra (Wild Ass) Sanctuary
P2 - Gir National Park
P3 - Hingolgarh Sanctuary
P4 - Jessore Sanctuary
P5 - Kachchh Desert Sanctuary
P6 - Marine National Park and Sanctuary
P7 - Nal Sarovar Sanctuary
P8 - Narayan Sarovar Sanctuary
P9 - Ratanmahal Sanctuary
P10 - Velavadar National Park

GRASSLANDS

G1 - Banni
G2 - Gaga Great Indian Bustard Sanctuary
G3 - Kengarpur in Kachchh
G4 - Lala Area
G5 - Mithiala
G6 - Pipala
G7 - Ranigoda / Hipavali
G8 - Rampura in Dahod
G9 - Rampura in Wankaner
G10 - Velavadar National Park

WETLANDS

W1 - Great Rann of Kachchh
W2 - Little Rann of Kachchh
W3 - Nal Sarovar Sanctuary
W4 - Thol Sanctuary

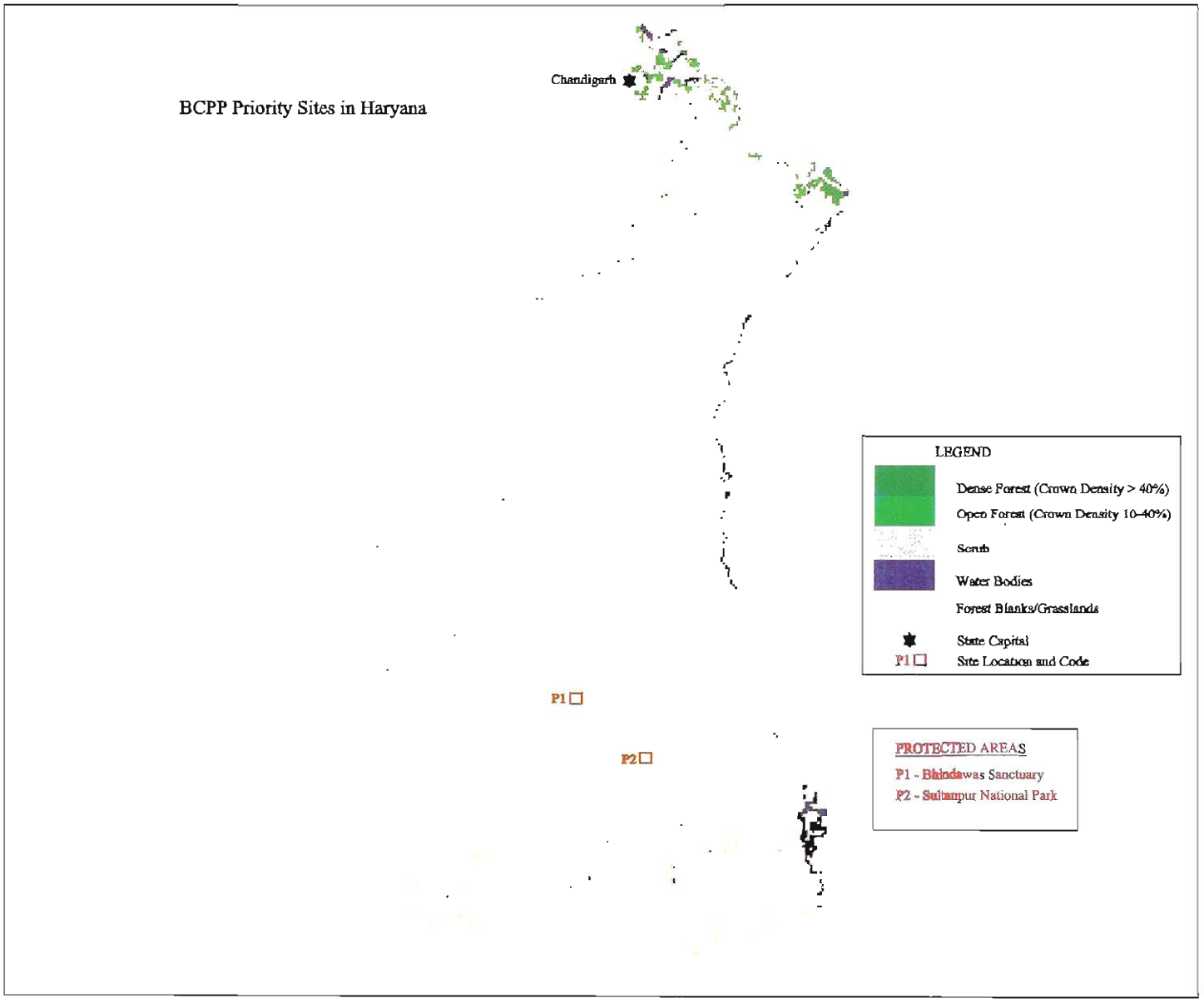
COAST

C1 - Gulf of Kachchh (Marine National Park and Sanctuary)

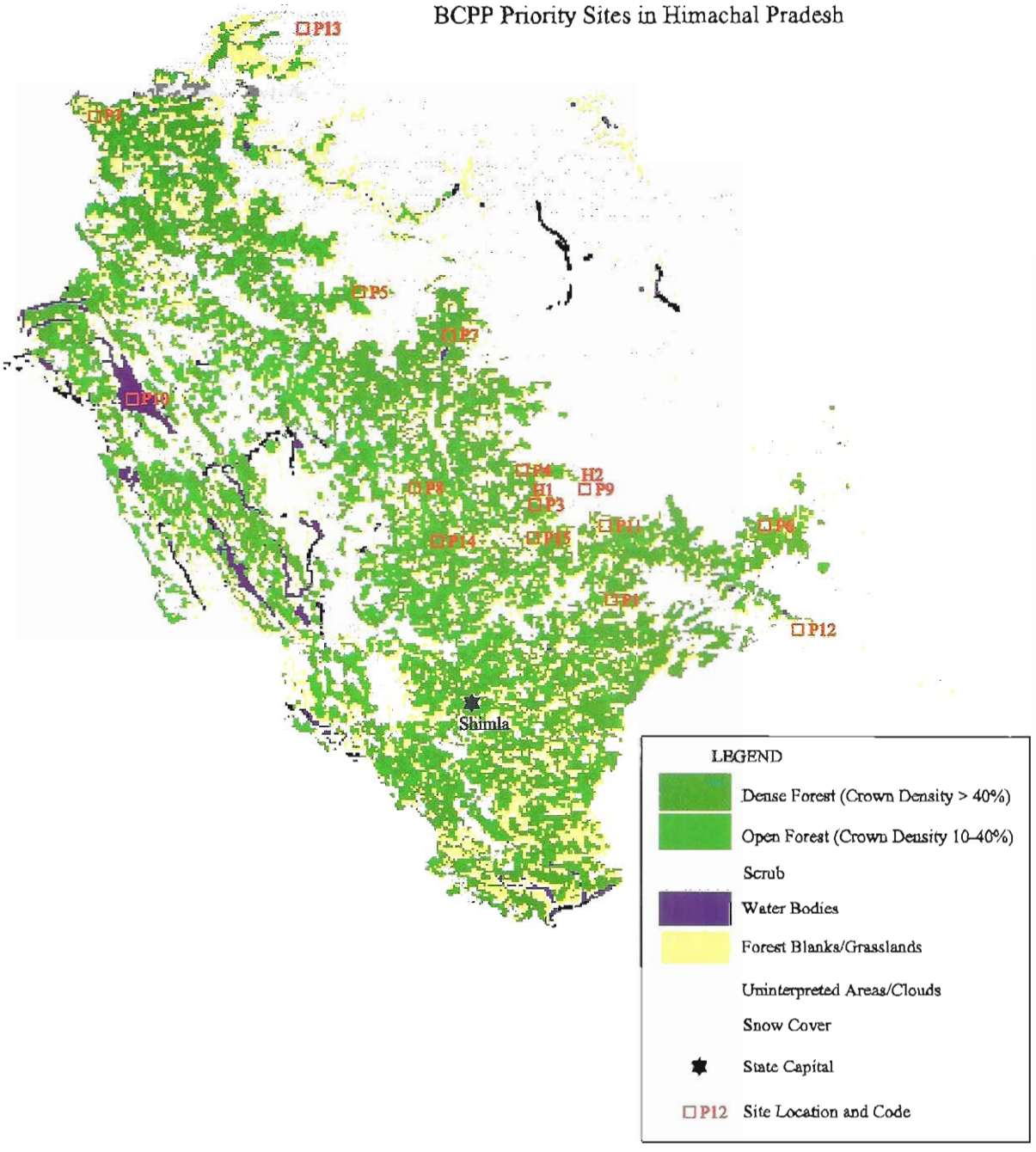
MARINE SITE

M1 - Gulf of Kachchh (Marine National Park and Sanctuary)

BCPP Priority Sites in Haryana



BCPP Priority Sites in Himachal Pradesh



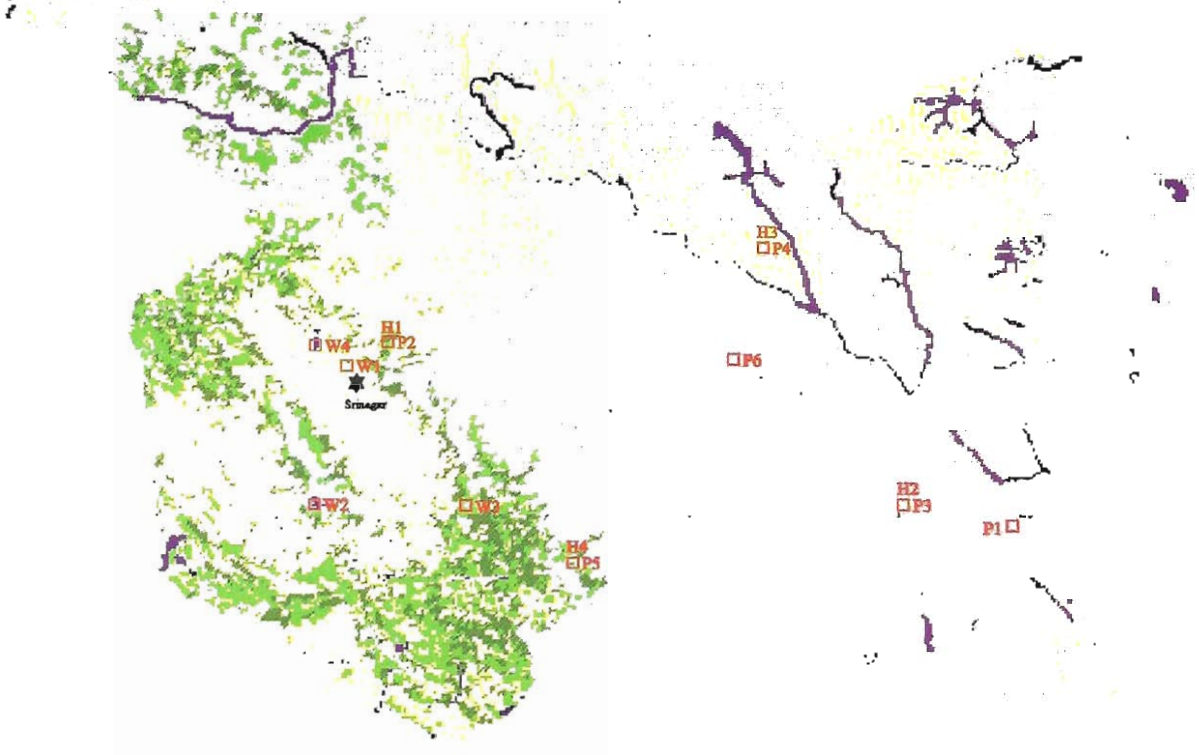
PROTECTED AREAS

P1 - Daranghati Sanctuary
P2 - Gamgul Siahbehi Sanctuary
P3 - Great Himalayan National Park
P4 - Kanawar Sanctuary
P5 - Kugti Sanctuary
P6 - Lippa Asrang Sanctuary
P7 - Manali Sanctuary
P8 - Nargu Sanctuary
P9 - Pin Valley National Park
P10 - Pong Lake Sanctuary
P11 - Rupi Bhaba Sanctuary
P12 - Sangla Sanctuary
P13 - Sechu Tuan Nalah Sanctuary
P14 - Shikari Devi Sanctuary
P15 - Tirthan Sanctuary

TRANS AND GREATER HIMALAYAS

H1 - Great Himalayan National Park
H2 - Pin Valley National Park

BCPP Priority Sites in Jammu and Kashmir



LEGEND

- Dense Forest (Crown Density > 40%)
- Open Forest (Crown Density 10-40%)
- Scrub
- Water Bodies
- Forest Blanks/Grasslands
- Uninterpreted Areas/Clouds
- Snow Cover
- State Capital
- P3 Site Location and Code

PROTECTED AREAS

P1 - Changthang Sanctuary
P2 - Dachigam National Park
P3 - Hemis National Park
P4 - Karakoram Sanctuary
P5 - Kishtwar National Park
P6 - Overa-Aru Sanctuary

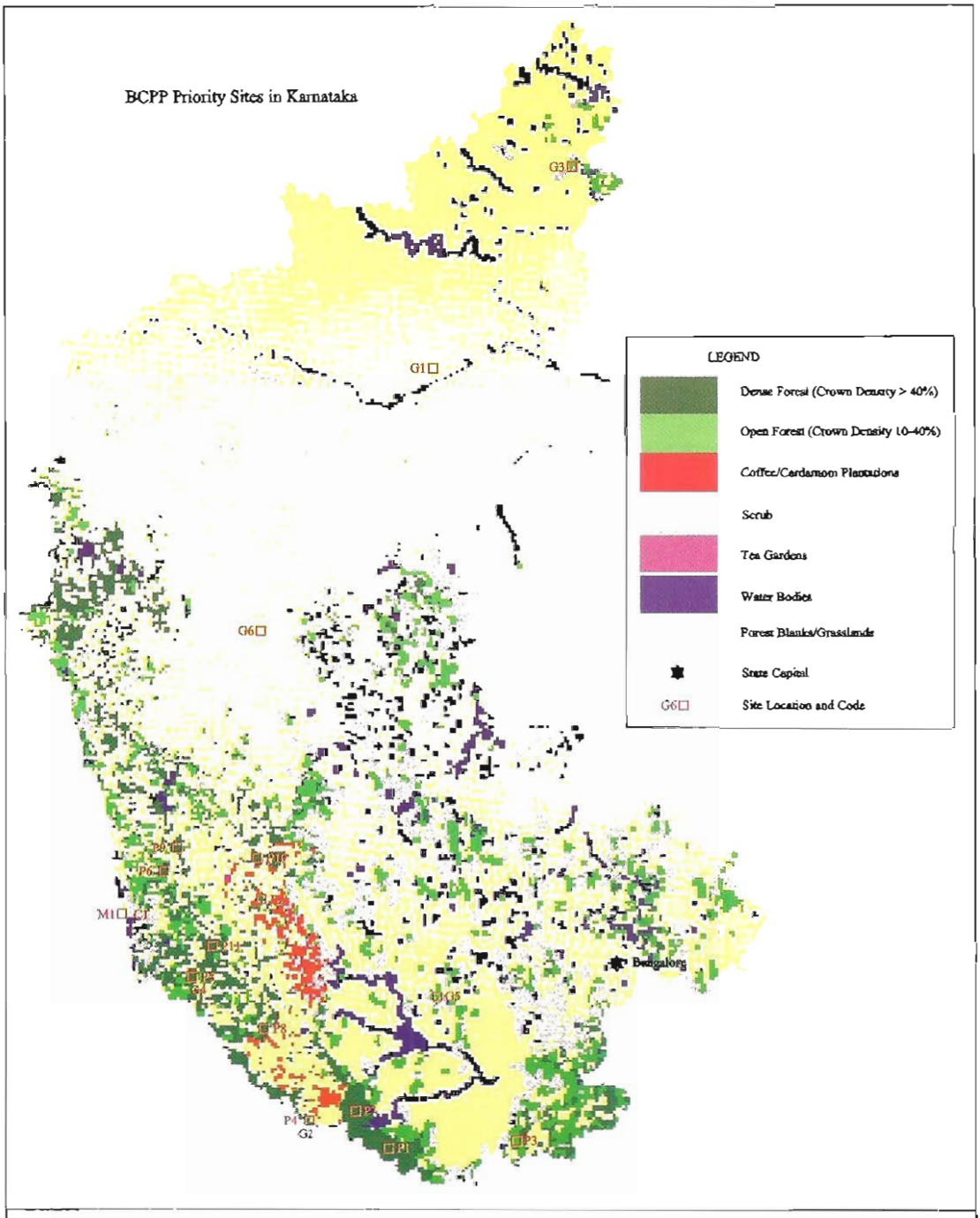
WETLANDS

W1 - Dal Lake
W2 - Haigam Lake
W3 - Hokarsar Lake
W4 - Wular Lake

TRANS AND GREATER HIMALAYAS

H1 - Dachigam National Park
H2 - Hemis National Park
H3 - Karakoram Sanctuary
H4 - Kishtwar National Park

Note: The exact location of a Trans-himalayan priority site ie; Chang-Chemo is not available and could not be plotted.



PROTECTED AREAS

P1 - Bandipur National Park
P2 - Bhadra Sanctuary
P3 - Biligiri Rangaswamy Temple Sanctuary
P4 - Brahmagiri Sanctuary
P5 - Kudremukh National Park
P6 - Mookambika Sanctuary
P7 - Nagarahole National Park
P8 - Pushpagiri Sanctuary
P9 - Sharavathi Valley Sanctuary
P10 - Shettihally Sanctuary
P11 - Someshwara Sanctuary

GRASSLANDS

G1 - Bilgi
G2 - Brahmagiri Sanctuary
G3 - Chincholi
G4 - Kudremukh National Park
G5 - Melkote Temple Sanctuary
G6 - Ranebennur Sanctuary

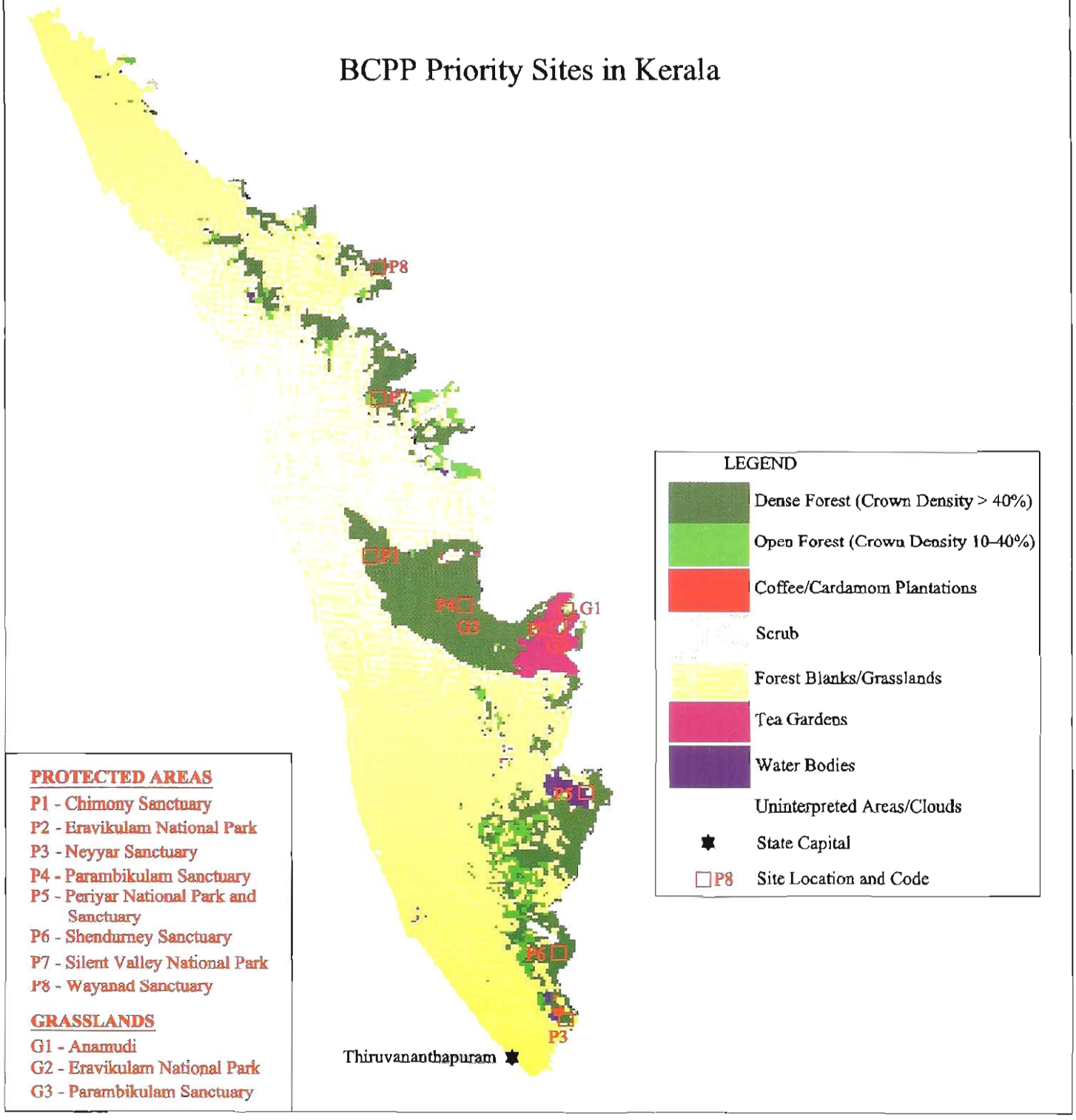
COAST

C1- Kundapur

MARINE SITE

M1- Kundapur

BCPP Priority Sites in Kerala

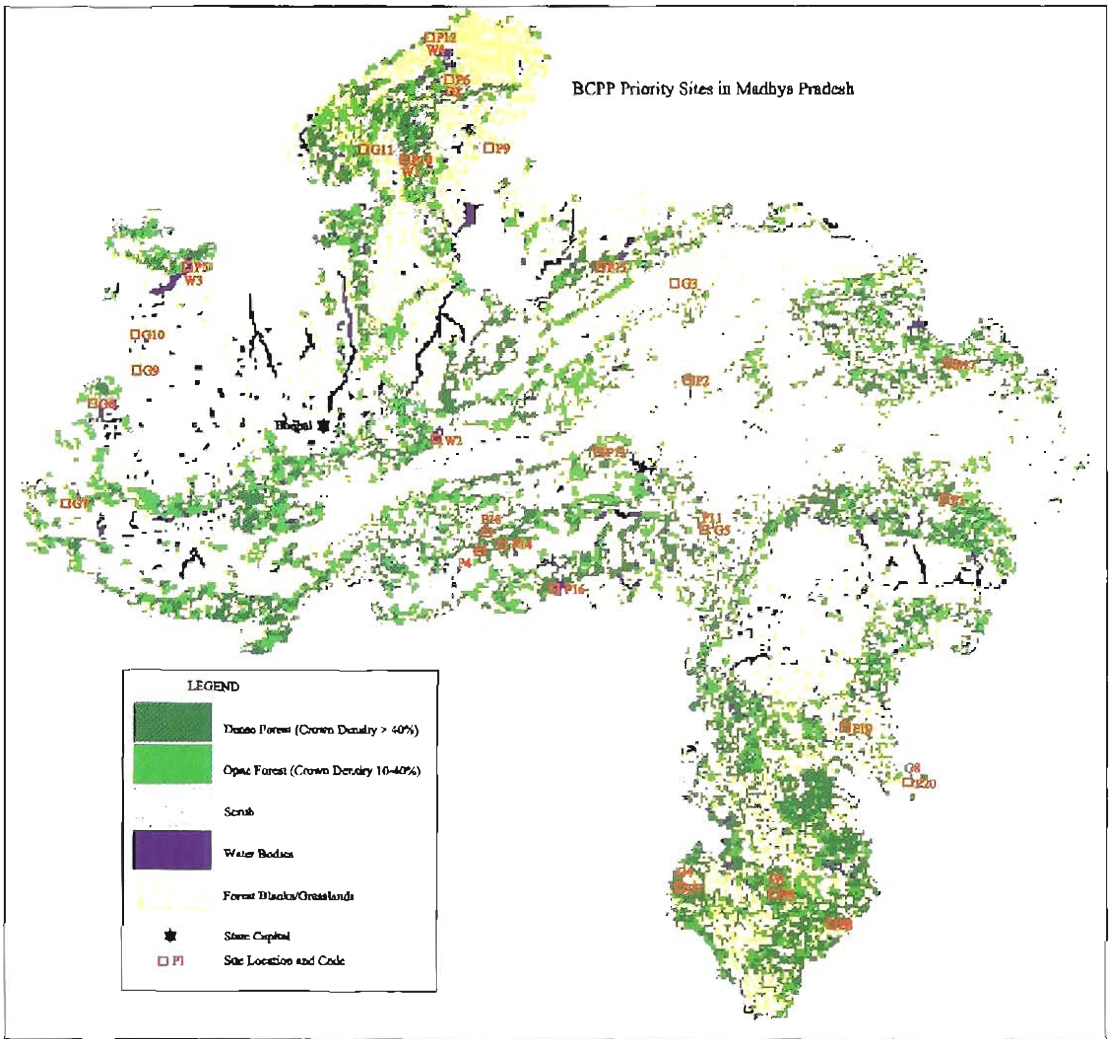


PROTECTED AREAS

P1 - Chimony Sanctuary
P2 - Eravikulam National Park
P3 - Neyyar Sanctuary
P4 - Parambikulam Sanctuary
P5 - Periyar National Park and Sanctuary
P6 - Shendurney Sanctuary
P7 - Silent Valley National Park
P8 - Wayanad Sanctuary

GRASSLANDS

G1 - Anamudi
G2 - Eravikulam National Park
G3 - Parambikulam Sanctuary



PROTECTED AREAS

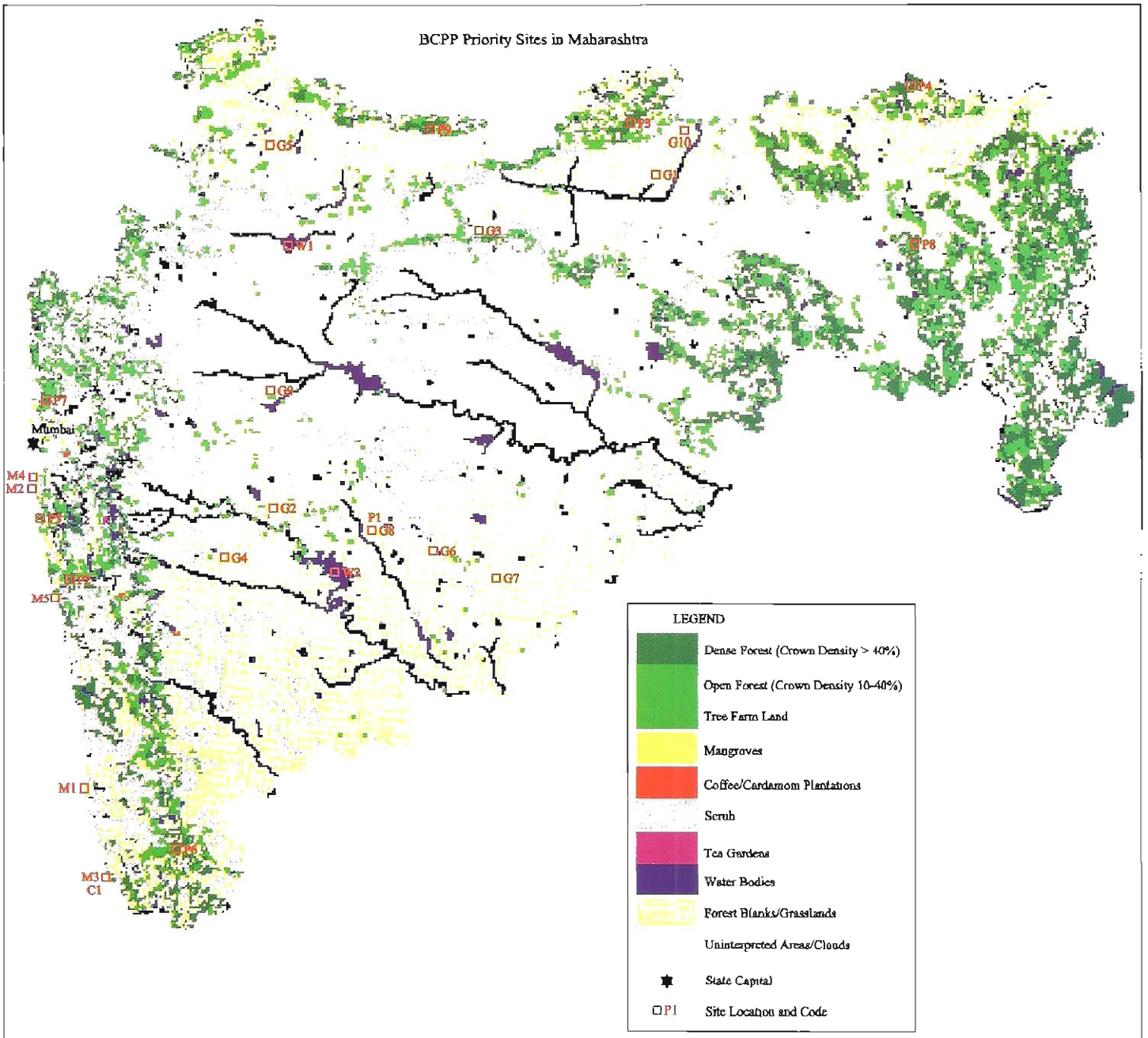
P1 - Achanakmar Sanctuary
P2 - Bandhavgarh National Park
P3 - Bhairamgarh Wild Buffalo Sanctuary
P4 - Bori Sanctuary
P5 - Gandhi Sagar Sanctuary
P6 - Ghatigaon Great Indian Bustard Sanctuary
P7 - Indravati National Park
P8 - Kanger Ghati National Park
P9 - Karera Great Indian Bustard Sanctuary
P10 - Madhav National Park
P11 - Kanha National Park
P12 - National Chambal Sanctuary
P13 - Neoradehi Sanctuary
P14 - Pachmarhi Sanctuary
P15 - Panna National Park
P16 - Pench National Park and Sanctuary
P17 - Sanjay National Park
P18 - Satpura National Park
P19 - Sitanadi Sanctuary
P20 - Udanti Sanctuary

GRASSLANDS

G1 - Bhairamgarh Wild Buffalo Sanctuary
G2 - Ghatigaon Great Indian Bustard Sanctuary
G3 - Gunnar
G4 - Indravati National Park
G5 - Maidans of Kanha National Park
G6 - Sailana Sanctuary
G7 - Sardarpur Sanctuary
G8 - Udanti Sanctuary
G9 - Jhalwa, Ambha and Dhamnod
G10 - Naulakha and Rewas Magra
G11 - Pohri

WETLANDS

W1 - Chandpata Lake (Madhav N.P.)
W2 - Dihaila Jheel
W3 - Gandhi Sagar Sanctuary
W4 - National Chambal Sanctuary



PROTECTED AREAS

P1 - Great Indian Bustard Sanctuary
P2 - Koyna Sanctuary
P3 - Melghat Sanctuary
P4 - Pench National Park
P5 - Phansad Sanctuary
P6 - Radhanagari Bison Sanctuary
P7 - Sanjay Gandhi National Park
P8 - Tadoba National Park
P9 - Yawal Sanctuary

GRASSLANDS

G1 - Akola Grassland
G2 - Chapedgaon
G3 - Gyanaganga Sanctuary
G4 - Khadrapur
G5 - Lalling
G6 - Madha
G7 - Mohol
G8 - Nanaj, Karnala and Boramani (all within the Great Indian Bustard Sanctuary)
G9 - Virgaon
G10 - Wadali

WETLANDS

W1 - Nandur Madhmeshwar
W2 - Ujanee Reservoir

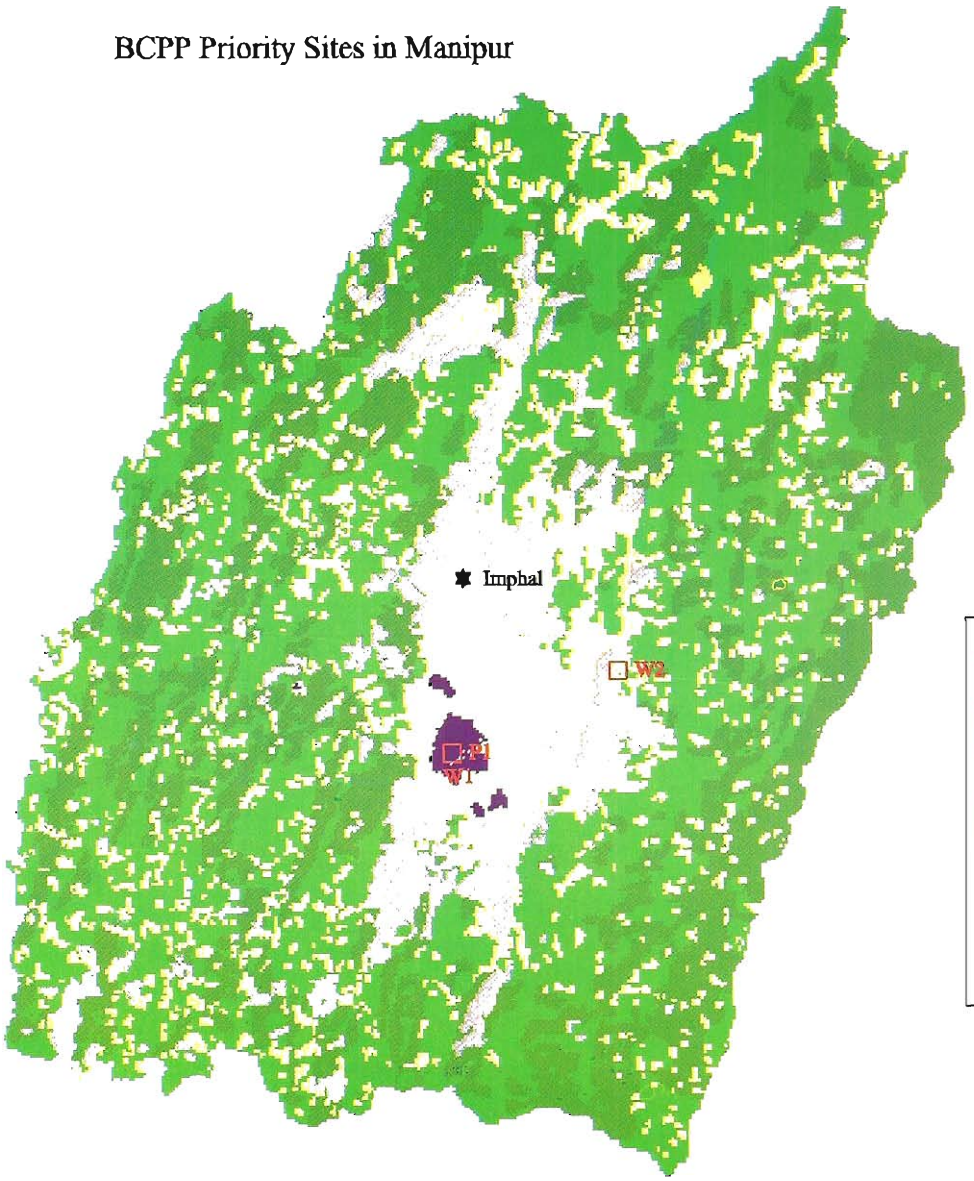
COASTS

C1 - Malvan (Marine) Sanctuary

MARINE SITES

M1 - Achara, Deogad and Vijaydurg
M2 - Colaba
M3 - Malvan
M4 - Mumbra-Diva, Vikroli
M5 - Ratnagiri

BCPP Priority Sites in Manipur



LEGEND

- Dense Forest (Crown Density > 40%)
- Open Forest (Crown Density 10-40%)
- Scrub
- Water Bodies
- Forest Blanks/Grasslands
- Uninterpreted Areas/Clouds
- State Capital
- Site Location and Code

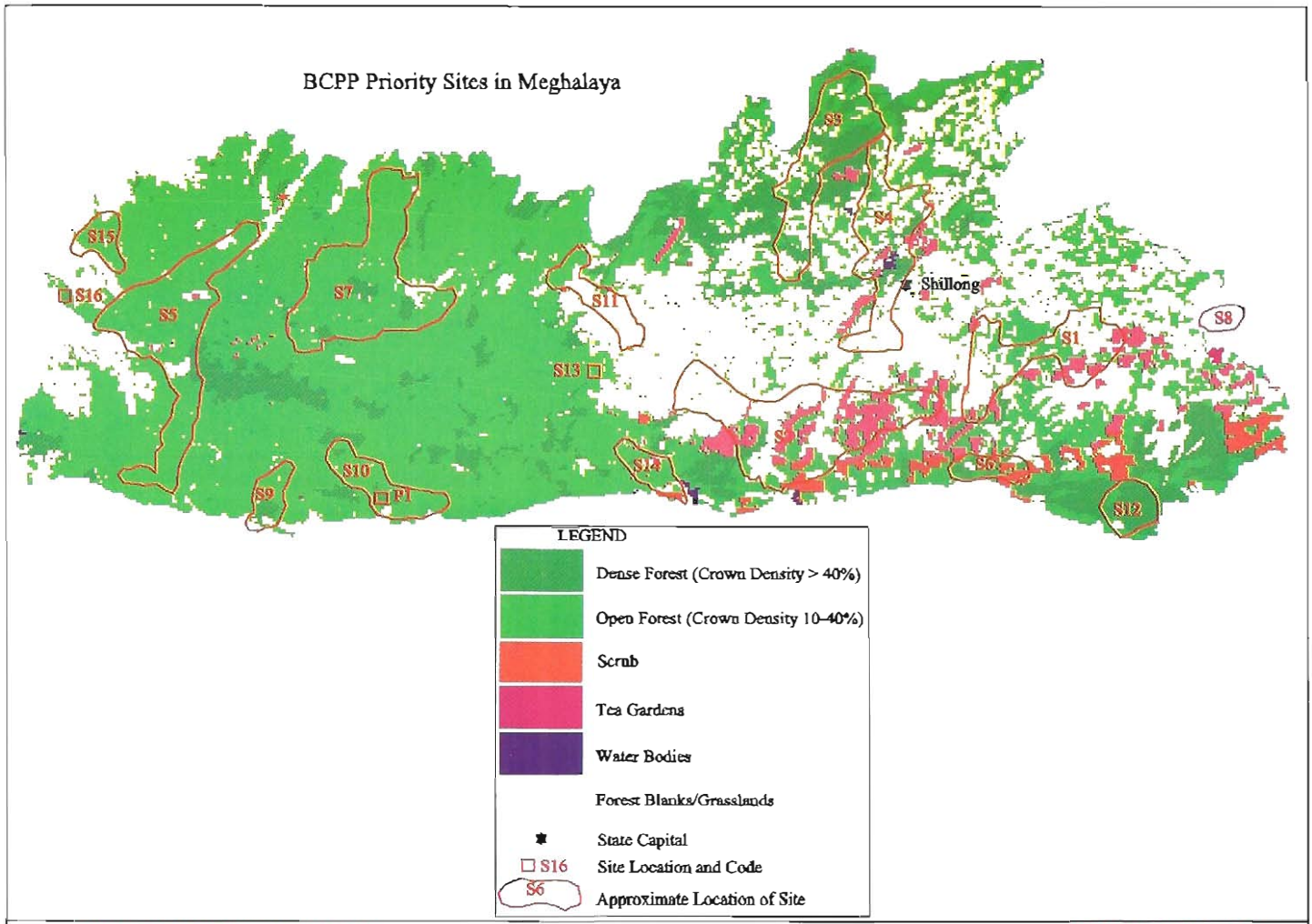
WETLANDS

W1 - Loktak Lake (Keibul Lamjao National Park)
W2 - Phumlen Lake

PROTECTED AREA

P1 - Keibul Lamjao National Park

Note: The exact locations of two prioritised wetlands ie; Ikop Lake and Kharung Lake are not available and have therefore not been plotted.



STATE LEVEL PRIORITY SITES

S1 - Nartiang, Jowai, Jarain, Umtapoh, Shangpung, Raliang, Khliehriat, Sutunga,Thadlaskein, Laskein, Mynso

S2 - Jakrem, Mawblong, Mawsynram, Cherrapunjee, Shella, Sohrarim,Pynursla

S3 - Burnihat, Umling, Lailad, Nongpoh, Umtesor, Umtyngar, Nongkhyllem, Mairang

S4 - Umsning, Sumer, Umsaw, Umtham, Umwai, Umran, Barapani, Umsing, Shillong,LaitkorPeak, Mawphlang, Mawkdok, Nongkrem, Laitlynkot

S5 - Anogiri, Jengjal, Rongram, Selbalgiri, Tura, Damalgiri, Adugiri, Kherapara, Barengapara, Dalu, Thebrangiri, Assimgiri

S6 - Dawki, Muktapur

S7 - Songsak, Rongrenggiri, Williamnagar, Darugiri, Rongjeng, Damra, Dainadubi, Manikganj, Simseng, Manda, Tasek, Dambu

S8 - Garampani, Kopili

S9 - Siju, Baghmara

S10 - Balphakram, Kanai, Mahadeo, Maheshkola

S11 - Sonapahar, Nongstoin, Rambari

S12 - Sonapur, Umkiang

S13 - Mawpat (within and around)

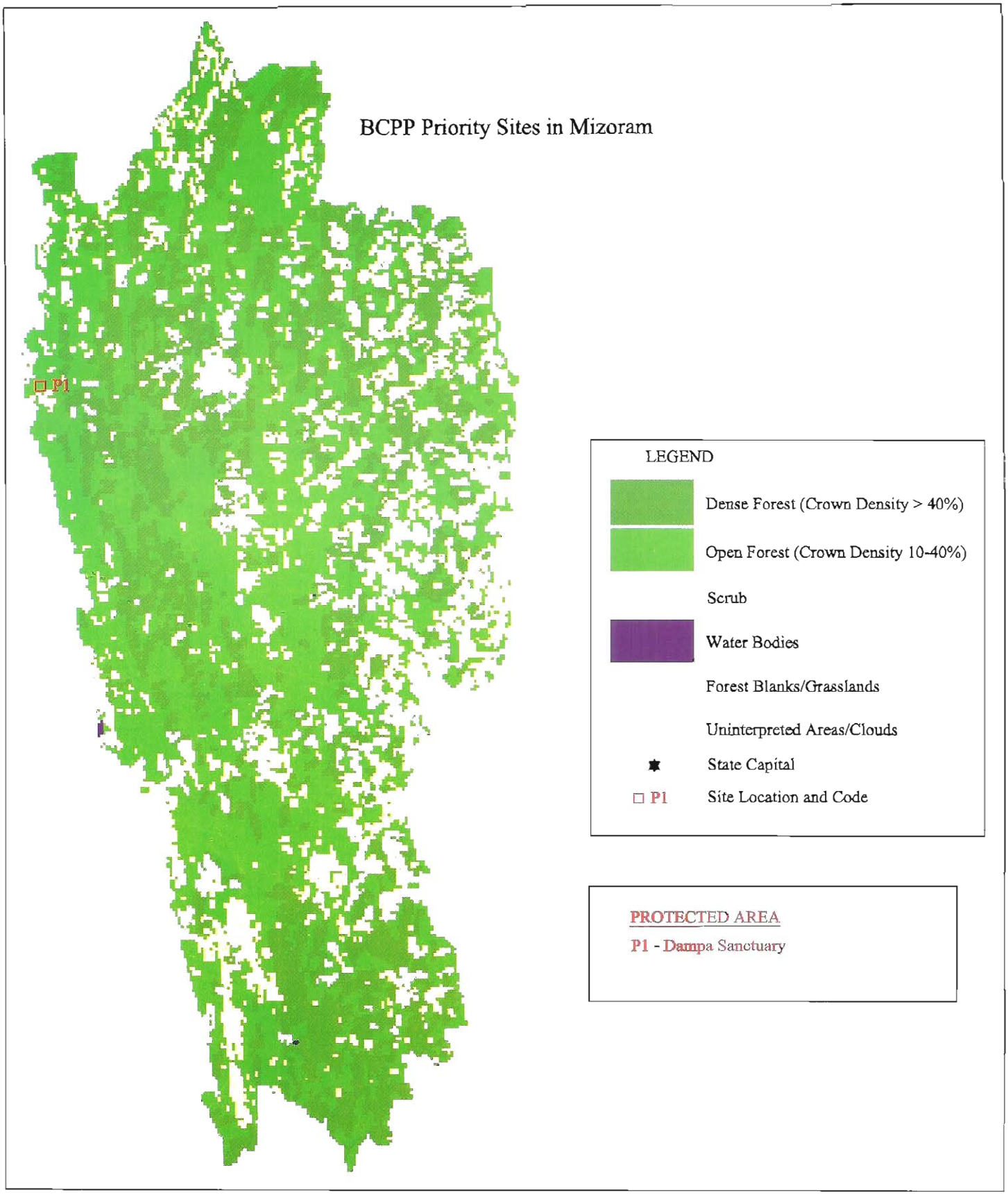
S14 - Balat, Ranikor, Nongkhlaw

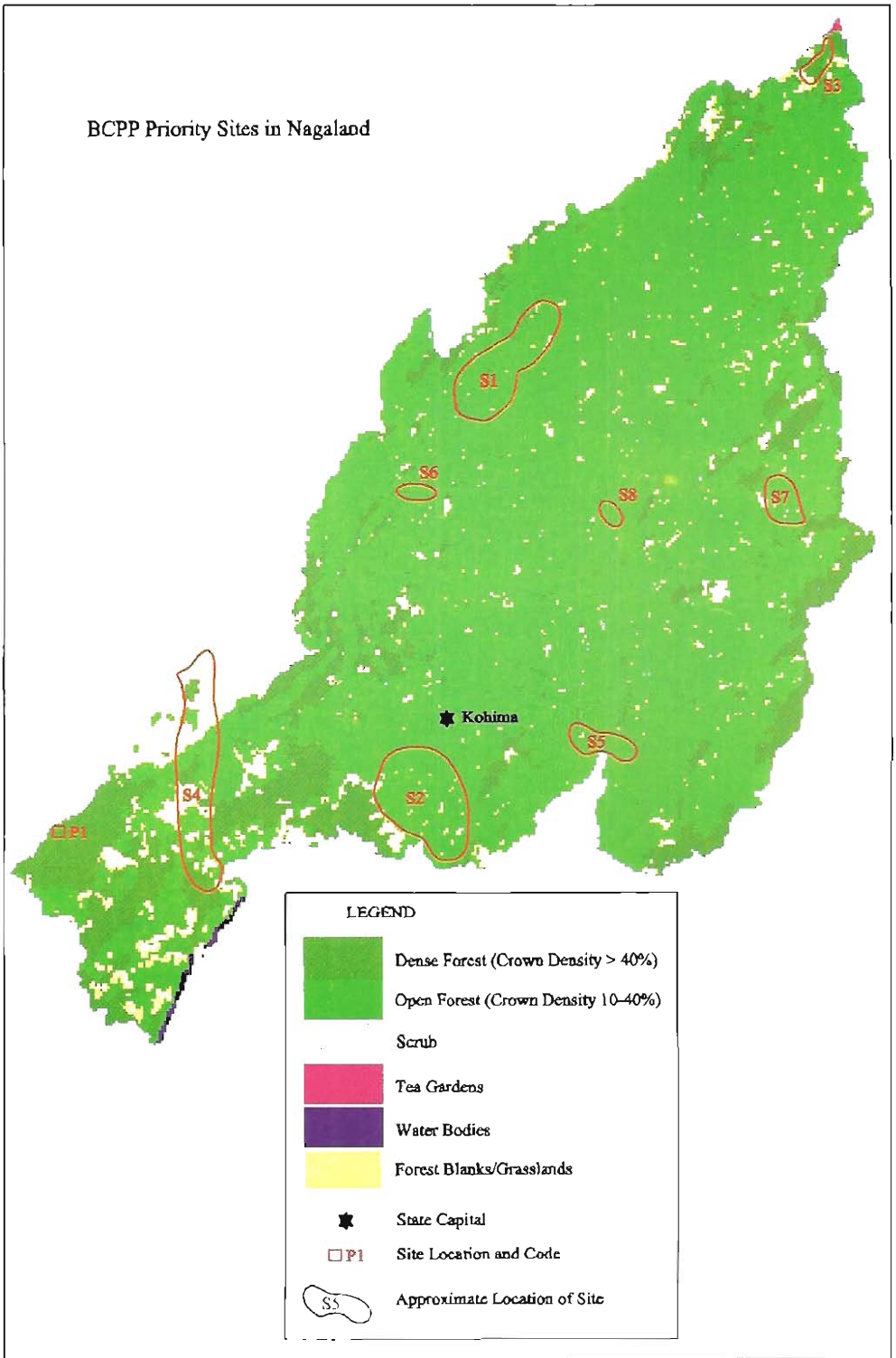
S15 - Phulbari, Digranggiri, Duragiri, Rongsagiri

S16 - Garobadha (within and around)

PROTECTED AREA

P1 - Balphakram National Park


BCPP Priority Sites in Mizoram
P1
LEGEND
Dense Forest (Crown Density > 40%)
Open Forest (Crown Density 10-40%)
Scrub
Water Bodies
Forest Blanks/Grasslands
Uninterpreted Areas/Clouds
State Capital
P1 Site Location and Code
PROTECTED AREA
P1 - Dampa Sanctuary

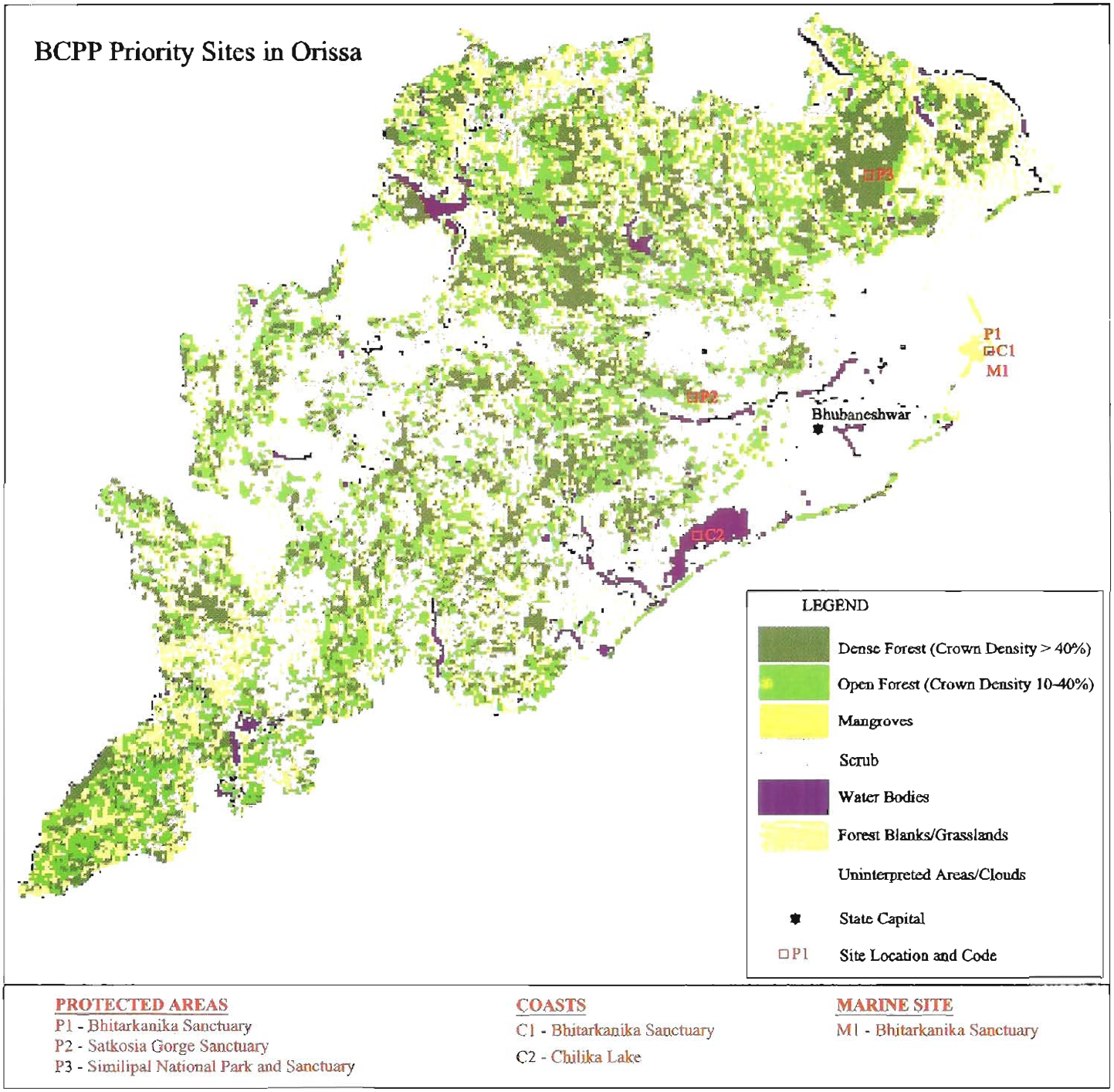


STATE LEVEL PRIORITY SITES

S1 - Merangkong, Changki, Mokokchung, Lungkam, Longsa
S2 - Kohima, Japro, Tekhabami
S3 - Tizit, Mon
S4 - Dimapur, Rangapahar, Jaluke, Peren
S5 - Dzulhami, Phek, Meluri
S6 - Wokha (within and around)
S7 - Tuensang, Shamatore
S8 - Zunheboto (within and around)

PROTECTED AREA

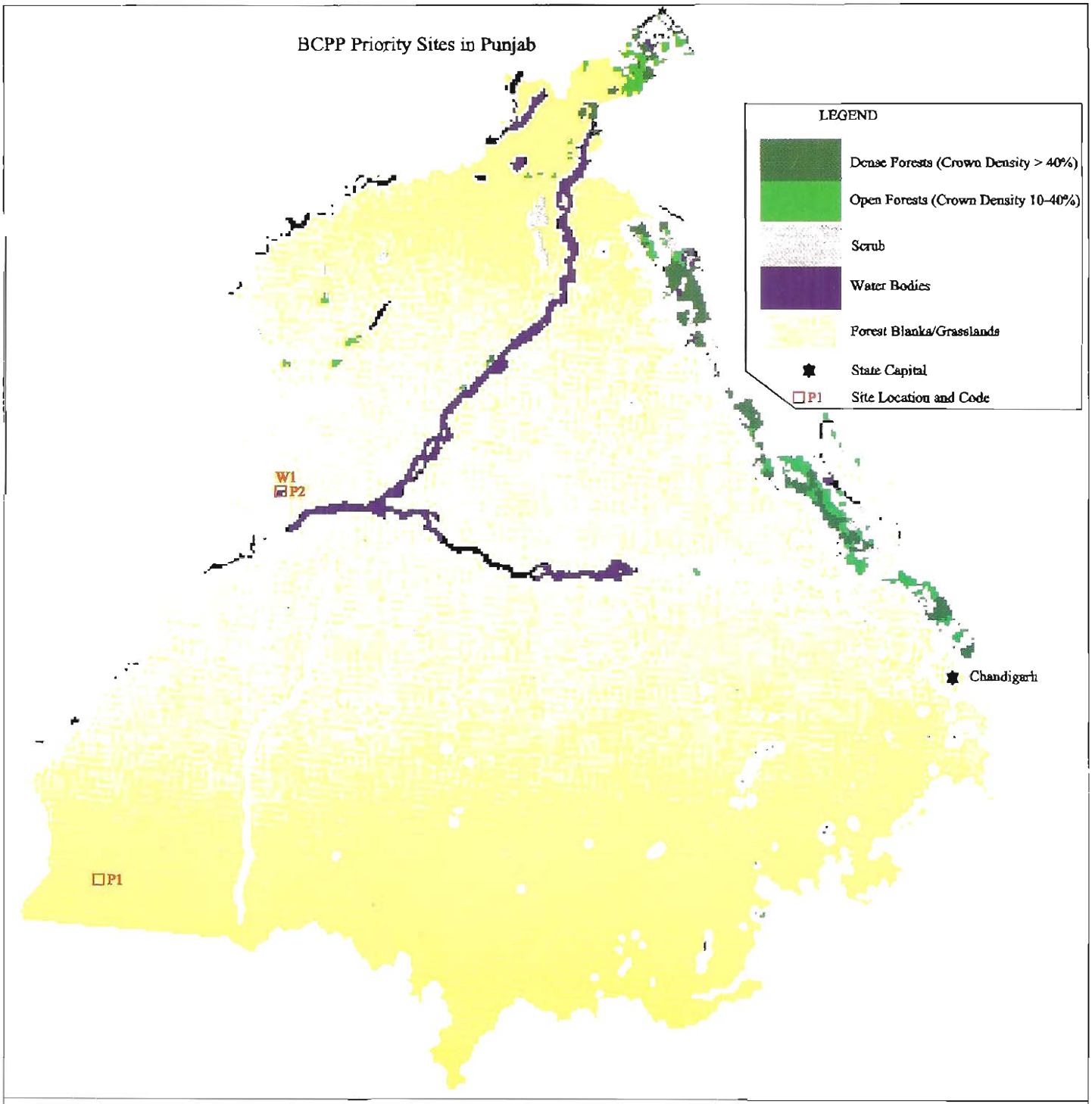
P1 - Intanki National Park



PROTECTED AREAS
P1 - Bhitarkanika Sanctuary
P2 - Satkosia Gorge Sanctuary
P3 - Similipal National Park and Sanctuary

COASTS
C1 - Bhitarkanika Sanctuary
C2 - Chilika Lake

MARINE SITE
M1 - Bhitarkanika Sanctuary



PROTECTED AREAS

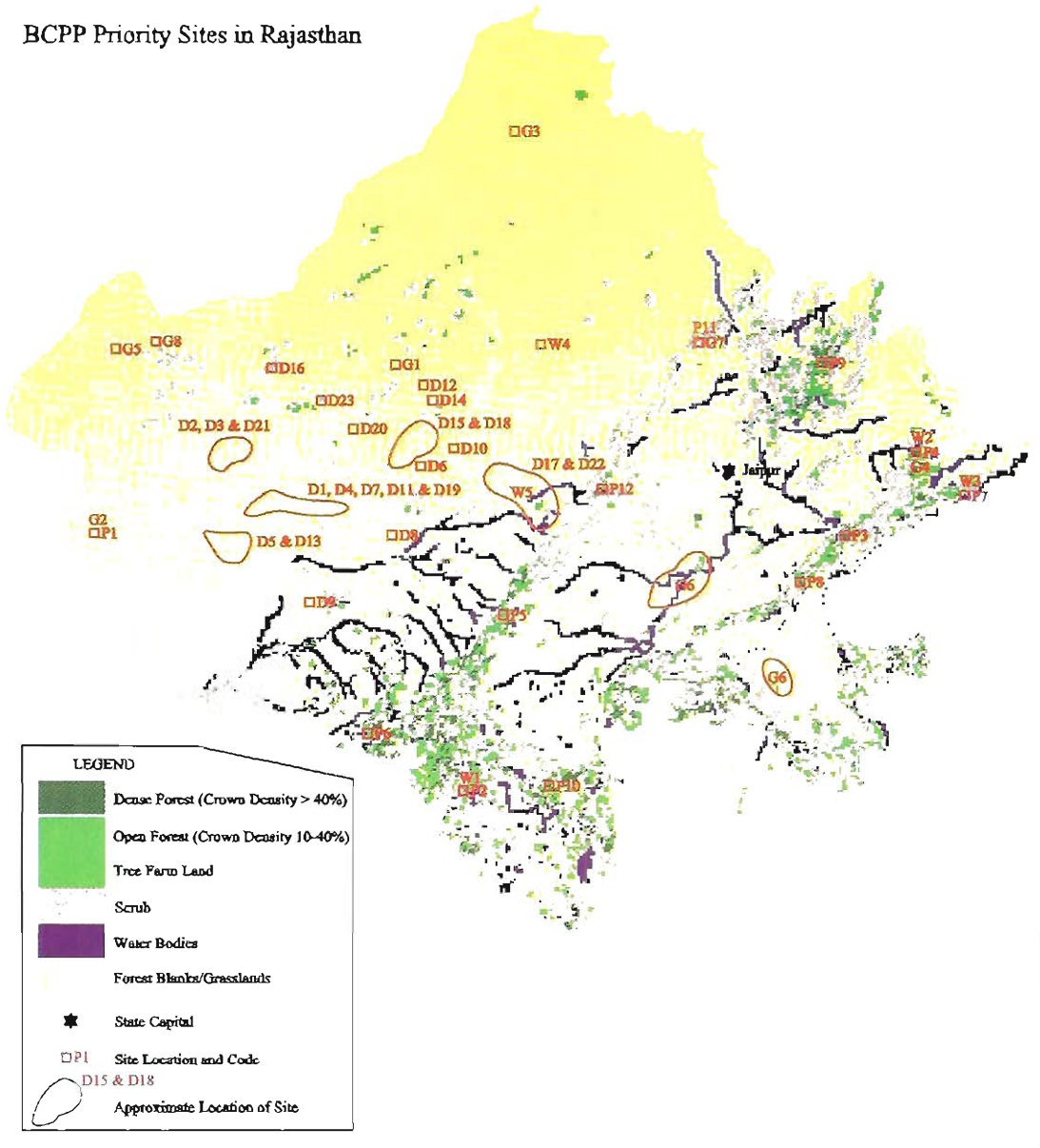
P1 - Abohar Sanctuary

P2 - Harike Lake Sanctuary

WETLAND

W1 - Harike Lake Sanctuary

BCPP Priority Sites in Rajasthan



GRASSLANDS

G1 - Bap
G2 - Desert National park
G3 - Diyatra-Khetolai
G4 - Keoladeo-Ghana National park
G5 - Ramgarh
G6 - Scattered grasslands of eastern Rajasthan
G7 - Tal Chapper Sanctuary
G8 - Sultana

WETLANDS

W1 - Jaisamand Lake
W2 - Keoladeo Ghana National Park
W3 - National Chambal Sanctuary
W4 - Sambhar lake
W5 - Sardar Samand

DESERTS

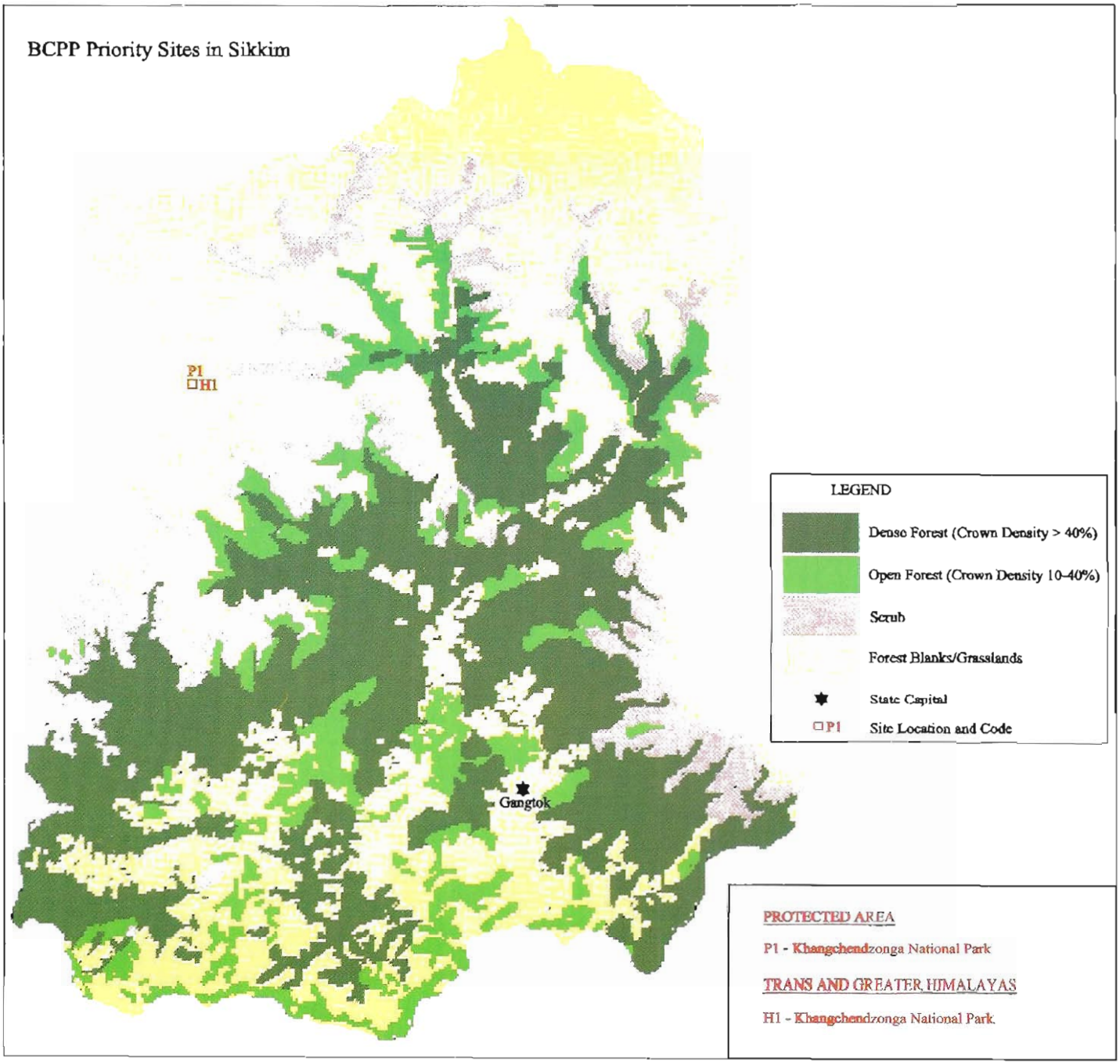
D1 - Asadi
D2 - Aakal Wood Fossil Park
D3 - Bariyada
D4 - Bhinyad
D5 - Bisala
D6 - Dechu
D7 - Dharvi
D8 - Dhava Doli
D9 - Dhorimanna
D10 - Guda Bishnoi
D11 - Kanasar
D12 - Kheechan
D13 - Kiradu
D14 - Lohawat
D15 - Malunga
D16 - Nachna-Mohangarh IGNP Area
D17 - Netra
D18 - Nevara
D19 - Radana
D20 - Rajmathai
D21 - Rasala
D22 - Sardar Samand
D23 - Ujjalan

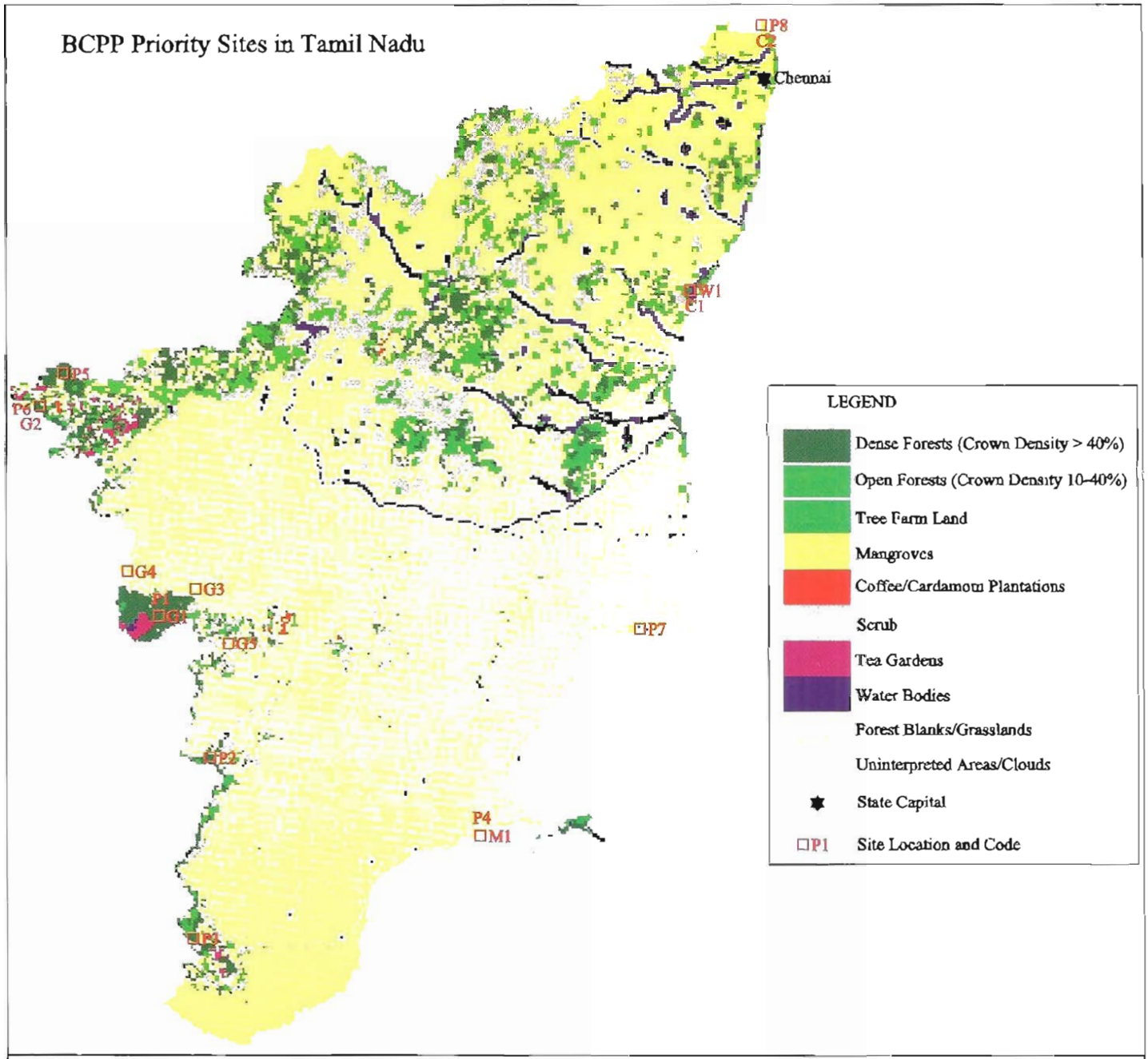
PROTECTED AREAS

P1 - Desert National Park
P2 - Jaisamand Sanctuary
P3 - Kaila Devi Sanctuary
P4 - Keoladeo Ghana National Park
P5 - Kumbhalgarh Sanctuary
P6 - Mount Abu Sanctuary
P7 - National Chambal Sanctuary
P8 - Ranthambhore National Park
P9 - Sariska National Park and Sanctuary
P10 - Sita Mata Sanctuary
P11 - Tal Chapper Sanctuary
P12 - Todgarh Raoli Sanctuary

Note: The exact location of a prioritised wetland ie; Thar Desert Wetland is not available and hence could not be plotted.

BCPP Priority Sites in Sikkim





PROTECTED AREAS

P1 - Anamalai Sanctuary
P2 - Grizzled Squirrel Sanctuary
P3 - Kalakad Mundanthurai Tiger Reserve
P4 - Marine National Park
P5 - Mudumalai Sanctuary
P6 - Mukurthy National Park
P7 - Point Calimere Sanctuary
P8 - Pulicat Lake Sanctuary

GRASSLANDS

G1 - Anamalai Sanctuary (including Grass Hills)
G2 - Mukurthy National Park
G3 - Pacchaipal Malai
G4 - Kuchi Malai
G5 - Palani Hills

WETLANDS

W1 - Kaliveli Tank

COASTS

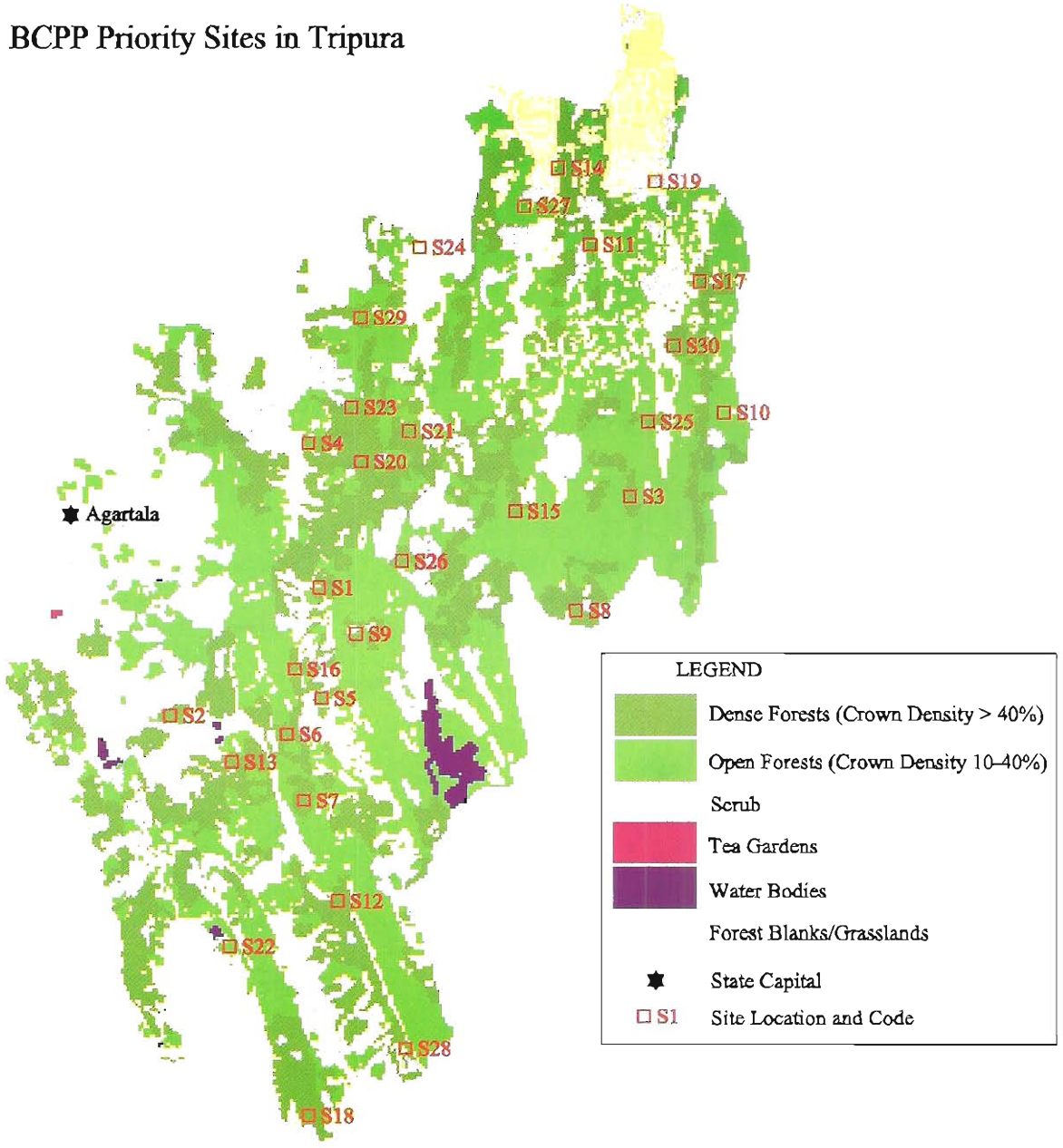
C1 - Kaliveli Tank
C2 - Pulicat Lake Sanctuary

MARINE SITE

M1 - Marine National Park (Gulf of Mannar)

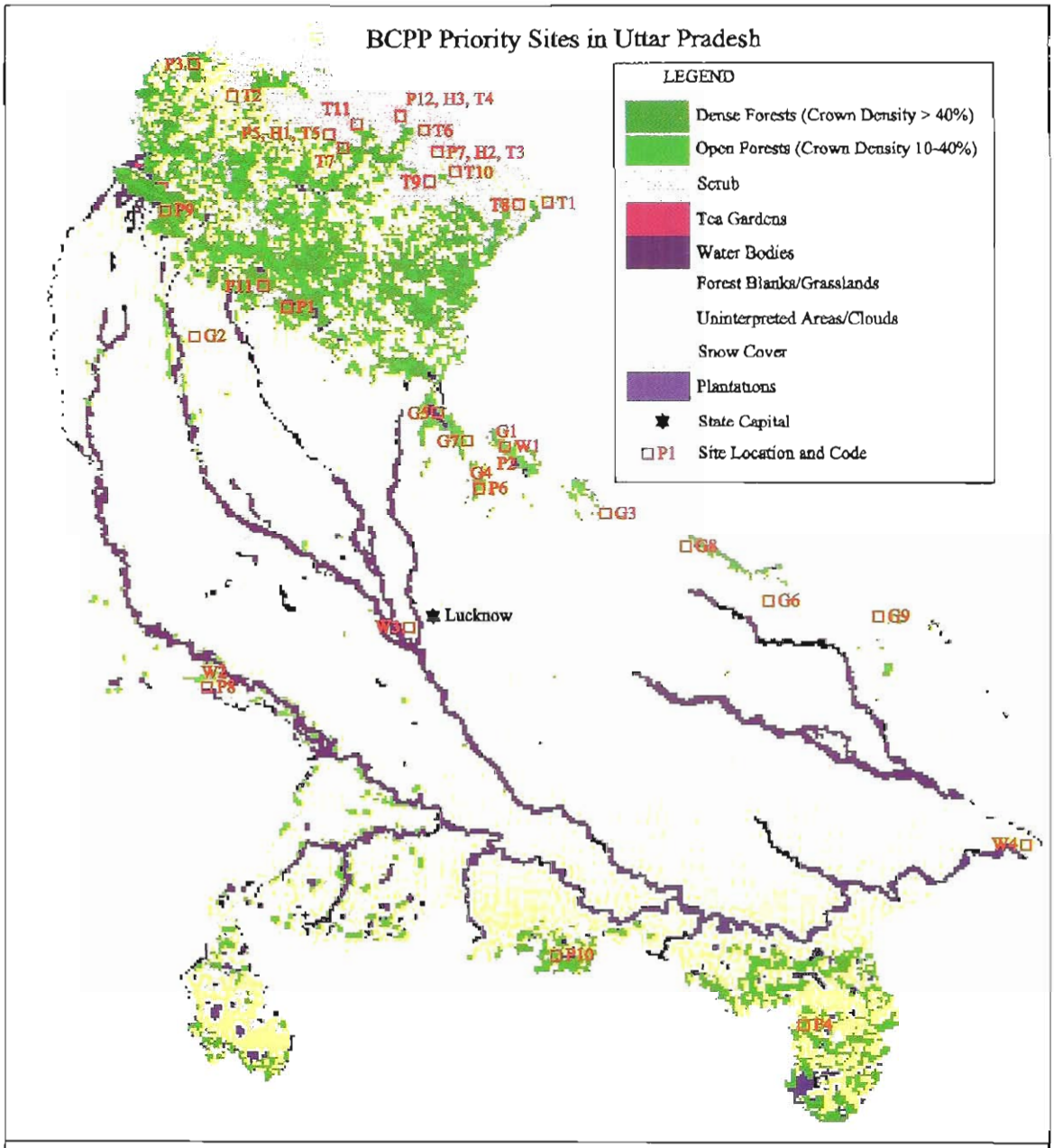
Note: The exact location of a prioritised wetland ie; Ousteri tank could not be plotted as it is not available.

BCPP Priority Sites in Tripura



STATE LEVEL PRIORITY SITES

S1 - Killa
S2 - Kalapania
S3 - Lalchhara
S4 - Harbang
S5 - Latmachhara
S6 - Maharani
S7 - Garjee
S8 - Thalchhara
S9 - Paharpur
S10 - Jampui
S11 - Kacharichhara
S12 - Kalshi
S13 - Harijala
S14 - Unnakoti
S15 - Joychandrapara
S16 - Debbari
S17 - Bangshul
S18 - Harbatali
S19 - Juri
S20 - Simulchhara
S21 - Kamlachhara
S22 - Malumbari
S23 - Tulashikha
S24 - Chhotosurma
S25 - Satnala
S26 - Kiranpara
S27 - Satarmia Howr
S18 - Baishnabpur
S29 - Bidyabill
S30 - Bhrupara



PROTECTED AREAS

P1 - Corbett National Park
P2 - Dudhwa National Park
P3 - Govind Pashuvihar Sanctuary
P4 - Kaimur Sanctuary
P5 - Kedarnath Sanctuary
P6 - Kishanpur Sanctuary
P7 - Nanda Devi National Park
P8 - National Chambal Sanctuary
P9 - Rajaji National Park
P10 - Ranipur Sanctuary
P11 - Sonanadi Sanctuary
P12 - Valley of Flowers National Park

GRASSLANDS

G1 - Dudhwa National National Park
G2 - Hastinapur Sanctuary
G3 - Katerniaghat Sanctuary
G4 - Kishanpur Sanctuary
G5 - Lagga-Bagga
G6 - North Gonda
G7 - Pilibhit Forests
G8 - Sohilwa Sanctuary
G9 - Sohagi Barwa Sanctuary

WETLANDS

W1 - Dudhwa National Park
W2 - National Chambal Sanctuary
W3 - Nawabganj Sanctuary
W4 - Suraha Tal Sanctuary

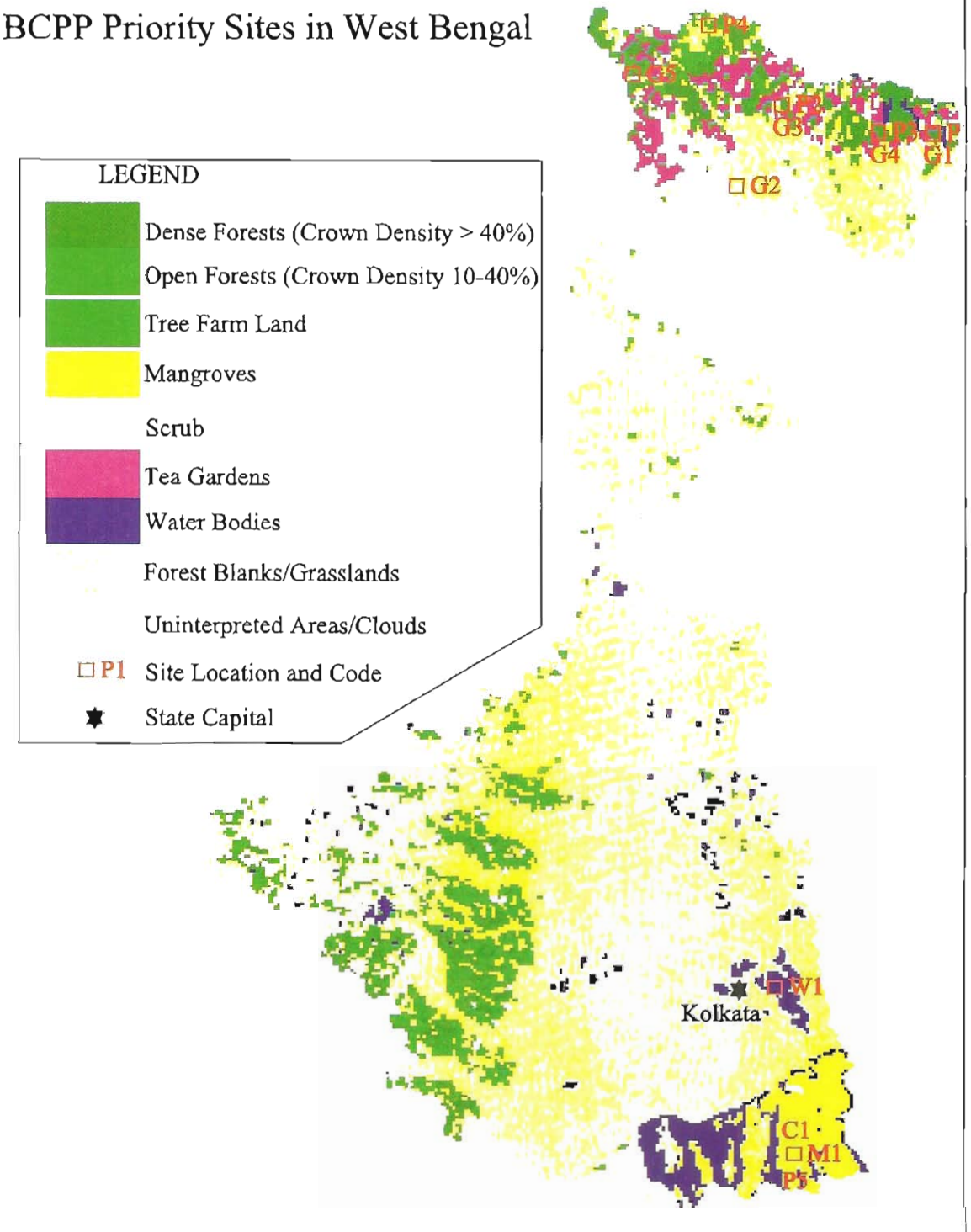
TRANS AND GREATER HIMALAYAS

H1 - Kedarnath Sanctuary
H2 - Nanda Devi National Park
H3 - Valley of Flowers National Park

TIMBER LINE ZONES

T1 - Byans
T2 - Dodital
T3 - Dibrugheeta, Deodi (within Nanda Devi National Park)
T4 - Hemkund, Bhyundar (within Valley of Flowers National Park)
T5 - Kedarnath, Khatling (within Kedarnath Sanctuary)
T6 - Malai, Niti, Dunagiri
T7 - Okhimath
T8 - Panchachuli
T9 - Pindari
T10 - Ralam
T11 - Rudranath, Tungnath

BCPP Priority Sites in West Bengal



PROTECTED AREAS

P1 - Buxa National Park and Sanctuary
P2 - Gorumara National Park
P3 - Jaldapara Sanctuary
P4 - Sinchal Sanctuary
P5 - Sunderban National Park

GRASSLANDS

G1 - Buxa Tiger Reserve
G2 - Flood plains of the Teesta River
G3 - Gorumara National Park
G4 - Jaldapara Sanctuary
G5 - Sahabad-Sayadabad Grasslands

WETLAND

W1 - Salt lake Swamp

COAST

C1 - Sundarban National Park

MARINE SITE

M1 - Sundarban National Park

Key to the Map Showing BCPP Priority Sites in India

Prioritised Protected Areas

Andhra Pradesh

P1 ETURUNAGARAM SANCTUARY
P2 GUNDLA BRAHMESHWARAM SANCTUARY
P3 KAWAL SANCTUARY
P4 KINNERASANI SANCTUARY
P5 KOLLERU SANCTUARY
P6 KRISHNA SANCTUARY
P7 NAGARJUNASAGAR - SRISAILAM TIGER RESERVE
P8 PAKHAL SANCTUARY
P9 PAPIKONDA SANCTUARY
P10 PRANAHITA SANCTUARY
P11 PULICAT SANCTUARY
P12 SRI LANKAMELLESHWARA SANCTUARY
P13 SRI VENKATESHWARA NATIONAL PARK

Arunachal Pradesh

P14 DIBANG SANCTUARY
P15 D'ERING (LALI) SANCTUARY
P16 ITANAGAR SANCTUARY
P17 KAMLANG SANCTUARY
P18 MEHAO SANCTUARY
P19 MOULING NATIONAL PARK
P20 NAMDAPHA NATIONAL PARK
P21 PAKHUI SANCTUARY

Assam

P22 BARNADI SANCTUARY
P23 DIBRU-SAIKHOWA SANCTUARY
P24 KAZIRANGA NATIONAL PARK
P25 LAOKHOWA SANCTUARY
P26 MANAS NATIONAL PARK

Bihar

P27 BHIMBANDH SANCTUARY
P28 DALMA SANCTUARY
P29 HAZARIBAGH SANCTUARY
P30 PALAMAU SANCTUARY
P31 VALMIKI TIGER RESERVE
P32 VIKRAMSHILA GANGETIC DOLPHIN SANCTUARY

Goa

P33 BHAGWAN MAHAVEER NATIONAL PARK AND SANCTUARY

Gujarat

P34 DHRANGADHRA (WILD ASS) SANCTUARY
P35 GIR NATIONAL PARK
P36 HINGOLGARH SANCTUARY
P37 JESSORE SANCTUARY
P38 KACHCHH DESERT SANCTUARY
P39 MARINE NATIONAL PARK AND SANCTUARY
P40 NAL SAROVAR SANCTUARY
P41 NARAYAN SAROVAR SANCTUARY
P42 RATANMAHAL SANCTUARY
P43 VELAVADAR NATIONAL PARK

Haryana

P44 BHINDAWAS SANCTUARY
P45 SULTANPUR NATIONAL PARK

Himachal Pradesh

P46 DARANGHATI SANCTUARY
P47 GAMGUL SIAHBEHI SANCTUARY
P48 GREAT HIMALAYAN NATIONAL PARK
P49 KANAWAR SANCTUARY
P50 KUGTI SANCTUARY
P51 LIPPA ASRANG SANCTUARY
P52 MANALI SANCTUARY
P53 NARGU SANCTUARY
P54 PIN VALLEY NATIONAL PARK
P55 PONG LAKE SANCTUARY
P56 RUPI BHABA SANCTUARY
P57 SANGLA SANCTUARY
P58 SECHU TUAN NALAH SANCTUARY
P59 SHIKARI DEVI SANCTUARY
P60 TIRTHAN SANCTUARY

Jammu and Kashmir

P61 CHANGTHANG SANCTUARY
P62 DACHIGAM NATIONAL PARK
P63 HEMIS NATIONAL PARK
P64 KARAKORAM SANCTUARY
P65 KISHTWAR NATIONAL PARK
P66 OVERA-ARU SANCTUARY

Karnataka

P67 BANDIPUR NATIONAL PARK
P68 BHADRA SANCTUARY
P69 BILIGIRI RANGASWAMY TEMPLE SANCTUARY
P70 BRAHMAGIRI SANCTUARY

P71 KUDREMUKH NATIONAL PARK
P72 MOOKAMBIKA SANCTUARY
P73 NAGARAHOLE NATIONAL PARK
P74 PUSHPAGIRI SANCTUARY
P75 SHARAVATHI VALLEY SANCTUARY
P76 SHETTIHALLY SANCTUARY
P77 SOMESHWARA SANCTUARY

Kerala

P78 CHIMONY SANCTUARY
P79 ERAVIKULAM NATIONAL PARK
P80 NEYYAR SANCTUARY
P81 PARAMBIKULAM SANCTUARY
P82 PERIYAR NATIONAL PARK AND SANCTUARY
P83 SHENDURNEY SANCTUARY
P84 SILENT VALLEY NATIONAL PARK
P85 WAYANAD SANCTUARY

Madhya Pradesh

P86 ACHANAKMAR SANCTUARY
P87 BANDHAVGARH NATIONAL PARK
P88 BHAIRAMGARH WILD BUFFALO SANCTUARY
P89 BORI SANCTUARY
P90 GANDHI SAGAR SANCTUARY
P91 GHATIGAON GREAT INDIAN BUSTARD SANCTUARY
P92 INDRAVATI NATIONAL PARK
P93 KANGER GHATI NATIONAL PARK
P94 KARERA GREAT INDIAN BUSTARD SANCTUARY
P95 MADHAV NATIONAL PARK
P96 KANHA NATIONAL PARK
P97 NATIONAL CHAMBAL SANCTUARY
P98 NEORADEHI SANCTUARY
P99 PACHMARHI SANCTUARY
P100 PANNA NATIONAL PARK
P101 PENCH NATIONAL PARK AND SANCTUARY
P102 SANJAY NATIONAL PARK
P103 SATPURA NATIONAL PARK
P104 SITANADI SANCTUARY
P105 UDANTI SANCTUARY

Maharashtra

P106 GREAT INDIAN BUSTARD SANCTUARY
P107 KOYNA SANCTUARY
P108 MELGHAT SANCTUARY
P109 PENCH NATIONAL PARK
P110 PHANSAD SANCTUARY
P111 RADHANAGARI BISON SANCTUARY
P112 SANJAY GANDHI NATIONAL PARK
P113 TADOBA NATIONAL PARK
P114 YAWAL SANCTUARY

Manipur

P115 KEIBUL LAMJAO NATIONAL PARK

Meghalaya

P116 BALPHAKRAM NATIONAL PARK

Mizoram

P117 DAMPA SANCUTARY

Nagaland

P118 INTANKI NATIONAL PARK

Orissa

P119 BHITARKANIKA SANCTUARY
P120 SATKOSIA GORGE SANCTUARY
P121 SIMILIPAL NATIONAL PARK AND SANCTUARY

Punjab

P122 ABOHAR SANCTUARY
P123 HARIKE LAKE SANCTUARY

Rajasthan

P124 DESERT NATIONAL PARK
P125 JAISAMAND SANCTUARY
P126 KAILA DEVI SANCTUARY
P127 KEOLADEO GHANA NATIONAL PARK
P128 KUMBHALGARH SANCTUARY
P129 MOUNT ABU SANCTUARY
P130 NATIONAL CHAMBAL SANCTUARY
P131 RANTHAMBHORE NATIONAL PARK
P132 SARISKA NATIONAL PARK AND SANCTUARY
P133 SITA MATA SANCTUARY
P134 TAL CHAPPER SANCTYUARY
P135 TODGARH RAOLI SANCTUARY

Sikkim

P136 KHANGCHENDZONGA NATIONAL PARK

Tamil Nadu

P137 ANAMALAI SANCTUARY
P138 GRIZZLED SQUIRREL SANCTUARY
P139 KALAKAD MUNDANTHURAI TIGER RESERVE
P140 MARINE NATIONAL PARK
P141 MUDUMALAI SANCTUARY
P142 MUKURTHY NATIONAL PARK
P143 POINT CALIMERE SANCTUARY
P144 PULICAT LAKE SANCTUARY

Uttar Pradesh

P145 CORBETT NATIONAL PARK
P146 DUDHWA NATIONAL PARK

P147 GOVIND PASHUVIHAR SANCTUARY
P148 KAIMUR SANCTUARY
P149 KEDARNATH SANCTUARY
P150 KISHANPUR SANCTUARY
P151 NANDA DEVI NATIONAL PARK
P152 NATIONAL CHAMBAL SANCTUARY
P153 RAJAJI NATIONAL PARK
P154 RANIPUR SANCTUARY
P155 SONANADI SANCTUARY
P156 VALLEY of FLOWERS NATIONAL PARK

West Bengal

P157 BUXA NATIONAL PARK AND SANCTUARY
P158 GORUMARA NATIONAL PARK
P159 JALDAPARA SANCTUARY
P160 SINCHAL SANCTUARY
P161 SUNDERBAN NATIONAL PARK

Prioritised Grasslands

Andhra Pradesh

G1 HAMIREDDYPALLI
G2 MUDINANIPALLI
G3 NELLIBANDA
G4 ROLLAPADU SANCTUARY
G5 SHAMSABAD
G6 SIRUVELLA
G7 VIKARABAD

Arunachal Pradesh

G8 CHAPORIES OF LOHIT RIVER
G9 SCATTERED GRASSLANDS BETWEEN SESSERI AND SIBIA RIVERS
G10 D'ERING (LALI) SANCTUARY
G11 DIBANG SANCTUARY
G12 KERIM
G13 NAMDAPHA NATIONAL PARK

Assa ··

G14 BARNADI SANCTUARY
G15 BORCHAPORI
G16 BORDALANI
G17 BURHACHAPORI SANCTUARY
G18 DIBRU-SAIKHOWA SANCTUARY
G19 HUGRAJULI
G20 JAMJING AND SENGAJAN
G21 KOBO CHAPORI
G22 KOCHMORA
G23 KAZIRANGA NATIONAL PARK
G24 LAOKHOWA SANCTUARY
G25 MANAS NATIONAL PARK
G26 NAMERI NATIONAL PARK
G27 ORANG SANCTUARY
G28 PABHA
G29 PABITORA SANCTUARY
G30 PANI-DIHING SANCTUARY
G31 AMARPUR, SIBIA CHAPORI, SADIYA PLAINS (BHIMCHAPORI, KUNDIL KALIYA R.F. AND AMBIKAPUR)

Bihar

G32 VALMIKI TIGER RESERVE

Gujarat

G33 BANNI
G34 GAGA GREAT INDIAN BUSTARD SANCTUARY
G35 KENGARPUR IN-KACHCHH
G36 LALA AREA
G37 MITHIALA
G38 PIPALA
G39 RANIGODA-HIPAVALI
G40 RAMPURA IN DAHOD
G41 RAMPURA IN WANKANER
G42 VELAVADAR NATIONAL PARK

Karnataka

G43 BILGI
G44 BRAHMAGIRI SANCTUARY
G45 CHINCHOLI
G46 KUDREMUKH NATIONAL PARK
G47 MELKOTE TEMPLE SANCTUARY
G48 RANEBENNUR SANCTUARY

Kerala

G49 ANAMUDI
G50 ERAVIKULAM NATIONAL PARK
G51 PARAMBIKULAM SANCTUARY

Madhya Pradesh

G52 BHAIRAMGARH WILD BUFFALO SANCTUARY
G53 GHATIGAON GREAT INDIAN BUSTARD SANCTUARY
G54 GUNNAR
G55 INDRAVATI NATIONAL PARK
G56 MAIDANS OF KANHA NATIONAL PARK
G57 SAILANA SANCTUARY
G58 SARDARPUR SANCTUARY
G59 UDANTI SANCTUARY
G60 JHALWA, AMBHA AND DHAMNOD
G61 NAULAKHA AND REWAS MAGRA
G62 POHRI

Maharashtra

G63 AKOLA GRASSLAND
G64 CHAPEDGAON

G65 GYANAGANGA SANCTUARY
G66 KHADRAPUR
G67 LALLING
G68 MADHA
G69 MOHOL
G70 NANAJ, KARNALA AND BORAMANI (ALL WITHIN THE GREAT INDIAN BUSTARD SACTUARY)
G71 VIRGAON
G72 WADALI

Rajasthan

G73 BAP
G74 DESERT NATIONAL PARK
G75 DIYATRA-KHETOLAI
G76 KEOLADEO-GHANA NATIONAL PARK
G77 RAMGARH
G78 SCATTERED GRASSLANDS OF EASTERN RAJASTHAN
G79 TAL CHAPPER SANCTUARY
G80 SULTANA

Tamil Nadu

G81 ANAMALAI SANCTUARY (INCLUDING GRASS HILLS)
G82 MUKURTHY NATIONAL PARK
G83 PACCHAIPAL MALAI
G84 KUCHI MALAI
G85 PALANI HILLS

Uttar Pradesh

G86 DUDHWA NATIONAL PARK
G87 HASTINAPUR SANCTUARY
G88 KATERNIAGHAT SANCTUARY
G89 KISHANPUR SANCTUARY
G90 LAGGA-BAGGA
G91 NORTH GONDA
G92 PILIBHIT FORESTS
G93 SOHELWA SANCTUARY
G94 SOHAGI BARWA SANCTUARY

West Bengal

G95 BUXA TIGER RESERVE
G96 FLOOD PLAINS OF THE TEESTA RIVER
G97 GORUMARA NATIONAL PARK
G98 JALDAPARA SANCTUARY
G99 SAHABAD-SAYADABAD GRASSLANDS

Prioritised Wetlands

Andhra Pradesh

W1 KOLLERU SANCTUARY

Arunachal Pradesh

W2 NAMDAPHA NATIONAL PARK

Assam

W3 DIPOR BEEL
W4 MANAS NATIONAL PARK

Bihar

W5 CHAURS OF NORTH BIHAR

Gujarat

W6 GREAT RANN OF KACHCHH
W7 LITTLE RANN OF KACHCHH
W8 NAL SAROVAR SANCTUARY
W9 THOL SANCTUARY

Jammu and Kashmir

W10 DAL LAKE
W11 HAIGAM LAKE
W12 HOKARSAR LAKE
W13 WULAR LAKE

Madhya Pradesh

W14 CHANDPATA LAKE (MADHAV NATIONAL PARK)
W15 DEHAILA JHEEL
W16 GANDHI SAGAR SANCTUARY
W17 NATIONAL CHAMBAL SANCUTARY

Maharashtra

W18 NANDUR MADHMESHWAR
W19 UJANEE RESERVOIR

Manipur

W20 LOKTAK LAKE (KEIBUL LAMJAO NATIONAL PARK)
W21 PHUMLEN LAKE

Punjab

W22 HARIKE LAKE SANCTUARY

Rajasthan

W23 JAISAMAND LAKE
W24 KEOLADEO GHANA NATIONAL PARK
W25 NATIONAL CHAMBAL SANCTUARY
W26 SAMBHAR LAKE
W27 SARDAR SAMAND

Tamil Nadu

W28 KALIVELI TANK

Uttar Pradesh

W29 DUDHWA NATIONAL PARK
W30 NATIONAL CHAMBAL SANCTUARY

W31 NAWABGANJ SANCTUARY
W32 SURAHA TAL SANCTUARY

West Bengal

W33 SALT LAKE SWAMP

Note The following wetland sites have not been plotted Because their exact location is not available:

1. Deopani, Arunachal Pradesh
2. Ikop and Kharung Lake, Manipur
3. Thar Desert Wetland, Rajasthan
4. Ousteri Tank, Tamil Nadu

Prioritised Coastal Sites

Andhra Pradesh

C1 CORINGA
C2 PULICAT LAKE

Gujarat

C3 GULF OF KACHCHH (MARINE NATIONAL PARK AND SANCTUARY)

Karnataka

C4 KUNDAPUR

Maharashtra

C5 MALVAN (MARINE) SANCTUARY

Orissa

C6 BHITARKANIKA SANCTUARY
C7 CHILIKA LAKE

Tamil Nadu

C8 KALIVELI TANK
C9 PULICAT LAKE SANCTUARY

West Bengal

C10 SUNDARBAN NATIONAL PARK

Prioritised Marine Sites

Gujarat

M1 GULF OF KACHCHH (MARINE NATIONAL PARK AND SANCTUARY)

Karnataka

M2 KUNDAPUR

Maharashtra

M3 ACHARA, DEOGAD AND VIJAYDURG
M4 COLABA
M5 MALVAN
M6 MUMBRA-DIVA, VIKROLI
M7 RATNAGIRI

Orissa

M8 BHITARKANIKA SANCTUARY

Tamil Nadu

M9 MARINE NATIONAL PARK (GULF OF MANNAR)

West Bengal

M10 SUNDARBAN NATIONAL PARK

Prioritised Sites in Trans and Greater Himalayas

Himachal Pradesh

H1 GREAT HIMALAYAN NATIONAL
H2 PIN VALLEY NATIONAL PARK

Jammu and Kashmir

H3 DACHIGAM NATIONAL PARK
H4 HEMIS NATIONAL PARK
H5 KARAKORAM SANCTUARY
H6 KISHTWAR NATIONAL PARK

Sikkim

H7 KHANGCHENDZONGA NATIONAL PARK

Uttar Pradesh

H8 KEDARNATH SANCTUARY
H9 NANDA DEVI NATIONAL PARK
H10 VALLEY of FLOWERS NATIONAL PARK

Note: The entire trans and greater himalayan region in Arunachal Pradesh was highlighted as a priority However, since no specific site was mentioned as a priority site, none have been plotted

In addition, Chang-Chemo, a site in Jammu and Kashmir has not been plotted since its exact location is not available.

Prioritised Island Sites

Andaman Islands

A1 AUSTIN STRAIT
A2 DIGLIPUR DIVISION
A3 DUGONG CREEK
A4 INTERVIEW ISLAND SANCTUARY
A5 JARAWA RESERVE
A6 KARMATANG VILLAGE VICINITY
A7 MOUNT HARRIET NATIONAL PARK
A8 NARCONDAM ISLAND SANCTUARY
A9 NORTH REEF ISLAND SANCTUARY
A10 NORTH SENTINAL ISLAND SANCTUARY
A11 RITCHIE's ARCHIPELAGO
A12 RUTLAND ISLAND SANCTUARY
A13 SADDLE PEAK NATIONAL PARK
A14 WANDOOR MARINE NATIONAL PARK

Nicobar Islands

N1 CAMPBELL BAY NATIONAL PARK
N2 GALATHEA NATIONAL PARK
N3 GREAT NICOBAR ISLAND
N4 INDIRA OR PYGMALION POINT
N5 KAMORTA ISLAND
N6 TERESA ISLAND

Lakshadweep Islands

L1 KADMAT ISLAND
L2 KALPENI ISLAND
L3 MINICOY ISLAND
L4 PITTI ISLAND
L5 SUHELI (SOUTH AND NORTH) ISLANDS

Note: To look at the detailed plotting of the Island sites, please refer to the maps given along with the relevant chapters on prioritisation of biodiversity rich sites in the Indian Islands.

Prioritised Sites in the Thar Desert (Rajasthan)

D1 ASADI
D2 AAKAL WOOD FOSSIL PARK
D3 BARIYADA
D4 BHINYAD
D5 BISALA
D6 DECHU
D7 DHARVI
D8 DHAVE DOLI
D9 DHORIMANNA
D10 GUDA BISHNOI
D11 KANASAR
D12 KHEECHAN
D13 KIRADU
D14 LOHAWAT
D15 MALUNGA
D16 NACHNA-MOHANGARH IGNP AREA
D17 NETRA
D18 NEVARA
D19 RADANA
D20 RAJMATHAI
D21 RASALA
D22 SARDAR SAMAND
D23 UJJALAN

Prioritised Sites in the Timber Line Zone (Uttar Pradesh)

T1 BYANS
T2 DODITAL
T3 DIBRUGHEETA, DEODI (WITHIN NANDA DEVI NATIONAL PARK)
T4 HEMKUND, BHYUNDAR (WITHIN VALLEY OF FLOWERS NATIONAL PARK)
T5 KEDARNATH, KHATLING (WITHIN KEDARNATH SANCTUARY)
T6 MALAI, NITI, DUNAGIRI
T7 OKHIMATH
T8 PANCHACHULI
T9 PINDARI
T10 RALAM
T11 RUDRANATH, TUNGNATH

State Level Priority Sites

Arunachal Pradesh

S1 DEMWEE SEWAK
S2 DEOMALI NAMSAI
S3 DOIMARA
S4 PE PER KIMIN

Meghalaya

S5 NARTIANG, JOWAI, JARAIN, UMTAPOH, SHANGPUNG, RALIANG, KHLIEHRIAT, SUTUNGA, THADLASKEIN, LASKEIN, MYNSO

S6 JAKREM, MAWBLONG, MAWSYNRAM, CHERRAPUNJEE, SHELLA, SOHRARIM, PYNURSLA
S7 BURNIHAT, UMLING, LAILAD, NONGPOH, UMTESOR, UMTYNGAR, NONGKHYLLEM, MAIRANG
S8 UMSNING, SUMER, UMSAW, UMTHAM, UMWAI, UMRAN, BARAPANI, UMSING, SHILLONG, LAITKORPEAK, MAWPHLANG, MAWKDOK, NONGKREM, LAITLYNKOT
S9 ANOGIRI, JENGJAL, RONGRAM, SELBALGIRI, TURA, DAMALGIRI, ADUGIRI, KHERAPARA, BARENGAPARA, DALU, THEBRANGIRI, ASSIMGIRI
S10 DAWKI, MUKTAPUR
S11 SONGSAK, RONGRENGGIRI, WILLIAMNGAR, DARUGIRI, RONGJENG, DAMRA, DAINADUBI, MANIKGANJ, SIMSENG, MANDA, TASEK, DAMBU
S12 GARAMPANI, KOPILI
S13 SIJU, BAGHMARA
S14 BALPHAKRAM, KANAI, MAHADEO, MAHESHKOLA
S15 SONAPAHAR, NONGSTOIN, RAMBARI
S16 SONAPUR, UMKIANG
S17 MAWPAT (WITHIN AND AROUND)
S18 BALAT, RANIKOR, NONGKHLAW
S19 PHULBARI, DIGRANGGIRI, DURAGIRI, RONGSAGIRI

S20 GAROBADHA (WITHIN AND AROUND)

Nagaland

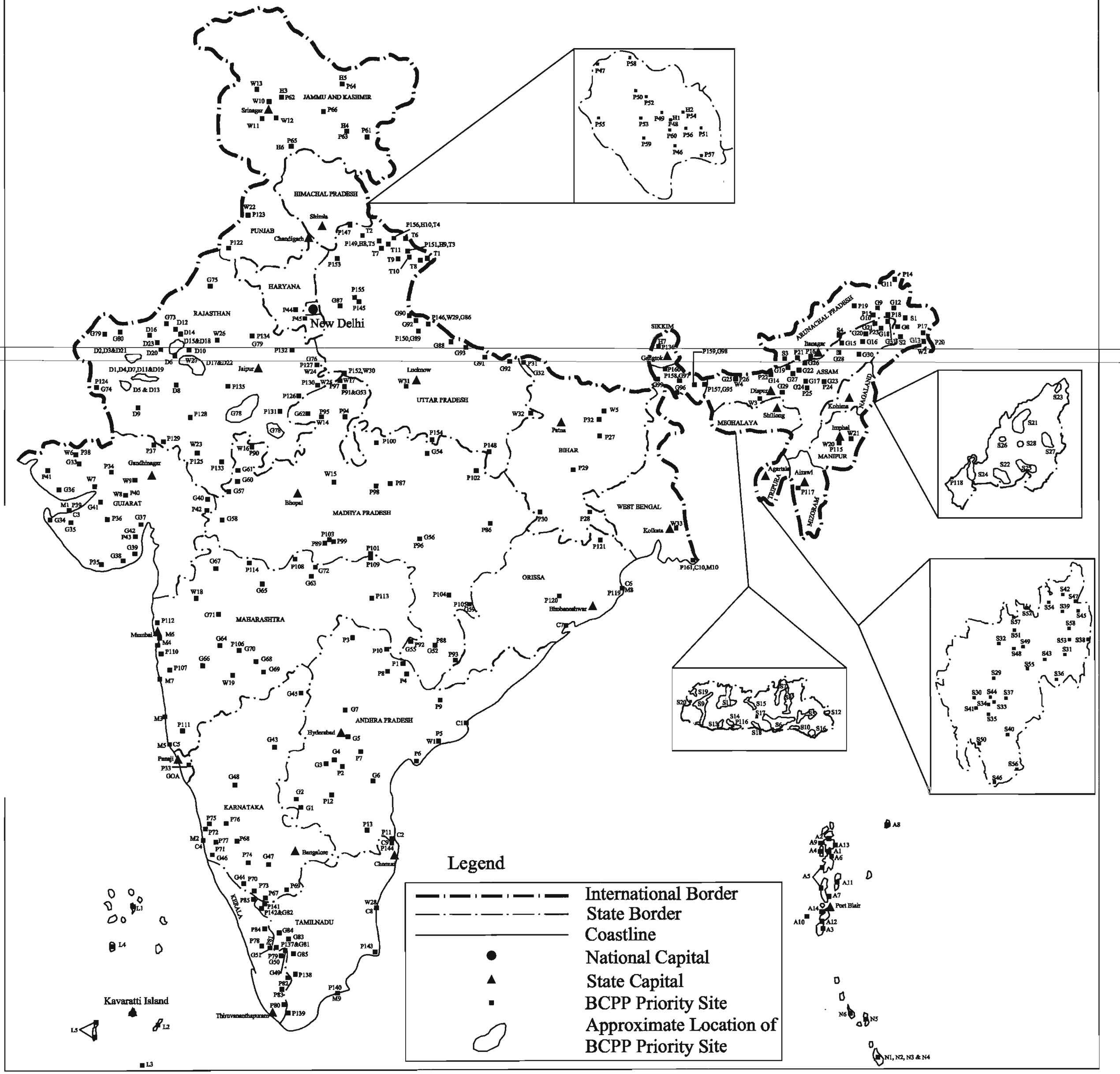
S21 MERANGKONG, CHANGKI, MOKOKCHUNG, LUNGKAM, LONGSA
S22 KOHIMA, JAPFO, TEKHABAMI
S23 TIZIT, MON
S24 DIMAPUR, RANGAPAHAR, JALUKE, PEREN
S25 DZULHAMI, PHEK, MELURI
S26 WOKHA (WITHIN AND AROUND)
S27 TUENSANG, SHAMATORE
S28 ZUNHEBOTO (WITHIN AND AROUND)

Tripura

S29 KILLA
S30 KALAPANIA
S31 LALCHHARA
S32 HARBANG
S33 LATMACHHARA
S34 MAHARANI
S35 GARJEE
S36 THALCHHARA
S37 PAHARPUR
S38 JAMPUI
S39 KACHARICHHARA
S40 KALSHI
S41 HARIJALA
S42 UNNAKOTI
S43 JOYCHANDRAPARA
S44 DEBBARI
S45 BANGSHUL
S46 HARBATALI
S47 JURI
S48 SIMULCHHARA
S49 KAMLACHHARA
S50 MALUMBARI
S51 TULASHIKHA
S52 CHHOTOSURMA
S53 SATNALA
S54 KIRANPARA
S55 SATARMIA HOWR
S56 BAISHNABPUR
S57 BIDYABILL
S58 BHRUPARA

Note. Site S12 (Garampani, Kopili) is located in an area that is disputed between Meghalaya and Assam

BCPP PRIORITY SITES IN INDIA



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