NATIONAL POLICY AND MACROLEVEL ACTION STRATEGY ON

BIODIVERSITY

GOVERNMENT OF INDIA
MINISTRY OF ENVIRONMENT & FORESTS

Published : December, 1999

Published by the Director, Zoological Survey of India, for the Ministry of Environment and Forests, Govt. of India. The funds for publishing this document were made available by the UNDP from the UNDP/GEF Biodiversity Enabling Activity Project on the Preparation of India's First National Report to the CBD.

सत्यमेव जयते

टी. आर. बालू
T. R. BAALU

मंत्री
पर्यावरण एवं वन
भारत सरकार
नई दिल्ली-110003
MINISTER
ENVIRONMENT & FORESTS
GOVERNMENT OF INDIA
NEW DELHI-110003

PREFACE

Biodiversity is vital for the survival of this planet and for continuation of evolutionary processes. Biodiversity has direct consumptive value in food, agriculture, medicine and industry.

We can understand biodiversity to mean variety of life forms we see around us. The issues relating to biodiversity are however extremely complex. While utilisation of biological resources is essential for human welfare, it is equally essential to conserve these resources for future generations. The challenge lies in adopting a path of utilisation which does not conflict with conservation of biodiversity and also ensures benefit sharing arising from its use.

India has a long history of conservation and sustainable use of natural resources. Strategies and plans for the conservation and sustainable use of biological diversity are rooted in the rich spiritual and cultural traditions of our country.

Over the years, India has developed an organisational structure and a legal and policy framework for the protection of environment and wildlife in the country. After becoming a Party to the Convention on Biological Diversity in 1994, India has taken many important steps in further strengthening the existing strategies. In order to consolidate, adapt, and augment existing strategies and to initiate new programmes based on a sound coordinated policy for future actions, this Ministry after wide-ranging consultations with all stakeholders, has developed this National Policy and Macrolevel Action Strategy. This document will provide the framework for preparing detailed action programmes at the microlevel for conservation and sustainable use of biodiversity in the country.

T R Baalu

(T.R. BAALU)

30th November, 1999
New Delhi.

विश्वनाथ आनंद
VISHWANATH ANAND

सत्यमेव जयते

सचिव
पर्यावरण एवं वन मंत्रालय
भारत सरकार
SECRETARY
MINISTRY OF ENVIRONMENT & FORESTS
GOVERNMENT OF INDIA

Foreword

India is one of the 12 megabiodiversity countries of the world. With only 2.4% of the land area, India already accounts for 7-8% of the recorded species of the world. India is equally rich in traditional and indigenous knowledge. The Convention on Biological Diversity offers opportunities to India to realise benefits from its rich biological resources and associated traditional knowledge.

Biodiversity is a multi-disciplinary subject involving diverse sectoral activities and actions, and has a large number of stakeholders. For addressing the entire gamut of issues involved in conservation and sustainable use of biodiversity, a mix of interventions is required including programmes, policies, action plans and legal framework.

Adopting a consultative process with all stakeholders, this Ministry has drawn up a National Policy and Action Strategy on Biodiversity. This is a macrolevel statement of strategies, gaps and further action needed for conservation and sustainable use of biodiversity in a broader perspective. The document identifies the basic goals and thrust areas and outlines action points for various subjects.

I wish to place on record my appreciation for the sincere and diligent efforts put in by Dr. G.V. Sarat Babu, Joint Director and Dr. Sujata Arora, Deputy Director for developing this document. I also wish to thank my colleagues, Shri Vinod Vaish, Special Secretary and Shri R.H. Khwaja, Joint Secretary for their supervision. Funds for publication of this document have been made available by UNDP under the UNDP/GEF Biodiversity Enabling Activity project.

(VISHWANATH ANAND)

CONTENTS

ABBREVIATIONS

ASEAN	:	Association of South East Asian Nations
BSI	:	Botanical Survey of India
CCMB	:	Centre for Cellular and Molecular Biology
CDRI	:	Central Drug Research Institute
CEE	:	Centre for Environmental Education
CIMAP	:	Central Institute for Medicinal and Aromatic Plants
CITES	:	Convention on International Trade in Wild Species of Fauna and Flora
CMFRI	:	Central Marine & Fisheries Research Institute
CNH	:	Central National Herbarium
CSIR	:	Council of Scientific & Industrial Research
CZA	:	Central Zoo Authority
DBT	:	Department of Biotechnology
DOD	:	Department of Ocean Development
EPA	:	Environmental Protection Act
FAO	:	Food and Agricultural Organisation
FRI	:	Forest Research Institute
FSI	:	Forest Survey of India
GATT	:	General Agreement of Trade and Tariffs
ICAR	:	Indian Council of Agricultural Research
ICFRE	:	Indian Council of Forestry Research and Education
ICIMOD	:	International Centre for Integrated Mountain Development
ICMR	:	Indian Council of Medical Research
IIFM	:	Indian Institute of Forest Management
IPRs	:	Intellectual Property Rights
IUCN	:	International Union for Conservation of Nature and Natural Resources
JFM	:	Joint Forest Management
MOA	:	Ministry of Agriculture
MOEF	:	Ministry of Environment and Forests
MHRD	:	Ministry of Human Resources Development
NBAGR	:	National Bureau of Animal Genetic Resources
NBFGR	:	National Bureau of Fish Genetic Resources
NBPGR	:	National Bureau of Plant Genetic Resources
NBRI	:	National Botanical Research Institute
NCERT	:	National Council of Education, Research & Training
NCS	:	National Conservation Strategy
NEAC	:	National Environment Awareness Campaign
NFP	:	National Forest Policy
NGO	:	Non Governmental Organisation
NMNH	:	National Museum of Natural History

NWAP	:	National Wildlife Action Plan
NZC	:	National Zoological Collection
RRL	:	Regional Research Laboratory
SACEP	:	South Asian Cooperative Environment Programme
UGC	:	University Grants Commission
UNCLOS	:	United Nations Commission for Law of Seas
UNDP	:	United Nations Development Programme
UNEP	:	United Nations Environment Programme
WII	:	Wildlife Institute of India
WWF-India	:	World Wide Fund for Nature-India
ZSI	:	Zoological Survey of India

LIST OF TABLES

LIST OF BOXES

CHAPTER 1

Conservation and sustainable use of biodiversity is fundamental to ecologically sustainable development. Biodiversity is part of our daily lives and livelihood, and constitutes resources upon which families, communities, nations and future generations depend. Every country has the responsibility to conserve, restore and sustainably use the biological diversity within its jurisdiction. Biological diversity is fundamental to the fulfilment of human needs. An environment rich in biological diversity offers the broadest array of options for sustainable economic activity, for sustaining human welfare and for adapting to change. Loss of biodiversity has serious economic and social costs for any country. The experience of the past few decades has shown that as industrialization and economic development in the classical sense takes place, patterns of consumption, production and needs, change, straining, altering and even destroying ecosystems. India, a megabiodiversity country, while following the path of development, has been sensitive to needs of conservation and hence is still rich in biological resources. Ethos of conservation and harmonious living with nature is very much ingrained in the lifestyles of India's people.

India's strategies for conservation and sustainable

utilisation of biodiversity in the past have comprised providing special status and protection to biodiversity rich areas by declaring them as National Parks, Wildlife Sanctuaries, Biosphere Reserves, Ecologically fragile and sensitive areas, off loading pressure from reserve forests by alternative measures of fuelwood and fodder need satisfaction, by afforestation of degraded areas and wastelands, creation of *ex situ* conservation facilities such as gene banks etc.

The challenge before India is not only to sustain the efforts of the past but also further add to them in accordance with a rational need assessment such that they are to the advantage of the country and humankind while maintaining and accelerating growth and development to alleviate the living standards of Indian people. Distribution and magnitude of biodiversity that exists today is a result of over 3.5 billion years of evolution, involving speciation, migration and extinction. Effect of human influences on such evolution was minimal in this evolutionary process till the onset of advanced agriculture and subsequently industrial revolution. The impact of human influence in recent years has been quite substantial.

Biodiversity refers to variety of life forms we see around us. It encompasses the whole range of mammals, birds, reptiles, amphibians, fish, insects and other invertebrates, plants, fungi and micro-organisms such as protista, bacteria and viruses. Biodiversity is recognised at three levels, namely, species level, genetic level, and ecosystem level. Genetic diversity refers to variation within individual species; species diversity pertains to the variety of species; and ecosystem diversity refers to diversity of ecosystems and habitats.

Biodiversity is dynamic at all the three levels, the genetic composition of species changes over time in response to natural and human-induced selection pressures; occurrence and relative abundance of species in ecological communities change as a result of ecological and physical factors; and ecosystems strongly respond to external dynamics and internal pressures. Ecological systems do not exist as discrete units but represent different parts of a natural continuum.

Global Biodiversity Assessment (UNEP 1995) estimates the total number of species to be between 13 and 14 million. It further records that so far only 1.75 million species have been described. Scientists estimate that a unicellular organism has genes ranging between a hundred to a few hundreds. The enormity of magnitude of genetic diversity harboured by 13-14 million species would seem to be beyond simple imagination even. Ecosystem diversity has not even been reasonably explored as yet. In India, so far, 89,000 species of animals and 47,000 species of plants have been described by the Zoological Survey of India (ZSI) and the Botanical Survey of India (BSI), respectively. Genetic differences between the individuals of a species provide the basis for the diversity that is found between species. Since in nature no organism lives in isolation, each species is dependent on other species as also on ecological systems. As there is complete interdependence in nature, change in a habitat affects the diversity of the species contained in it. Conversely, any change in the number and assemblage of species also affects the nature of the habitat.

1.2 NEED FOR BIODIVERSITY CONSERVATION

India is one of 12 megabiodiversity countries of the world. The innumerable life forms harboured by the forests, deserts, mountains, other land, air and oceans provide food, fodder, fuel, medicine, textiles etc. Now that the negative side of the synthetic products and processes and side effects of chemical drugs etc. are becoming more and more apparent and the world is shifting to products and processes based on natural resources, these life forms are potentially important for developments in the fields of food, medicines, textiles, energy, recreation and tourism. Value and potential of some species is already known. Bioprospecting for genes and biochemicals has been undertaken to some extent. Yet, there are innumerable species, the

potential of which is not as yet known. It would therefore be prudent to not only conserve the species we already have information about, but also species we have not yet identified and described from economic point of view. *Taxus baccata*, a tree found in the Sub-Himalayan regions, once believed to be of no value is now considered to be effective in the treatment of certain types of cancer. In addition, as discussed in earlier sections, the need to conserve biodiversity because of interdependence of species in nature for survival demands conservation of all elements of biodiversity.

Besides, while the diversity of genes, species and ecosystems is a valuable resource that can be tapped as human needs and demands change, the still more basic reasons for conservation are the moral, cultural and religious values. The close linkages between biodiversity and cultural diversity have helped to determine cultural values. Most of the world's religious texts teach respect for the diversity of life and concern for its conservation.

While the importance of biodiversity can be understood, it is not easy to define the value of biodiversity, and very often difficult to estimate it. Many aspects of biodiversity cannot be quantified, let alone valued. Apart from the tremendous economic benefits, biodiversity has aesthetic, ethical, cultural, social and scientific importance. For purposes of understanding, the value of biodiversity is classified into direct and indirect values.

The direct values imply the uses of components of biodiversity directly for consumptive, productive and non-consumptive purposes. On the other hand, the functions performed by biodiversity which are not of any direct use, but are either ecological processes as future options or due to their mere existence constitute the indirect values.

Biodiversity has direct consumptive value in agriculture, medicine and industry. Approximately 80,000 edible plants have been used at one time or another in human history, of which only about 150 have even been cultivated on a large scale. Today a mere 10 to 20 species provide 80-90% food requirements of the world.

In India, many rural communities particularly the tribals obtain considerable part of their daily food from the wild plants. Some examples are : *Ceropegia bubosa* in Central India and Western Ghats; *Codonopsis ovata* in Himalayan region; *Ardisia* and *Meliosma pinnata* in the North-east; *Eremurus himalaicus*, *Origanum vulgare* and *Urtica hyperborea* in Lahul-Spiti and Ladakh; *Allium*

carolinianum and *Cicer microphyllum* in Kashmir and *Sesuvium portulacastrum* in Coastal areas. Similarly, a variety of faunal species, e.g., insects, molluscs, spiders, wild herbivores are consumed by many tribal and non-tribal communities in India.

At one time, nearly all medicines were derived from biological resources. Even today they remain vital and as much as 67-70% of modern medicine are derived from natural products. In developing countries, a large majority of the people rely on traditional medicines for their primary health care, most of which involve the use of plant extracts. Around 20,000 plant species are believed to be used medicinally in the third world. In India, almost 95% of the prescriptions are plant-based in the traditional systems of Unani, Ayurveda and Sidha. Many indigenous medicines also utilise animals and their parts or extracts as remedies for various diseases.

For housing and construction activities, wood, thatch, bamboo, cane, coconut and other plant materials are utilised. Apart from shelter, plant products are also used for other kinds of construction such as pipes for irrigation and suspension bridges in the Himalaya. A number of house-hold items such as ropes, mats, baskets, brooms, furniture, decorative items, fishing and agricultural implements are made from plant and animal parts. Items of clothing are derived from a large number of plants and animals, while cotton is the most widely used natural fibre, others include silk and wool from animals and jute from a plant.

Diverse habitats and species also have non-consumptive use-value. Tourism, recreation and scientific research are the major examples. The indirect use-value of biodiversity includes ecosystem process of biological diversity which provides valuable ecological services to the biosphere; some examples are the ecosystem's ability to absorb pollution, maintain soil fertility and micro-climates, recharge ground water, and provide other invaluable services.

Considering the potential value of biodiversity in the future, the option value represents the willingness to pay to retain the option of preserving access to a diverse range of habitats, species and genes. An example of option value is the future value of plant-derived drugs.

The existence values are intrinsic values, not associated with actual or potential use, which reflect the utility that people derive from simply knowing that a habitat or a species exists. For example, for many of us, simply knowing that a particular species (e.g., elephant, tiger, whale) or an ecosystem (e.g., wetlands, deserts) exists, is inspiring and comforting.

Many plants, animals and their parts are used in rituals all over the country. To name a few : flowers of *Hibiscus, Datura* and *Euphorbia*; leaves of *Aegle marmelos* (bel), *Eragrostis cynasuroides* (kusa grass), rice til, chenopods, odorous roots of *Dolomiaea macrocephala* (dhup). Further, sacred values are attached to entire ecosystems, for example patches of forests were believed to be the abode of gods, and are used only for prayers and rituals. Many sacred groves still exist in different parts of India.

1.3 CONVENTION ON BIOLOGICAL DIVERSITY

Concern for conservation of biodiversity at global level figured for the first time in the discussions at the UN Conference on the Human Environment held in Stockholm in 1972. Though UNEP identified conservation as a priority area in 1973, it was only towards late 1980s that systematic and concerted efforts to look at biodiversity conservation profile at international level started with constitution of an Ad Hoc Working Group of Experts on Biological Diversity by UNEP in 1987. Eventually, an Expert Group was constituted by UNEP which started its work in 1989 culminating in the Convention on Biological Diversity (CBD) at the UN Conference on Environment and Development (UNCED) held at Rio de Janeiro in June, 1992. This Convention entered into force on 29th December, 1993. At present, 175 countries are Parties to the Convention.

This international treaty is a historic treaty in that it not only reflects the commitment of global community for conservation and sustainable use of biodiversity, but also visualises sharing of benefits arising out of utilisation of genetic resources with the countries of origin. The three principle objectives of the Convention captured in Article 1 reflect this. According to this, the main objectives of the Convention are :

- the conservation of biological diversity;
- the sustainable use of the components of biodiversity;
- the fair and equitable sharing of benefits arising out of the utilisation of genetic resources.

The objective of equitable sharing of benefits has to be further seen in the reaffirmation of sovereign rights of States over their own biodiversity which entitles a country to equity and fairness in sharing of benefits arising out of the utilisation of their genetic resources.

The 23 preambular paragraphs of the Convention recognise and reaffirm :

- the intrinsic value of biological diversity;
- the sovereign rights of States over their biological resources;
- the fundamental requirement of *in situ* conservation of ecosystems and natural habitats;
- the supporting role of *ex situ* measures;
- the vital role of local communities and women in the conservation and sustainable use of biological diversity;
- the desirability of sharing equitably the benefits arising from the use of traditional knowledge, skills, innovations and practices;

- the importance of and the need to promote regional and global cooperation for conservation; and
- the requirements of substantial investments to conserve biological diversity.

The significant implications of the provisions of the Convention and the main obligations of the Contracting Parties are as follows :

Parties are required to take measures for *in situ* conservation of biological diversity, promote rehabilitation and restoration of degraded ecosystems, and ensure protection of threatened species (Article 8). Parties are obliged to respect, preserve and maintain knowledge, innovations and practices of indigenous and local communities and encourage the equitable sharing of benefits arising from the use of such knowledge, innovations and practices (Article 8 j). Parties are also to adopt measures for *ex situ* conservation of components of biological diversity, for complementing the *in situ* efforts (Article 9). Parties are to facilitate access to genetic resources on mutually agreed upon terms with prior informed consent of the country providing these resources (Article 15). The recepient country is to share in a fair and equitable way the results of research and development and the benefits arising from the commercial and other utilisation of genetic resources with the party providing such resources. The Convention calls for transfer of relevant technologies, including biotechnologies on'fair and most favourable' terms from the developed to the developing nations, which provide genetic resources used for the development of these technologies (Article 16). It also calls on the private sector to facilitate access to and transfer of such technologies developed by them (Article 16.4). The Contracting Parties are to cooperate in this regard to ensure that patents and other intellectual property rights are supportive of and do not run counter to the objectives of the Convention (Article 16.5). Recombinant technology (or genetic engineering) are increasingly gaining ground and are being seen as potentially useful for various sectors by experts. Recognising that introduction of these biotechnologies requires

utmost care and caution based on precautionary principle, outlined in Agenda 21, particularly because recall of an introduced organism in nature would well *nigh* be possible, the Convention commits the Parties to consider an international protocol for safe transfer, handling and use of any living modified organism resulting from biotechnology (Article 19.3). Parties are also to take measures for facilitating access on a fair and equitable basis and on mutually agreed upon terms to the results and benefits arising from biotechnologies based upon genetic resources provided/transferred (Article 19.2). The developed

country Parties are committed to contribute to a fund to enable developing country Parties to meet the 'agreed full incremental costs' for implementing the provisions of the Convention (Article 20.2). The financial mechanism is to operate within a democratic and transparent system of governance and 'function under the authority' of the Conference of the Parties (Article 21).

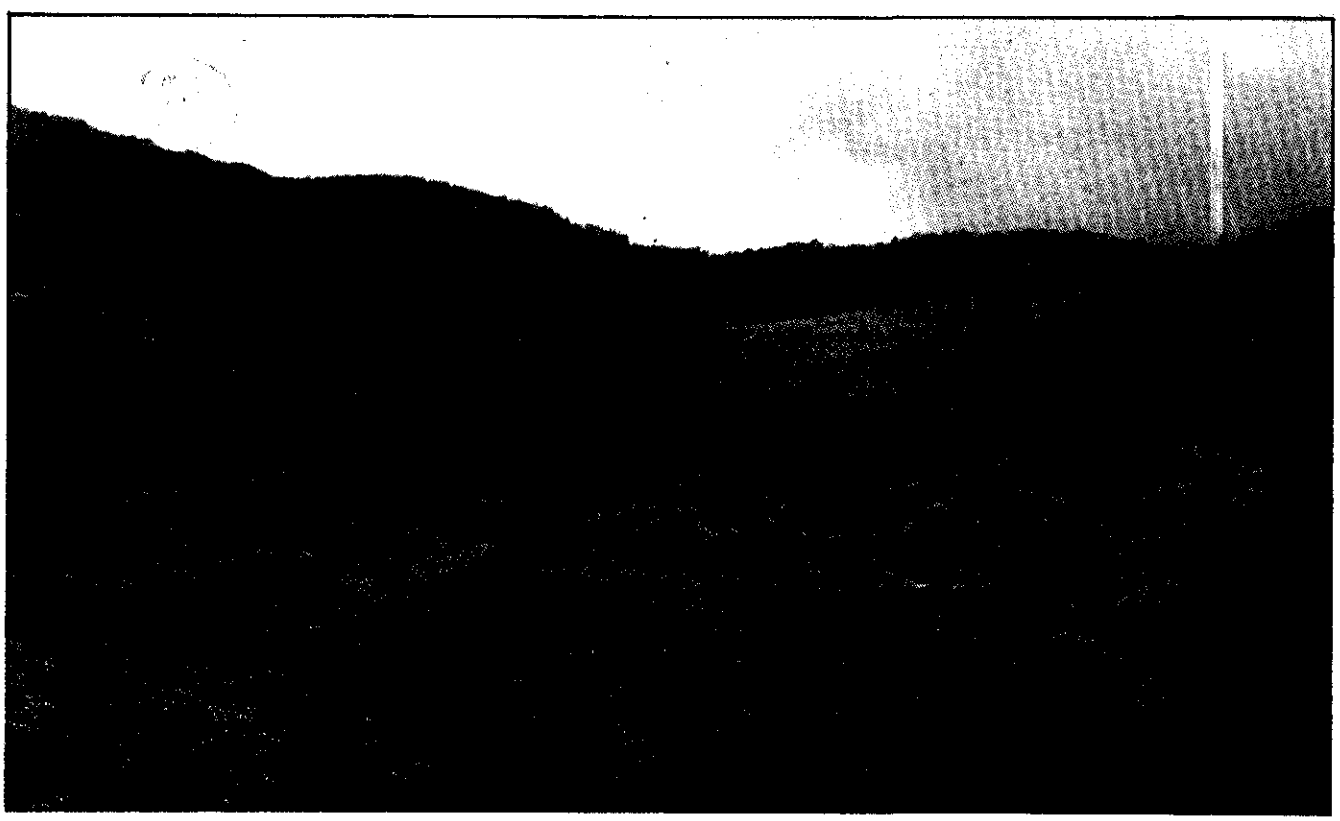
Important points to note about the Convention are that facilitation of access by developing countries is linked with equitable sharing of benefits; thus, making it a two-way process. Technology flows are also founded on the principle of equity with the developing countries providing resources and traditional technologies, and developed countries sharing and transferring technologies including biotechnologies and providing financial resources to help developing countries meet their commitments and realise benefits.

From the foregoing, it is amply clear that the Convention is the first global comprehensive agreement to address all aspects of biological diversity — genetic resources, species and ecosystems — which would have revolutionary and far reaching implications. Being based on considerations of equity and shared responsibility, the Convention envisages a reciprocity of arrangements between developed and developing countries, thereby promoting a renewed partnership between them.

The main implementation measures for the Convention are to be through national strategies, plans or programmes, to be developed in accordance with each country's situations and capabilities. Although qualified with phrases like 'as far as possible' and 'as appropriate' throughout its text, the Convention commits the Contracting Parties to take substantive action in many areas including :

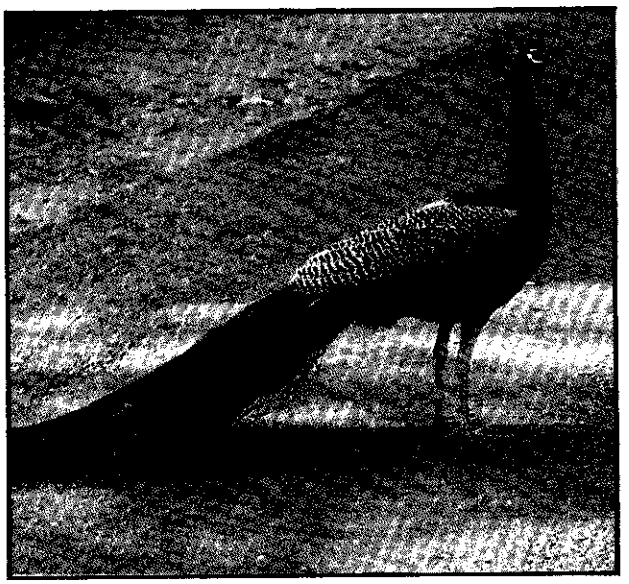
- development of national plans, strategies or programmes for conservation and sustainable use of biodiversity; and integrating these into relevant sectoral or cross-sectoral plans, programmes and policies;
- inventorisation and monitoring of components of biodiversity and of processes adversely impacting it; developing and strengthening of *in situ* mechanisms for biodiversity conservation both within and outside protected areas;
- development of *ex situ* measures for biodiversity conservation, as a complement to *in situ* approaches;
- restoration of degraded ecosystems and recovery of endangered species;

- adopting measures to avoid and minimise adverse impacts on biodiversity;
- protecting and encouraging customary use of biological resources that are compatible with conservation or sustainable use requirements;
- adopting economically and socially sound measures that act as incentives for conservation and sustainable use of components of biodiversity;
- promoting and encouraging research contributing towards achieving the objectives of the Convention;
- developing educational and public awareness programmes with respect to conservation and sustainable use of biodiversity;
- facilitating access to genetic resources on mutually agreed terms and prior informed consent; and taking measures for fair and equitable sharing of benefits arising from utilisation of the resources thus transferred;
- facilitating access to and transfer of technology, including biotechnology to developing countries under fair and most favourable terms;
- facilitating exchange of information relevant to biodiversity;
- promoting scientific and technical cooperation with other Parties;
- consideration of a protocol for safe transfer, handling and use of living modified organisms resulting from biotechnology; and
- providing new and additional financial resources by the developed country Parties to enable the developing country Parties to meet the agreed full incremental costs for implementing the provisions of this Convention.



1.4 APPROACH

India's central concern is to formulate and implement a Biodiversity Action Plan which is consistent with the ecological, social, cultural and economic mosaic of the country. India's cultural diversity which is closely linked with its



biogeographic features, offers a major challenge to implement a biodiversity action plan. The current phase of 'graduated' economic liberalisation in India which began in 1991, proceeds hand in hand with a sustained process of political decentralisation which aims to devolve works and responsibilities on culturally diverse populations to implement local development plans. Project and programme designs for biodiversity conservation need to be predicated on socio-cultural convergence and user harmony. This is particularly important as stakeholders of biological resources are not a homogenous lot on account of their varying social and cultural situations. The stakeholders have varying and often conflicting demands on biological resources. While it is axiomatic that biodiversity values arise from consumptive and non-consumptive use values of bioresources, it is often overlooked that these values are inherently 'non-cumulative'. Thus management of forest ecosystems from the point of 'option value' may be at the cost of, say, its consumptive use value on which may depend the subsistence base of tribals and other village communities inhabiting these ecosystems. What emerges in such a scenario may not just be the loss of consumptive use values but also social displacement effects induced by disruptions of traditional lifestyles and subsistence base of the affected human communities due to altered management practices. New techniques for ex-ante impact assessment of biodiversity conservation projects need to be formulated and developed to capture the appropriate institutional and other support for biodiversity conservation efforts in India.

Natural resource accounting systems and techniques are still in their infancy, and reliable and easily usable methods are not as yet available. A direct casuality of this absence of reliable technique is biological diversity. Often cesses, charges and other fiscal instruments have therefore been advocated to confer value on biological resources. Underlying assumption in these suggestions is that utilisation by secondary users of biological resources such as industry would be controlled once they are confronted with the rising costs of obtaining these resources on charges. Overt objective of such suggestions is to generate revenues which could provide much needed financial resources for biodiversity conservation programmes. However, the latitude, feasibility and the eventual usefulness of these controls and fiscal instruments need to be clearly analysed and understood before fiscal tools for biodiversity conservation are designed. The scenario is extremely complex viewed in the context that basically biological resources lie in the boundaries of the State; tribals in particular and local population in general

in most States have rights of access to Non Timber Forest Produce (NTFP) either through well-defined rights or through traditional rights; large size of populations depend for their daily food, health care and energy needs on bioresources.

The Biodiversity Action Plan of India proposes to design actions based on the evaluation of on-going strategies, and programmes, assessment of current and future needs of conservation and sustainable utilisation, recognition of the current and future use of bioresources by secondary users, designing of physical and fiscal instruments, particularly implications and impacts of such instruments in the short and long term.

CHAPTER 2

All biological resources indigenous to or naturalised in India fall within the sovereign jurisdiction of the State. Though conservation has been a concurrent theme in various policy pronouncements in the forestry sector and to a certain extent in other related sectors, a formal policy statement on biodiversity of the country has not been there, even though India is one of the few countries which have established institutions for biodiversity related issues. Some examples are Botanical Survey of India and Zoological Survey of India for survey and economic description of its biodiversity.

Diversified uses of biological resources have been established in the past couple of decades and the trend is on the increase. Commercial products and biotechnologies based on the use of biological resources are gaining ground in trade and economic spheres. The Convention on Biological Diversity taking note of all these developments, as also the urgent need of ensuring conservation and sustainable utilisation of biodiversity, provides an enabling environment for countries to secure conservation and sustainable utilisation with equity in sharing of benefits.

Attributing intrinsic value to biodiversity has

been a part of India's cultural ethos. The main goals of the National Policy and Macrolevel Action Strategy on Biodoversity are based not only on the extrinsic worth but also on the intrinsic value of biodiversity. The main goals of the National Policy and Macrolevel Action Strategy on Biodiversity are :

(i) Achieve conservation and sustainable use of biological diversity through consolidating ongoing efforts and initiating new steps, wherever necessary. This would include regeneration and rehabilitation of threatened species.

(ii) Secure participation of State Governments, communities, people, NGOs, industry and other stakeholders including women in the conservation and sustainable use of components of biodiversity.

(iii) Realise consumptive and nonconsumptive value of biodiversity through necessary investments in R&D and biotechnology development.

(iv) Ensure benefits to India as country of origin of biological resources and to local communities and people as conservers of biodiversity, creators and holders of indigenous knowledge systems, innovations and practices.

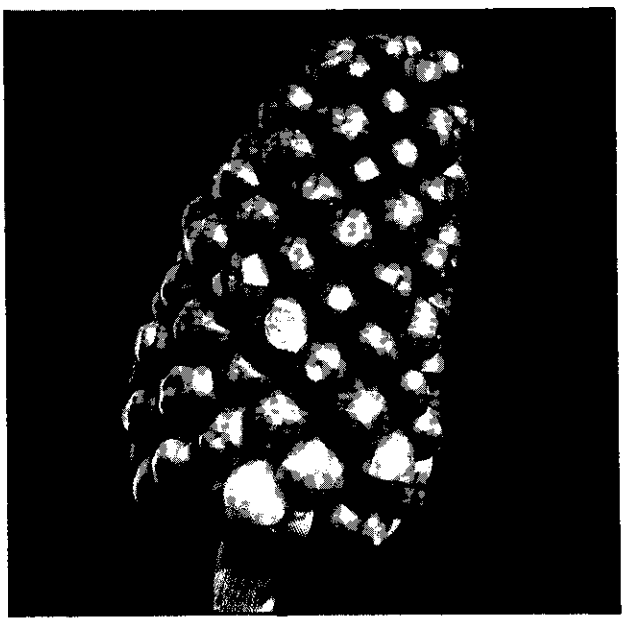
(v) Ensure consideration of biodiversity concerns in other sectoral policies and programmes.

The range of strategies and plans to achieve these five main goals will have to incorporate various missions and objectives which would be crucial to achieve the main goals. The major loci for action would be the State Governments and local bodies. The National Policy and Macrolevel Action Strategy would be governed by the following basic principles :

(i) India has sovereign rights over its own biological resources. Access to and utilisation of the biological diversity occurring in India would be in accordance with the administrative and legislative measures of the State, including with the prior approval of the Central Government or the State Governments as the case may be.

(ii) Local communities and people have over the years developed lifestyles, innovations and practices conducive to conservation and

sustainable use of biodiversity. They have developed a body of knowledge regarding the use of these resources for food, medicines, pesticides etc. Considering the dependence of the lifestyles of communities and local people on biological diversity, practices of utilisation conducive to conservation would be encouraged. Such practices, innovations and



knowledge would be protected and propagated for wider use subject to ensuring benefits to these communities/people for utilising such knowledge and practices. Any commercial use of such knowledge, innovations and practices would be permissible only after ensuring a due share of the community in the benefits realised from such knowledge, innovations and practices.

(iii) The existing network of protected areas for *in situ* conservation would be strengthened. These efforts would be complemented appropriately by the *ex situ* conservation measures.

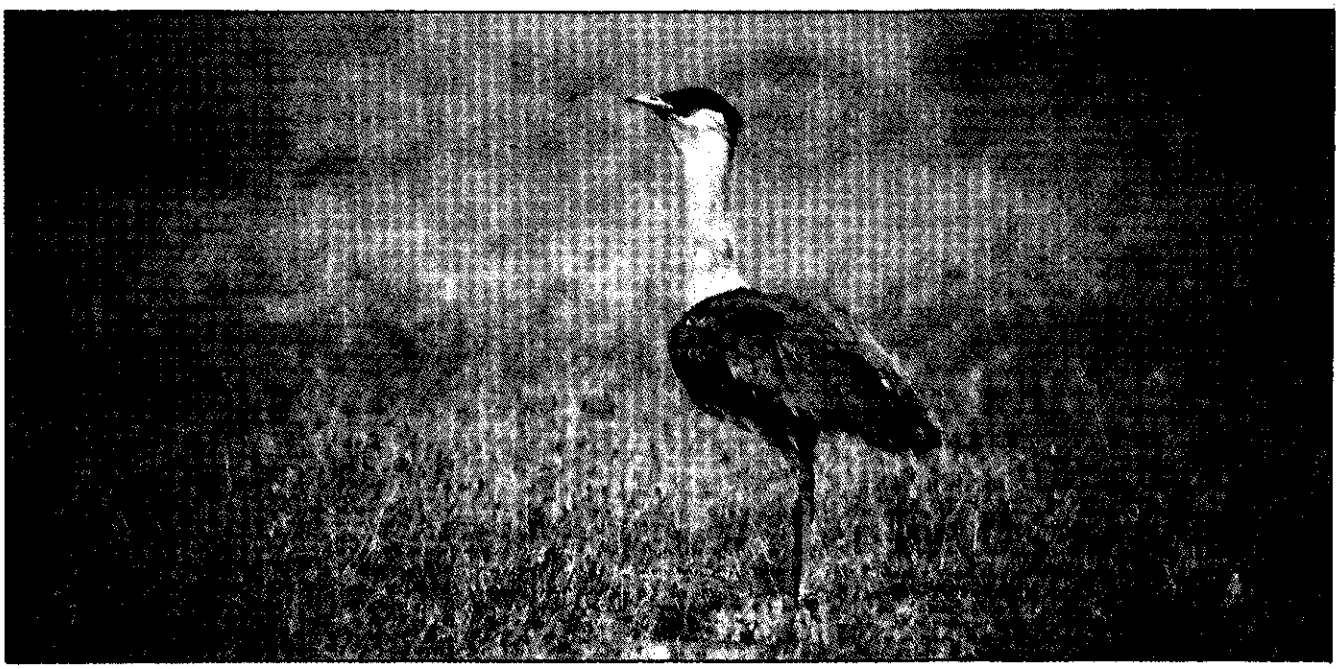
(iv) Special attention would be paid for conservation of representative ecosystems as Biosphere Reserves, and fragile ecosystems such as wetlands, mangroves and coral reefs.

(v) Considering the occurence of medicinal plants in India as also the richness of both coded and non coded knowledge systems of therapeutic, health and nutritional uses of these plants, one of the thrust areas would be conservation and *ex situ* cultivation of these plants alongwith scientific validation of priority applications to realise their economic and social potential.

(vi) Encouragement would be given to policies and programmes securing technological capacity building of the country for realising the actual and potential value of biodiversity along with conservation.

(vii) Sacred groves are the rich heritage of India. Occurring in various parts of the country, sacred groves harbour ecosystems at pristine level. These would be treated as special areas deserving full protection and conservation.

(viii) India is rich in endemic species. It has two hot-spots, namely, Western Ghats and Eastern Himalaya. There are other rich areas such as Andaman and Nicobar Islands and Satpura ranges which deserve similar mention. Developmental and other programmes and policies in these areas would take due note of such richness and would be designed that they



do not adversely affect the richness of these areas.

(ix) Rehabilitation and regeneration of threatened and endangered species of fauna and flora would be given priority in conservation efforts.

(x) Conservation and sustainable utilisation principles would equally and strongly apply to domesticated biodiversity as well including wild relatives of crop plants and domesticated animals etc.

(xi) Policies which directly or indirectly work as incentives for indiscriminate use of biodiversity will be discouraged. This would include review of policies to ensure that *ex situ* conservation of threatened and endangered speices or economically viable species is not jeopardised for want of policies which would make such cultivation remunerative.

(xii) Knowledge base of the flora and fauna occurring in the local areas would be created, strengthened and expanded by mass awareness. This would encourage stake building in conservation at the local levels.

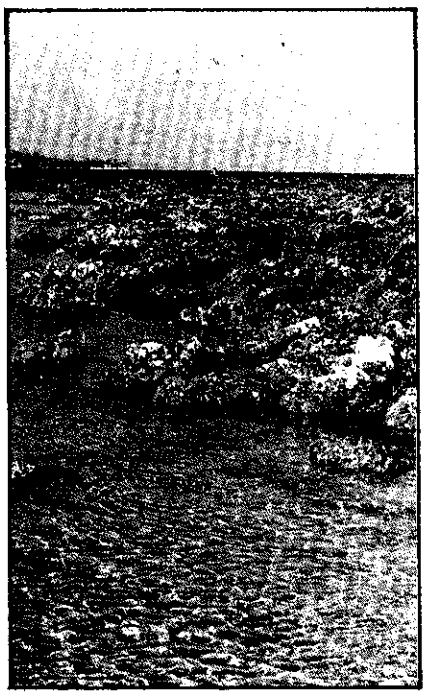
(xiii) Considering of conservation and sustainable use of biodiversity would be integrated in sectoral programmes.

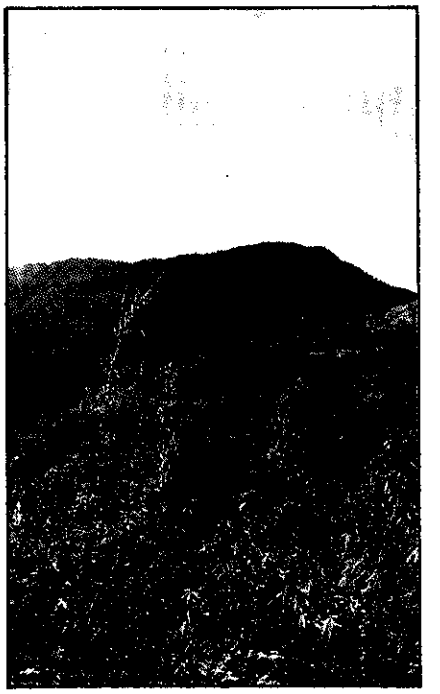
(xiv) Private and public sector investments for the development of sound practices for use of biological diversity including bioprospecting and development of bio-technology would be encouraged. Conservation and sustainable use would be integrated in such research and development.

(xv) Promotion of community and NGO participation would be encouraged in endeavours of conservation and sustainable use of biological diversity.

(xvi) Educating and building capacity of policymakers, industrialists, NGOs, local communities etc. on the need for biodiversity conservation, emphasizing its intrinsic worth.

(xvii) To channelise the conservation ethos of people into meaningful conservation and sustainable utilization of biological diversity, awareness building and education activities in this regard would be taken.





CHAPTER 3

BIODIVERSITY IN INDIA

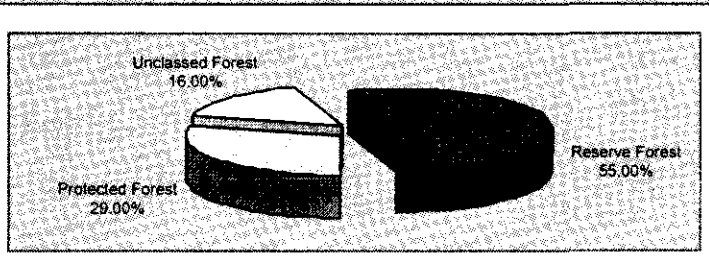
India is located in the south of Asia, between latitudes 6° and 38°N, and longitudes 69° and 97°E. The Indian land mass, extending over a total geographical area of about 329 million hectares, is bounded by the Himalaya in the North, the Bay of Bengal in the East, the Arabian Sea in the West, and Indian Ocean in the South. In terms of landmass, it is the seventh largest country in the world. Its coastline of about 7,500 km extends over 200 nautical miles in the off-shore forming an Exclusive Economic Zone (EEZ) of two million square kilometers. India has a tropical monsoon climate. The South-West monsoons and North-East monsoons bring rain into India. Rainfall is uneven and ill distributed, it varies both temporally and spatially. Western Ghats, along the States of Goa, Maharashtra, Karnataka and Kerala, West Bengal, and Assam receive an annual rainfall of 2000 mm. Maharashtra, Bihar, and Madhya Pradesh along the Vindhyan Mountains receive annual average rainfall of 1000 - 2000 mm. South coastal plains and North Western Deccan and upper Gangetic plains receive an annual rainfall of 500 - 1000 mm. Hot desert areas of Rajasthan and Gujarat and the cold desert areas of Ladakh in Jammu and Kashmir and Lahul-Spiti in Himachal Pradesh receive an annual rainfall of 100 mm.

ECOSYSTEM DIVERSITY

The wide variety in physical features and climate situations have resulted in a diversity of ecological habitats like forests, grasslands, wetlands, coastal and marine ecosystems and desert ecosystems, which harbour and sustain the immense biodiversity. India is one of the 12 megabiodiversity countries in the world.

Table 1 : State-wise Geographical Area and Actual Forest Cover

State/Union Territory	Geographical area	Recorded forest		Forest cover	
		Area	Per cent	Area	Per cent
Andhra Pradesh	275,068	63,814	23.20	43,290	15.7
Arunachal	83,743	51,540	61.54	68,602	81.9
Assam	78,438	30,708	39.15	23,824	30.4
Bihar	173,877	29,226	16.81	26,524	15.3
Delhi	1,483	42	2.83	26	1.7
Goa	3,702	1,424	38.46	1,252	32.8
Gujarat	196,024	19,393	9.89	12,578	6.4
Haryana	44,212	1,673	3.78	604	1.4
Himachal Pradesh	55,673	35,407	63.60	12,521	22.5
Jammu & Kashmir	222,235	20,182	9.08	20,440	9.2
Karnataka	191,791	38,724	20.19	32,403	16.9
Kerala	38,863	11,221	28.87	10,334	29.6
Madhya Pradesh	443,446	154,497	34.84	131,195	29.6
Maharashtra	307,690	63,842	20.75	46,143	15.0
Manipur	22,327	15,154	67.87	17,418	78.0
Meghalaya	22,429	9,496	42.34	15,657	69.8
Mizoram	21,081	15,95	75.59	18,775	89.1
Nagaland	16,579	8,629	52.04	14,221	85.8
Orissa	155,707	57,184	36.73	46,941	30.1
Punjab	50,362	2,901	5.76	1,387	2.8
Rajasthan	342,239	31,700	9.26	13,353	3.9
Sikkim	7,096	2,650	37.34	3,129	44.1
Tamil Nadu	130,058	22,628	17.40	17,064	13.1
Tripura	10,486	6,292	60.01	5,546	52.9
Uttar Pradesh	294,411	51,663	17.54	33,994	11.5
West Bengal	88,752	11,879	13.38	8,349	9.4
Andaman & Nicobar Islands	8,249	7,171	86.93	7,613	92.3
Chandigarh	114	31	27.19	7	6.1
Dadra & Nagar Haveli	491	203	41.34	204	41.5
Daman & Diu	112	N.A	N.A	3	2.7
Lakshadweep	32	N.A	N.A	-	-
Pondicherry	493	N.A	N.A	-	-
Total	**3,287,263**	**765,201**	**23.28**	**6,33,397**	**19.27**



Status of Recorded Forest Area

Source : Forest Survey of India, 1997

3.1.1 Forest Ecosystems

The forest cover of the country is placed at 633,397 sq. km. according to the Forest Survey of India assessment (1997). This presents 19.27% of India's total geographical area. The state-wise area and forest cover are tabulated in Table 1.

India is endowed with diverse forest types ranging from the Tropical wet evergreen forests in North-East to the Tropical thorn forests in the Central and Western India. The forests of the country can be divided into 16 major groups comprising 221 types. The distribution of these groups, and the percentage of total forest area covered by each are given in Table 2.

Forests provide several essential services to mankind. Forests are the source of a number of food items, fuelwood, fodder and timber. Other economic uses include providing raw material for forest based industries. Some of the minor forest produce include gums, resins, honey, etc. Forests perform important ecological functions such as maintaining delicate ecological balance, conserving soil, controlling floods, drought and pollution. Forests provide habitats for innumerable plants, animals and microorganisms. Forests are a source of recreation and religious inspiration.

Forests face threats on account of diversion of forest land for agriculture, industry, human settlements, other developmental projects. Construction of roads and canals, quarrying, shifting cultivation and encroachments are other threats. Degradation of forests results from illicit felling, excess removal of forest products, fodder, fuelwood, forest floor litter, overgrazing and forest fires.

Table 2 : Forest Types - distribution and percentage

Forest Type	Distribution	% of forest area
Tropical forests		
1. Tropical wet evergreen	North East & South, Andaman & Nicobar island	5.8
2. Tropical semi evergreen	South & East	2.5
3. Tropical moist deciduous	Central & East	30.3
4. Tropical littoral & swamp	Along the coast	0.9
5. Tropical dry deciduous	West & Central	38.2
6. Tropical thorn	West & Central	6.7
7. Tropical dry evergreen	Central & South	0.1
Subtropical forests		
8. Subtropical broad leaved hill forests	South	0.4
9. Subtropical pine	Sub-Himalayan tract	5.0
10. Subtropical dry evergreen	North-East & South	0.2
Temperate forests		
11. Montane wet temperate	Himalaya & Nilgiris (in Western Ghats)	2.0
12. Himalayan moist temperate	Temperate areas of Himalaya	3.4
13. Himalayan dry temperate	Dry temperate areas of Himalaya	0.2
Sub-alpine and alpine forests		
14. Sub-alpine	Himalaya	4.3
15. Moist alpine shrub	Himalaya	
16. Dry alpine shrub	Himalaya	

3.1.2 Grasslands

Grasslands, which are also known as steppes, prairies, pampas and savannas in various parts of the world, are vegetation types with predominance of grass and grass-like species. In India, the total area under grasslands is about 3.9% or 12 million ha. Grasslands in the country also exhibit a diversity ranging from semi-arid pastures in Deccan peninsula, humid semi water-logged grasslands of Terai belt, rolling shola grasslands on the hilltops of Western Ghats, and the high altitude alpine pastures of Himalaya. Box 1 gives the details of five distinct types of grasslands recognised in India.

It is estimated that the Indian grasslands harbour about 1256 species belonging to 245 genera.

Box 1 : Five distinct types of grasslands

1. **Sehima-Dicanthium type** : Spread over peninsular India, the key species include *Sehima nervosum, Heteropogon contortus, Dicanthium annulatum and Themeda quadrivalvis.*

2. **Dicanthium-Cenchrus-Lasiurus type** : Spread over northern parts of Gujarat, Rajasthan, western Uttar Pradesh, Delhi and semi-arid Punjab, this type has *Dicanthium annulatum, Cenchrus ciliaris, C. biflorus, Lasiurus indicus and Atylosia scarabaeoides* (a legume) as key species.

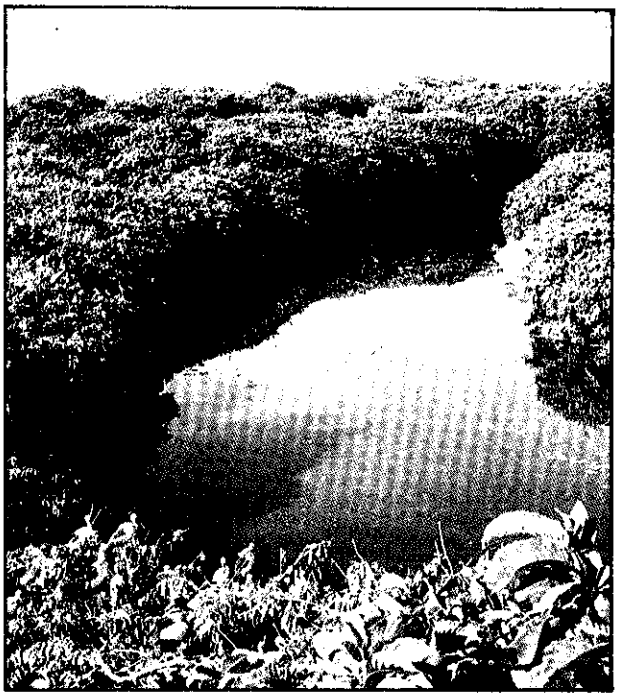
3. **Phragmites-Saccharum-Imperata type** : Covering the alluvial plains of the Ganga and the delta plains of West Bengal, the key species in this type are *Phragmites australis, Saccharum spontaneum, Imperata cylindrica and Desmostachya bipinnata.*

4. **Themeda-Arundinella type**: Spread over the northern plains to the outer humid mountains and hills in Assam, Manipur, West Bengal, Uttar Pradesh, Punjab, Himachal Pradesh and Jammu and Kashmir, this type has key species like *Themeda anaethera, Arundinella bengalensis, Bothriochloa intermdia, B. pertusa, Heteropogon contortus and Cassia tora* (a legume).

5. **Temperate-Alpine type** : covering the higher altitudes of Jammu and Kashmir, Uttar Pradesh, Himachal Pradesh, West Bengal, Sikkim and Arunachal Pradesh, the key species in this type are *Dactyis glomerata, Bromus inermis, Festuca pratensis* and *Themeda anathera.*

3.1.3 Wetlands

Wetlands are transitional zones that occupy intermediate position between dry land and open water. These ecosystems are dominated by the influence of water, they encompass diverse and



heterogeneous habitats ranging from rivers, fold plains and rainfed lakes to swamps, estuaries and salt marshes.

India by virtue of its extensive geographical stretch and varied terrain and climate, supports a rich diversity of inland and coastal wetland habitats. It is estimated that India has about 4.1 million ha. of wetlands (excluding paddy fields and mangroves), of which 1.5 million ha. are natural and 2.6 million ha. are man-made. The predominant wetland types in India can be seen in Box 2.

Wetlands in India harbour enormous diversity of floral and faunal species, many of which are endangered. Some of these have been tabulated in Tables 3 and 4.

Box 2 : Predominant wetland types

- Tanks, Reservoirs and other water bodies of the Deccan peninsula
- Backwaters and estuaries of west coast of the peninsula
- Saline expanses of Rajasthan and Gujarat
- Freshwater lakes and reservoirs of Gujarat, Rajasthan and Madhya Pradesh
- Deltas wetlands, lagoons and salt swamps of East coast
- Marshes, jheels, terrai swamps and chaur lands of the Gangetic plains
- Flood plains of Brahmaputra, marshes and swamps in the hills of North-eastern India
- Lakes and rivers of the montane regions in Jammu & Kashmir, Uttar Pradesh and Himachal Pradesh
- Wetlands in Islands of Bay of Bengal and Arabian Sea
- Coastal brackish water wetlands in West Bengal, Andhra Pradesh, Tamil Nadu and Kerala

Table 3 : Some rare and threatened plant species in Wetlands

Species	Family
Aldrovanda vesiculosa	Droseraceae
Hubbardia heptaneuron	Poaceae
Hydrilla polysperma	Hydrocharitaceae
Limnopoa meeboldii	Poaceae
Nymphaea tetragona	Nymphaeaceae
Podostemon subulatus	Podostemaceae
Cryptocoryne torulosa	Araceae
Cryptocoryne consobrina	Araceae
Cryptocoryne cognata	Araceae
Vallisneria triandra	Hydrocharitaceae
Hydrobryopsis sessilis	Podostemaceae
Amorphophalus longistalus	Araceae
Amorphophalus onchophilum	Araceae
Cyperus dwarkensis	Cyperaceae
Utricularia minor	Lentibulariaceae
Calamus nagbeti	Areaceae
Aponogeton appendiculatus	Aponogetonaceae
Aponogeton satarensis	Aponogetonaceae
Halophila stipularea	Hydrocharitaceae
Hydrophila pinnatifida	Acanthaceae
Dicrea acuminata	Podostemaceae
Hydrocera triflora	Balsaminaceae
Euryale ferox	Nymphaeceae
Aeschynomene aspera	Leguminosae
Nelumbo nucifera	Nelumbonaceae
Callitriche verna	Callitrichaceae
Eriocaulon humile	Eriocaulaceae

Table 4 : Some endangered animal species in Wetlands

Species	Common name	Wetland
1. *Cervus eldii eldii*	Manipur brow-antlered deer or Sangai	Kaibul lamjao National Park
2. *Dugong dugon*	Dugong	Gulf of Mannar Andaman & Nicobar Islands
3. *Cervus duvaucelii*	Swamp-deer or barasingha	Wetlands in terai Assam
4. *Prionailurus viverrinus*	Fishing cat	Swamps of Terai Himalayas, Sunderbans
5. *Platanisia gangetica*	Gangetic dolphin	Ganges, Chambal and Brahmaputra rivers
6. *Rhinoceros unicornis*	Indian one-horned rhinoceros	Kaziranga National Park, Manas
7. *Bubalus bubalis*	Water buffalo	Kaziranga National Park
8. *Panthera tigris*	Bengal tiger	Sunderban National Park
9. *Anser indicus*	Bar-headed goose	Wetlands of Ladakh
10. *Grus leucogeranus*	Siberian crane	Keroladeo Ghana National Park
11. *Houbaropsis bengalensis*	Bengal florican	Wetlands of
12. *Francolinus gularis*	Swamp Partridge	Manas National Park
13. *Ceryle lugubris*	Crested Kingfisher	
14. *Leptoptilos dubius*	Greater adjutant stork	
15. *Leptoptilos javanicus*	Lesser adjutant stork	
16. *Ardea insignis*	White-bellied heron	Rivers of Assam and Arunachal Pradesh
17. *Phoeniconaias minor*	Asian lesser flemingo	Rann of Kutch, Sundarbans
18. *Cairina scutulata*	While-winged wood duck	Assam & Arunachal Pradesh
19. *Megapodius nicobarensis*	Megapode	Nicobar Islands
20. *Anas gibberifrons albogularis*	Andaman grey teal	Andaman Islands
21. *Crocodylus palustris*	Marsh crocodile or Mugger	Hiran lake in Gir National Park
22. *Gavialis gangeticus*	Gharial	National Chambal Wildlife sanctuary
23. *Crocodylus porosus*	Estuarine crocodile	Bhitarkanika Wildlife Sanctuary
24. *Lepidochelys olivacea*	Olive ridley turtle	
25. *Dermochelys coriacea*	Leatherback Turtle	Andaman & Nicobar Islands
26. *Eretmochelys imbricata*	Hawksbill Turtle	

Wetlands are a highly productive ecosystem which serve as habitat for a variety of plants and animals. Wetlands perform essential functions including flood control, natural sewage treatment, stabilisation of shorelines against wave erosion, recharging of aquifers and supporting rich biodiversity. Many wetlands serve as the winter habitats for migratory birds.

Many of the wetland areas have been drained and reclaimed for agricultural and urban expansion. Siltation is a problem particularly in shallow lakes such as Chilka in Orissa and Kolleru in Andhra Pradesh. Some other wetlands, such as Srinagar's Dal Lake, are threatened by eutrophication. Wetlands are also subjected to the stresses such as agriculture runoffs, pesticides, construction of dams and barrages.

The Convention on Wetlands of International Importance, especially as Waterfowl Habitat, better known as the Ramsar Convention after the name of the place where it was adopted in 1971, is an international treaty which provides the framework for conservation of wetland habitats. Under this Convention, the Parties are required to interalia designate wetland sites for inclusion in a 'List of Wetlands of international significance' or commonly known as Ramsar sites. India acceded to the Convention in 1981. Six wetland sites have so far been designated as Ramsar sites. These are : Chilka lake in Orissa, Keoladeo Ghana National park in Rajasthan, Wular Lake in Jammu & Kashmir, Harike lake in Punjab, Loktak lake in Manipur and Sambhar lake in Rajasthan.

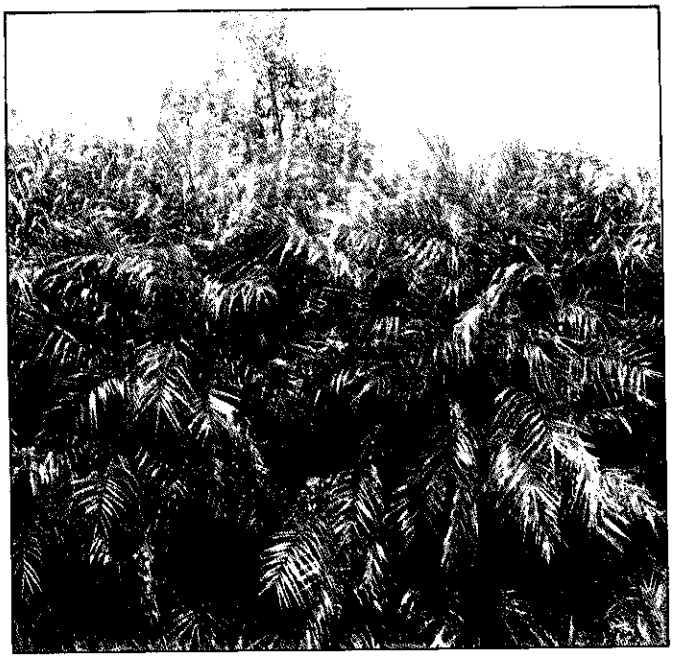
3.1.4 Coastal and Marine Ecosystem

The coastline of India including those of Andaman & Nicobar Islands and Lakshadweep islands extend over 7500 km. The marine ecosystem in India covers 2.1 million sq. km. area. The marine biodiversity specially from the deep sea region remains little explored. However, the available data on marine faunal biodiversity reveals that it represents more than 15% of the total fauna of the country. It is also noteworthy that 13 groups of animals are purely marine.

3.1.4.1 Mangroves

Mangroves are salt-tolerant ecosystems in tropical and subtropical regions. These ecosystems are largely characterised by assemblage of unrelated tree genera that share the common ability to grow in saline tidal zones. The evergreen broad leaved trees of mangrove forests are highly adapted to the stresses of flooding and salinity. The mangrove species adapt to their stressful environment through : (i) elaborate tube-like breathing structures called pneumatophores which grow vertically upwards from the roots, (ii) specialised root cell membrane that reduces the entry of salts and (iii) viviparous seedlings where the seed germinates on the parent plant itself thereby decreasing their morality in this unfavourable environment.

India harbours some of the best mangrove swamps in the world, located in the alluvial deltas of Ganga, Mahanadi, Godavari, Krishna and Cauvery rivers, and on the Andaman & Nicobar group of Islands. The total area covered by mangroves in India is estimated at about 6700 sq.



km. amounting to about 7% of the world's mangroves.

The largest stretch of mangroves in the country lies in the Sunderbans in West Bengal covering an area of about 4200 sq. km. The predominant mangrove species are *Avicennia officinalis, Excoecaria agallocha, Heritiera fomes, Bruguiera parviflora, Ceriops decandra, Rhizophora mucronata* and *Xylocarpus granatum*. Mangroves also harbour a number of molluscs, polychaetes and honeybees.

The Andaman & Nicobar group of Islands account for about 1200 sq. km. of mangroves with a preponderance of woody species. The dominant mangrove species are : *Rhizophora mucronata, R. stylosa, Bruguiera gymnorrhiza, Avicennia marina, Ceriops tagal, Nypa fruticans, Phoenix paludosa* and the brackish water marsh fern *Acrostichum aureum*, usually associated with *Acanthus ilicifolius*.

Small patches of mangroves are found on the west coast in the states of Gujarat, Maharashtra, Goa, Karnataka and Kerala. The main species found are *Avicennia marina, A. officinalis, Ceriops tagal, Salvadora persica, Rhizophora mucronata, Sonneratia alba, Kandelia candel, Acanthus ilicifolius* and *Heritiera littoralis*.

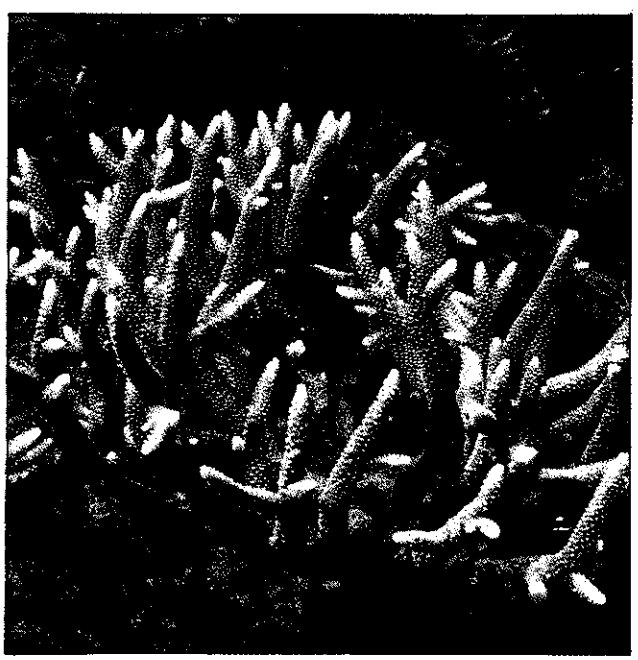
Mangroves also occur in the states of Orissa, Andhra Pradesh and Tamil Nadu on the eastern coast. The dominant species in this region include : *Bruguiera cylindrica, B. parviflora, Heretiera fomes, Rhizophora mucronata, Phoenix paludosa, Avicennia officinalis, A. marina* and *Ceriops tagal*.

Mangroves constitute an important economic resource providing fodder, fuelwood, tanbarks, edible fish, hides, honey, wax, various chemicals and medicines which are important sources of livelihood for people. Mangroves play an important role in stabilising shorelines, and protecting these from cyclones. Mangroves also harbour a variety of plants and animals including rare and endangered ones. Because of the value of their wood, many mangrove areas have been felled. Some areas have been drained and logged completely for reclamation of land, particularly in Mumbai and Cochin. Over-exploitation of fisheries, turtles, crocodiles and other fauna also has adverse impact on mangrove biota.

Increase in sewage and industrial effluents has deleterious impact on the biodiversity harboured by mangroves. Aquaculture with its high inputs of organic matter, fish feed etc. accelerates eutrophication of mangrove areas.

3.1.4.2 Coral reefs

Coral reefs are shallow-water tropical marine ecosystems which are characterised by a remarkably high biomass production due to upwelling of water. These are areas of high biodiversity on account of rich availability of nutrients. Large variety of fauna specially corals and coral reef fishes occur in these ecosystems.



Coral reefs are restricted to the seas between the latitudes of 30°N and 30°S, and are formed by the calcareous skeletons of stony coral polyps. They house the corals that are soft-bodied and radially symmetrical marine invertebrates belonging to the phylum Cnidaria. Individuals of a colony are called polyps. Millions of coral skeletons cemented together over a period ranging from a few thousand to millions of years form such reefs. These reefs can reach great depths and run continuously for hundreds of kilometers.

Coral reefs are divided into three major types :

- Fringing reefs which are the most common type, project seawards directly from the shore. They surround islands and continental land masses.
- Barrier reefs, though similar to fringing reefs, are separated from the landmass by a shallow lagoon.
- Atolls, which are most common in the Indo-Pacific region, rest on the summits of submerged volcanoes. They are usually oval or circular with a central lagoon.

In India, coral reefs occur in Andaman and Nicobar Islands, Lakshadweep Islands, Gulf of Kutch and Gulf of Mannar.

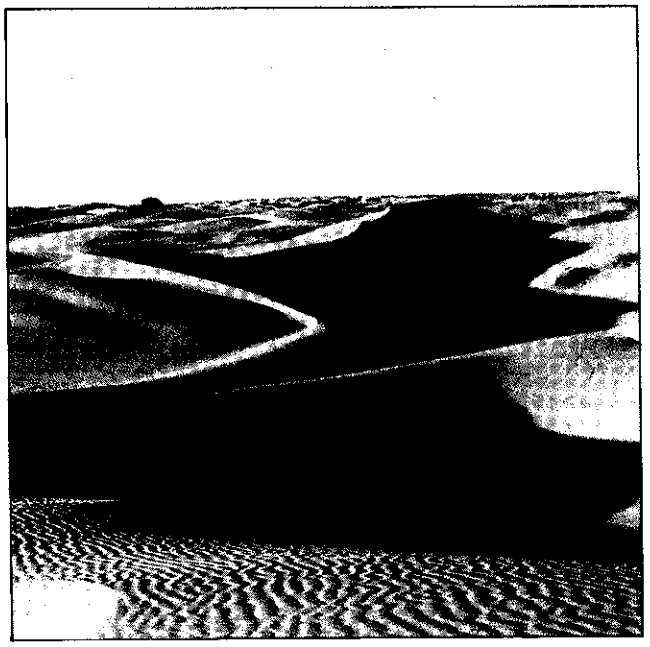
Coral reefs are the most productive marine ecosystems. They are also extremely sensitive and susceptible to environmental stress. Coral reefs have been subjected to stresses because of increase in industrialisation in coastal areas, offshore mining, dredging, construction, shell and coral collection and oil transport. The more serious threat however comes from quarrying of corals — the indiscriminate and excessive exploitation of corals and coral debris for cement industry.

3.1.5 Desert Ecosystems

Desert ecosystem is characterised by low precipitation, arid lands, with expanse of sands, rock or salt, which are largely barren except for sparse or seasonal vegetal cover. Species in this habitat are adapted to an extremely harsh, water-scarce environment.

Covering 2% of the landmass, deserts in India are classified into three distinct types:

- the sandy Thar desert of western Rajasthan and adjoining areas of other States
- the vast salt desert of Kutch in Gujarat
- the high altitude cold desert of Jammu & Kashmir and Himachal Pradesh.



The sandy Thar desert in India covers about 2,78,330 sq. km. of which 1,96,150 sq. km. is in Rajasthan, 62,180 sq. km. in Gujarat and 20,000 sq km. in Punjab and Haryana. This desert is characterised by various landforms composing shifting and fixed sand dunes, interdunal lands, rocky outcrops, flatlands and occasional clumps of trees. The sparse seasonal vegetatioin is mainly of the thorn forest type, with species like *Prosopis cineraria, Capparis decidua, Zizyphus nummularia, Acacia nilotica, Calotropis procera. Prosopis juliflora*, an exotic, is now well established in this region. Major faunal species found in these areas include desert fox, desert cat, Houbora bustard, chinkara, blackbuck, wolf and Great Indian bustard.

The salt desert of the Rann of Kutch is distinguished from the Thar by its exceptional salinity, caused by seasonal ingression of sea. The Rann meaning salt desert in local language, is spread over 9,000 sq. km. extending from 22^0 - 25^0N and 68^0 - 73^0E. It is characterised by a typical salt-marsh salt-bush plant community of halophytes and is the only nesting ground of Asian lesser flamingo in India. This is the only habitat of the rare Asiatic wild ass, *Equus hemionus* Rhur. Other animals found here include banded gecko, bullfrog, crow pheasant, little brown dove, hedgehog, bush rat etc.

Extending over the north of the Himalayan ranges, the cold desert characterised by extremely low temperatures going down below -45°C and low rainfall ranging from 500-800 mm annually, forms a plateau that extends from 4500 to 6000 m altitude in Western Himalayas. The cold deserts cover an area of 1,09,990 sq. km., of which 87,780 sq. km. lies in Ladakh region of Jammu & Kashmir and 22,210 sq. km. in Lahul-Spiti of Himachal Pradesh. Throughout this region, the precipitation is mostly in the form of snow. Floral and faunal diversity of these areas has been surveyed only recently. The vegetation, which is a sparse alpine steppe, has mostly herbaceous or shrubby species. Some of the most common species are *Salix daphnoides, Myricaria elegans, Cicer micorphyllum, Polygonum affine, Potentilla bifurca, and Pedicularis siphonantha.* A common adaptation of plants here to protect themselves from cold dry winds is the cushion habit, that is the plant species do not grow tall and assume stunted growth to avoid frost bite. The high altitude insect life exhibits very high endemism. The area has one of the richest wild sheep and goat community in the world, with eight distinct species and sub-species. Also found here are snow leopard, yak, urial, bharal commonly known as blue sheep, ibex commonly known as wild goat, and Keong commonly known as Tibetan wild ass.

3.2 SPECIES DIVERSITY

Biogeographically, India is situated at the trijunction of three realms namely Afro-tropical, Indo-Malayan and Paleo-Arctic realms, and therefore has characteristic elements from each of them. This assemblage of three distinct realms makes the country rich and unique in biological diversity. Based on the available data, India ranks tenth in the world and fourth in Asia in plant diversity, and ranks tenth in the number of mammalian species and eleventh in the number of endemic species of higher vertebrates in the world.

3.2.1 Status of Surveys

At present, 1.7 million species have been recorded so far in the world (Global Biodiversity Assessment, 1995). India's contribution to this record stands at 7%. Surveys conducted so far have inventorised over 47,000 species of plants and over 89,000 species of animals. As of now, only 70% of the area has been surveyed. It is estimated that the flora and fauna already identified are only part of what actually occur in India. The list is being constantly added to, especially in the case of lower plants and invertebrate animals. Survey and inventorisation of India's biodiversity is still far from complete especially the lower groups of plants and invertebrate animals.

3.2.1.1 Flora

As noted earlier, 47,000 species of flowering and non-flowering plants representing about 12% of the recorded world's flora have already been identified. Significant diversity has been recorded in Pteridophytes with 1022 species and Orchidaceae with 1082 species. Comparative statement of recorded number of plant species in India and the world is given in Table 5.

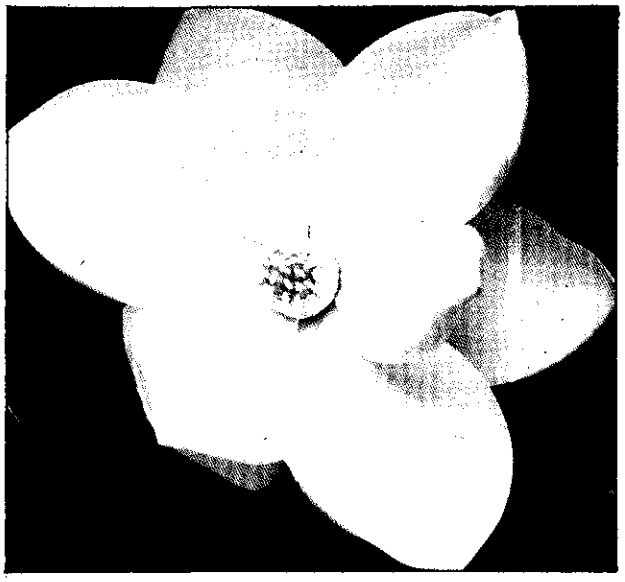


Table 5 : Comparative statement of recorded number of plant species in India and the world.

Taxa	Species		Percentage of India to the world
	India	World	
Bacteria	850	4,000	21.25
Viruses	unknown	4,000	-
Algae	6,500	40,000	16.25
Fungi	14,500	72,000	20.14
Lichens	2,000	17,000	11.80
Bryophyta	2,850	16,000	17.80
Pteridophyta	1,100	13,000	8.46
Gymnosperms	64	750	8.53
Angiosperms	17,500	250,000	7.00

3.2.1.2 Fauna

A total of 89,451 animal species have been recorded in India which represents 7.28% of the faunal species recorded in the world. Of these, the vast majority are insects with over 59,000 species. The vertebrate fauna, is also diverse and varied. A comparative statement of recorded number of animal species in India and the world is given in Table 6.

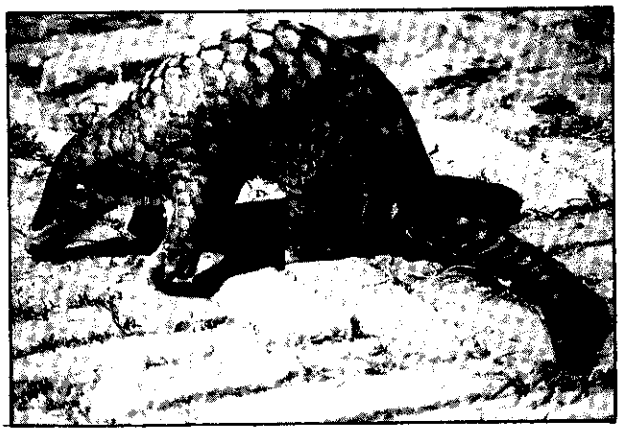


Table 6 : A comparative statement of recorded number of animal species in India and the World.

Taxa	Species		Percentage of India to the world
	India	World	
Protista	2,577	31,259	8.24
Mollusca	5,070	66,535	7.62
Arthropoda (Insecta, Crustacea etc.)	68,380	9,87,949	6.90
Other Invertebrates	8,329	87,121	9.56
Protochordata	119	2,106	5.65
Pisces	2,546	21,723	11.72
Amphibia	209	5,150	4.06
Reptilia	456	5,817	7.84
Aves	1,232	9,026	13.66
Mammalia	390	4,629	8.42

3.2.2 Endemic Species

Endemism of Indian biodiversity is significant. About 4,900 species of flowering plants or 33% of the recorded flora are endemic to the country. These are distributed over 141 genera belonging to 47 families. These are concentrated in the floristically rich areas of North-East India, the Western Ghats, North-West Himalaya and the Andaman & Nicobar Islands.

The Western Ghats and the Eastern Himalaya are reported to have 1,600 and 3,500 endemic species of flowering plants, respectively. These areas constitute two of the 18 hot spots identified in the world. It is estimated that 62% of the known amphibian species are endemic to India of which a majority occur in Western Ghats. Nearly 50% of the lizards found in India are endemic, with a large number being found also in Western Ghats. The distribution of endemic animals and plants in respective groups are tabulated in Tables 7 and 8.

3.2.3 Cultivated Plants

India is an acknowledged centre of crop diversity. It is considered to be the homeland of 167 important cultivated plant species and 320 species of their wild relatives. India is considered to be the centre of origin of 30,000-50,000 varieties of rice, pigeonpea, mango, turmeric, ginger, pepper, banana, bitter gourd, okra, coconut, cardamom, jack fruit, sugarcane, bamboo, taro, indigo, sunhemp, amaranths, gooseberries etc. The gene bank of National Bureau of Plant Genetic Resources (NBPGR) has a collection of over 1,59,080 varieties. The details of the active germplasm holdings and base collections of NBPGR are given in Table 9.

Table 7 : Endemic species of animals

Group	No. of species
Mollusca	
Land	878
Freshwater	89
Insects	16,214
Amphibia	110
Reptilia	214
Aves	69
Mammalia	38

Table 8 : Endemic species of plants

Group	No. of species
Pteridophyta	200
Angiosperms	4950

Table 9 : Active Germplasm Holdings and Base Collections at NBPGR.			
	Crop Groups	Active germplasm	Base collections holdings
1.	Cereals	12,086	43,409
2.	Pulses	38,695	22,269
3.	Millets & minor millets	10,349	14,488
4.	Oilseeds	19,808	14,278
5.	Vegetables	12,146	5,681
6.	Medicinal & aromatic plants	870	942
7.	Pseudocereals	4,739	736
8.	Tuber Crops/Spices	2,053	-
9.	Forage Crops	4,060	-
10.	Horticultural/Ornamentals	2,2212	-
11.	Fibre Crops	-	3,212
12.	Released crop varieties	-	904
13.	Reference samples (Medium Term)	-	53,161
	Total	1,07,018	1,59,080

3.3 GENETIC DIVERSITY

Genetic diversity is defined as variation in the genetic composition of individuals within or among species. India being one of the 12 megabiodiversity countries possesses rich genetic diversity. Studies in genetic diversity are not as yet very widespread and sharply focussed. However, studies in genetic diversity of wild crop relatives and domesticated animals have been carried out.

3.3.1 Wild relatives of crops

There are several hundred species of wild crop relatives distributed all over the country. A major centre for wild rice is the Eastern Peninsular India, i.e. West Bengal, Orissa and Andhra Pradesh. the North-Eastern hills and the Tamil Nadu hills are rich in wild relatives of millets. Wild relatives of wheat and barley have been located in the Western and North-Eastern Himalaya. Table 10 gives the statement of wild relatives of crops recorded so far.

Table 10 : Wild relatives of crops	
Crop	No. of wild relatives
Millets	51
Fruits	104
Spices and condiments	27
Vegetables and pulses	55
Fibre crops	24
Oil seeds, tea, coffee, tobacco and sugarcane	12
Medicinal plants	3000

3.3.2 Breeds of Domesticated Animals

India's domesticated animals comprise diverse livestock, poultry and other animal breeds. India's eight breeds of buffaloes represent the entire range of the genetic of the genetic diversity of buffaloes in the world. Table 11 gives the statement of breeds of domesticated animals.

Table 11 : Breeds of domesticated animals

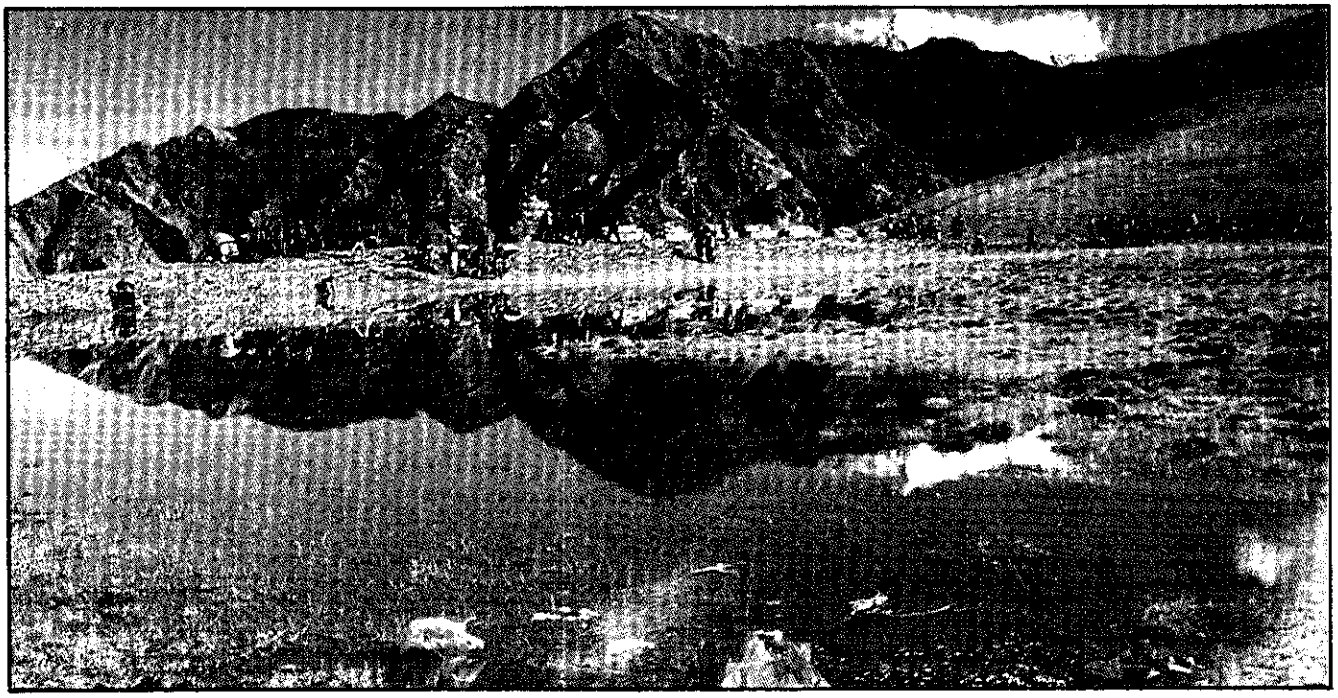
Group	No.
Cattle	27
Sheep	40
Goats	22
Camels	8
Horses	6
Donkeys	2
Poultry	18
Buffalo	8

3.4 THREATS TO BIODIVERSITY

The biodiversity in India's forests, grasslands, wetlands and mountains, deserts and marine ecosystems takes many pressures. One of the major causes for the loss of biological diversity in India has been the depletion of vegetative cover in order to expand agriculture. Since most of the biodiversity rich forests also contain the maximum mineral wealth, and are also the best sites for water impoundment, mining and development projects in such areas have often led to destruction of habitats. Poaching and illegal trade of wildlife products too have adversely affected biological diversity.

3.4.1 Threats to Ecosystem

Mountain ecosystems take the major negative impact of unplanned development, opening of roads, degradition of catchment areas and resultant landslides and erosion. Mountain ecosystems in Himalaya, Western Ghats and Eastern Ghats have been considered as fragile and have attracted special attention. Of the 6,33,970 million hectares of forests existing in 1997 (19.27% of India's geographical area), only a little more than half had dense forest cover with crown density of over 40%. Though the exact extent of loss of forest cover is difficult to assess, the major threats faced by the forest ecosystems in India are : commercial clear felling and selective clear felling; conversion for agriculture, settlements, roads; inundation for development projects like multipurpose river valley projects; shifting cultivation; conversion to



monoculture; army operations; grazing; mining; firewood collection; introduction of exotics; fire and pollution.

Grasslands are one of the most threatened ecosystems in India. Apart from commercial pressures, they come under pressure from grazing, fire, pollution, development projects, conversion for agriculture, tree plantations, and introduction and spread of exotics.

The lakes, marshes, river systems and other wetlands in the country are threatened mainly by domestic pollution from untreated sewage, industrial pollutants and toxic effluents, agricultural run-offs containing residues of pesticides and chemical fertiliser, and excessive siltation from degraded catchments. Excessive withdrawal of water from the water bodies for industry, irrigation or domestic use, dredging and reclamation of water bodies, excessive fishing, building of dams. jetties and canals are other factors adversely affecting the Indian wetlands. A number of wetlands are reported to be seriously threatened. These include : Wular, Dal, Harike, Chilka, Loktak and Kolleru lakes, Gulf of Khambat, estuaries of Karnataka coast, backwaters of Cochin and wetlands in the Andaman & Nicobar islands.

Mangroves of the country are subjected to serious threats due to their reclamation for urban development, e.g., near Mumbai, Cochin, and Port Blair, waste disposals, oil spillage etc.

Coral reef ecosystems are threatened because of mining, blasting, dredging, collection of reef biota, coastal clearance for development, sewage disposal, discharge of effluents from industries and thermal power plants, chemical pollution and oil spillage.

The sand desert of Western India, being one of the most densely populated of the world's deserts with a high livestock population faces heavy biotic pressure. Besides, expansion of mining, urbanisation and industrialisation also pose threat to this ecosystem. The salt desert of Gujarat is not thickly populated because it is inhospitable. However, the expanding salt extraction has resulted in widespread disturbance.

In the Indian cold desert, a major destructive factor is road construction which in turn leads to landslides and soil erosion. Other threats are overgrazing and excessive collection of fuelwood.

Desertification and land degradation *per se* pose potential threat to biodiversity.

3.4.2 Threats to species and genetic diversity

The major factors threatening the species and genetic diversity found in India are similar to those elsewhere in the world. Threats to species and genetic diversity are directly linked to threats to the ecosystem. In addition, habitat destruction, over exploitation, poisoning by pollutants, introduction of exotics, imbalances in community structure, epidemics, floods, droughts and cyclones affect species and genetic diversity. The diversity of indigenous varieties of livestock, crops and other cultivated plants face many threats from introduction of exotic and high-yielding hybrid varieties.

In this century itself, the Indian cheetah, Lesser Indian rhino, the Pink-headed duck, the Forest owlet and the Himalayan mountain quail are reported to have become extinct. 39 species of mammals, 72 birds, 17 reptiles, 3 amphibians, 2 fish and a large number of butterflies, moths and beetles, besides 1,336 plant species are considered vulnerable and

endangered. About 20 species of higher plants are categorised as "possibly extinct", as these species have not been sighted during the last 6-10 decades.

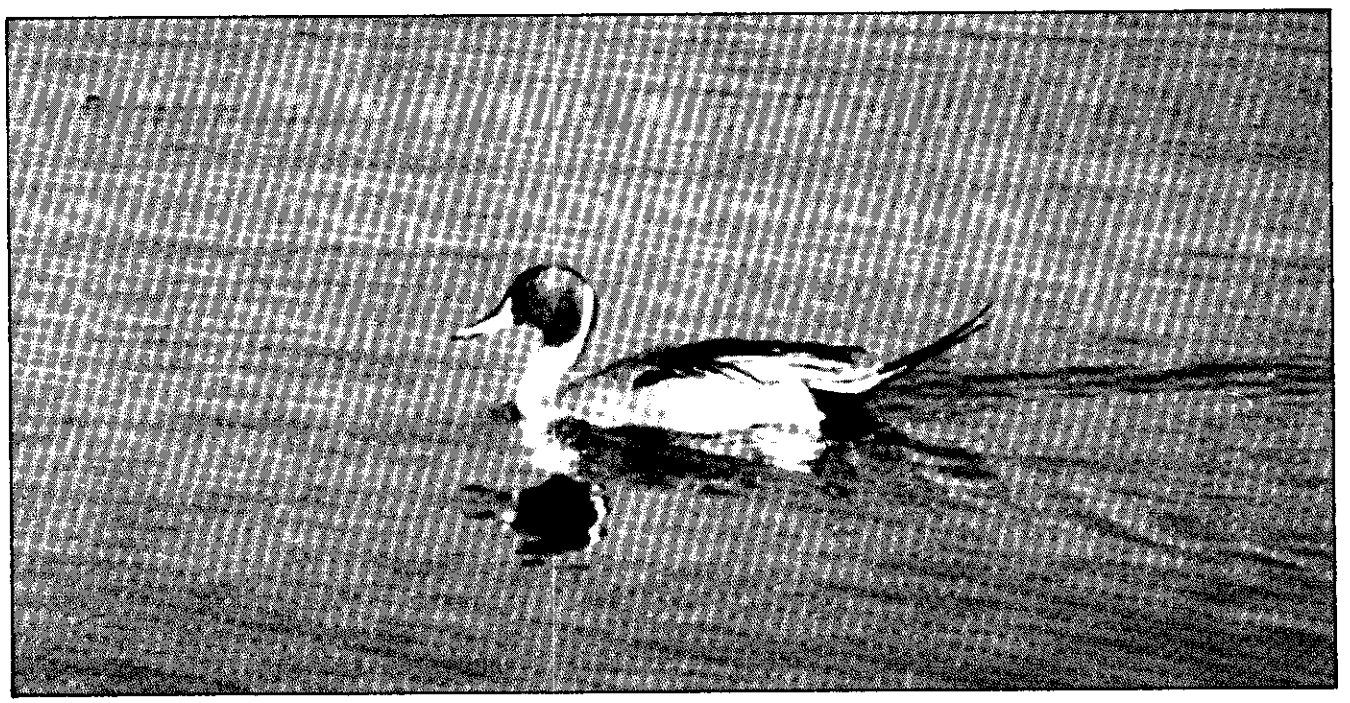
CHAPTER 4

Article 48-A and Article 51-A(G) of the Directive Principles of State Policy in the Constitution of India state that 'the State shall endeavour to protect and improve the environment and to safeguard the forests and wildlife in the country', and 'to protect and improve the national environment including forests, lakes, rivers and wildlife, and to have compassion for the living creatures'. A focussed articulation of these concerns in programmes and policies began to be seen in the wake of 1972 Stockholm Conference which got further sharpened after 1992 Rio conference. Between the Stockholm Conference and the Rio Summit, India has been able to develop a stable organisational structure for environment protection in the country. Legislation, policies and programmes were evolved during this period which were geared towards this objective. Numerous and wide ranging policies, programmes and projects were initiated which directly or indirectly serve to protect, conserve and sustainably use the country's biological resources. Some of such actions emanating from the Articles of the Convention are enumerated in Box No. 3

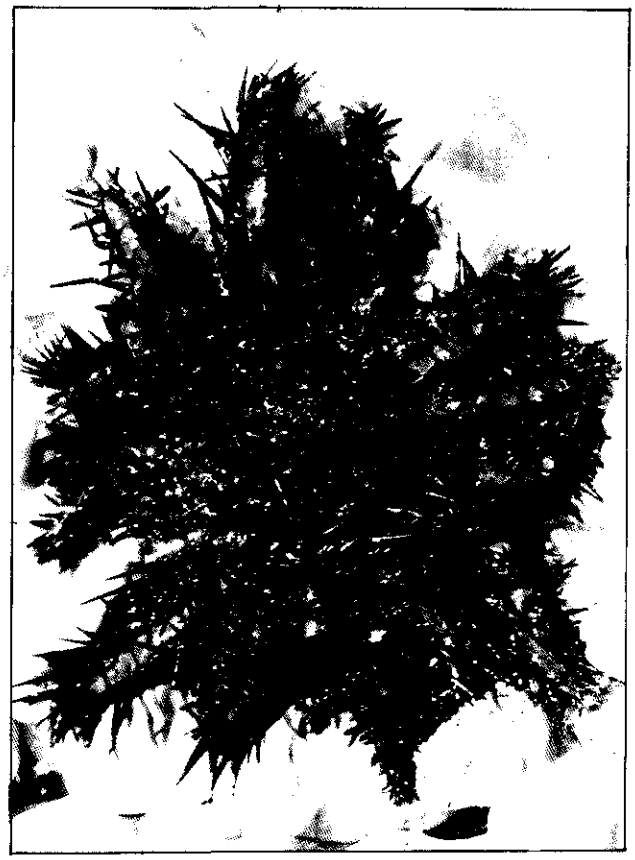
Box No. 3 Actions emanating from the Convention on Biological Diversity

Articles 1-5	Deal with objectives, use of terms, principle, scope and co operation.
Article 6	Preparation of country study/status report. Review of policy, legislation and institutional framework through widespread consultations, so as to ensure strengthening of ongoing activities of conservation and sustainable use and their integration with sectoral and cross-sectoral plans and programmes.
Article 7	Identification of gaps in survey, identification, monitoring and characterisation of floral and faunal resources presently being done, and accordingly strengthen these efforts.
	Build a comprehensive ecosystem specific data base.
Article 8	Examination of issues related to selection, establishment and management of protected area in order to identify the gaps *in situ* conservation and taking up of measures to plug these gaps.
	Expansion of ecodevelopment activities.
	In order to control the adverse impacts of introduction of alien species, the existing quarantine measures for screening of biomaterials entering the country to be reviewed and revised, if necessary.
	Harmonise present uses of other natural resources specially land and water to make them compatible with biodiversity conservation, through wideranging consultations at the Central and State levels.
	Need to respect, preserve and maintain knowledge, innovations and practices of indigenous and local communities and encourage the equitable sharing of benefits arising from the use of such knowledge, innovations and practices.
	Develop or maintain necessary legislation and other regulatory provisions for protection of threatened species.
	Intensification of *in situ* conservation measures through adequate financial support.
Article 9	Strengthen programmes for *ex situ* conservation especially of threatened species, through technical/ scientific and financial inputs.
Article 10	Interactions with agencies concerned to internalise the various action points for ensuring sustainable use of biological resources to ensure proper integration into national and state level decision making.
Article 11	Identify further incentives for conservation and sustainable use of biodiversity.
Article 12	Review and strengthen research and training and identifying thrust areas for the same.
Article 13	Review and strengthen ongoing activities for promoting education and awareness.

	Cooperate with other States, regional networks for development of educational and public awareness programmes.
Article 14	Ensure implementation of safeguards suggested in impact assessments for minimising threats to biodiversity.
Article 15	Facilitate access to genetic resources and ensure benefits to the country as the country of origin.
Article 16	Cooperate with other Parties to work out operational modalities for transfer of technologies.
	In accordance with the national legislation and international law, take measures to ensure that IPRs are supportive of the Convention.
Article 17	Cooperate with other Parties for exchange of information.
Article 18	Work out priorities for technical and scientific cooperation with other Parties.
Article 19	Ensure safe handling, use, storage and transfer of living modified organisms



In the following sections under different subject heads, the current conservation efforts, followed by identification of some significant gaps in the present efforts are described. Following from the lacunae identified are enumerated various action points. The action points are certainly not exhaustive and are intended to facilitate the process of conservation of biodiversity in the country. This is an iterative and dynamic process which will continue to evolve on its own with experience.



4.1 LEGISLATIVE AND POLICY FRAME WORK

4.1.1 Current Status

Subject relating to the environment and forests figure in the Concurrent List of the Constitution of India. Both the Central Government and the State Government legislate and formulate policies and programmes on the subject. At present, the major Central Acts having direct bearing on biodiversity issues are the following :

- the Indian Forest Act 1927
- the Forest (Conservation) Act 1980
- the Wildlife (Protection) Act 1972
- the Environment (Protection) Act 1986.

This legal framework has been able to control to some extent the growing trend of deforestation, pollution etc. For example, with the passage of the Forest Conservation Act 1980, the annual rate of diversion of forest land for non-forestry purposes has come down to 16,000 ha. annually as compared to 1,50,000 ha. in the pre-1980 period. In addition to these, there are several other Central Acts which have relevance to biodiversity. The important Acts are given in Box No. 4

Box 4 : Important Central Acts having relevance to biodiversity

- Fisheries Act, 1897.
- Destructive Insects and Pests Act, 1914.
- The Indian Forest Act, 1927.
- Indian Coffee Act, 1942
- Agricultural Produce (Grading and Marketing) Act, 1937.
- Import and Export (Control) Act, 1947.
- Rubber (Production and Marketing) Act, 1947.
- Tea Act, 1953.
- Prevention of Cruelty to Animals Act, 1960.
- Customs Act, 1962.
- Cardamon Act, 1965.
- Seeds Act, 1966.
- Wildlife (Protection) Act, 1972 and Wildlife (Protection) Amendment Act, 1991.
- Marine Products Export Development Authority Act, 1972.
- Water (Prevention and Control of Pollution) Act, 1974.
- Tobacco Board Act, 1975.
- Territorial Water, Continental Shelf, Exclusive Economic Zone and other Maritime Zones Act, 1976.
- Water (Prevention and Control of Pollution) Cess Act, 1977.
- Coconut Development Board Act, 1979.
- Maritime Zones of India (Regulation and Fishing by Foreign Vessels) Act. 1980.
- Forest (Conservation) Act, 1980.
- Air (Prevention and Control of Pollution) Act, 1981.
- National Oilseeds and Vegetable Oils Development Board, 1983.
- Agricultural and Processed Food Products Export Development Authority Act, 1985/ 1986.
- Environment (Protection) Act, 1986.
- Spices Board Act, 1986.
- National Dairy Development Board, 1987.
- New Seed Development Policy, 1988.
- Foreign Trade (Development and Regulation) Act, 1992.

The various Central Acts are supported by a number of State laws and statutes concerning forest and other natural resources.

The 73rd Amendment Act 1992 of the Constitution of India on Panchayats, which adds as Eleventh Schedule in the Contitution, has eight entries (viz. 2, 3, 6, 7, 11, 12, 15 and 29) which are linked to environmental protection and conservation.Similarly entry 8 of the 12th Schedule added to the Constitution by the 74th Amendment Act 1992 for constitution of Urban and local bodies assigns the function of 'Protection of environment and promotion of ecological effects' to these bodies.

India's Environmental Action Plan (EAP, 1993) identifies conservation and sustainable utilisation of biodiversity in selected ecosystems as one of the top seven priorities for future action. The National Conservation Strategy and Policy Statement on Environment and Sustainable Development (1992) outlines the cross sectoral policies and actions required to give greater attention to conservation of biodiversity. The National Forest Policy, as amended in 1988, stresses the sustainable use of forests, and the need for greater attention to ecologically fragile but biologically rich mountain and island ecosystems. The National Wildlife Action Plan (1973) identifies broad goals of establishing a network of representative protected areas developing appropriate management systems for them with due regard for the needs of local people or the ecosystems ensuring their support and involvement, and extending conservation effort beyond protected areas.

One of the major consideration in the environment impact assessment of development projects carried out by the Ministry of Environment & Forests is the protection of habitats and valuable ecosystems. The National Afforestation and Ecodevelopment Board of the Ministry undertakes large scale rehabilitation of degraded forest lands in the country.

India has ratified, and is a strong and active participant in the following International Conventions and agreements relevant to biodiver-sity: the Convention on International Trade in Wild Species of Endangered Fauna and Flora (CITES); the Ramsar Convention on Wetlands of International Importance especially as Water fowl Habitat; the World Heritage Convention; the Bonn Convention on Conservation of Migratory Species of Wild Animals; the FAO Commission on Plant Genetic Resources; and the UN Law of the Seas (UNCLOS).

4.1.2 Gaps

In general, the existing legal framework covers, though not fully, the various aspects related to wild components of biodiversity. However, the domesticated floral and faunal components are either not covered at all or are only partially covered through the existing legislation. Further, even for wild species, very few acts relate to their *ex situ* protection.

A glaring gap in the existing legislation relevant to biodiversity *vis-a-vis* the Convention is that most of these acts pertain mainly to use/exploitation of biological resources, than their conservation. Moreover, even specific acts such as the Wildlife (Protection) Act 1972 have focus on protection

rather than conservation. Even this protection is largely directed towards large animal species rather than the large spectrum of fauna and flora. Conservation includes not only protection, but also preservation, development, regeneration, propagation and sustainable use.

Based on the analysis of the existing legislation, a need for a comprehensive legislation on biodiversity conservation and use had been identified particularly to facilitate access to genetic resources while ensuring accrual of benefits to the country as the country of origin, ensuring due rewards and compensations to local communities and people for their contributions to conservation, knowledge systems, practices and innovations, to ensure suitable access to and acquisition of technologies including biotechnologies and to create a general positive environment for biodiversity conservation.

In addition, there is a need to criticially examine the existing laws relevant to biodiversity, in order

to bring them in tune with the provision of the Convention and to reflect the current understanding of biodiversity conservation.

Another major identified gap is the inadequate enforcement of existing laws.

Enunciation of basic principles of the policy relating to biodiversity has been done in Chapter 1.

4.1.3 Action Points

- Formulate a comprehensive legislation on biodiversity conservation and use, identify its elements, and enact the legislation
- Review and if need be revise regulations that govern the ownership, access and management of natural resources, in line with the provisions of the Convention.
- Consider enabling policies to prevent the transfer of prime agricultural land to non-agricultural purposes.
- Review the existing regulatory framework to ensure the safe handling, use, transfer and storage of genetically modified organisms.
- Formulate policies for protection of Wetlands, grasslands, sacred groves and other areas significant from the point of view of biodiversity.

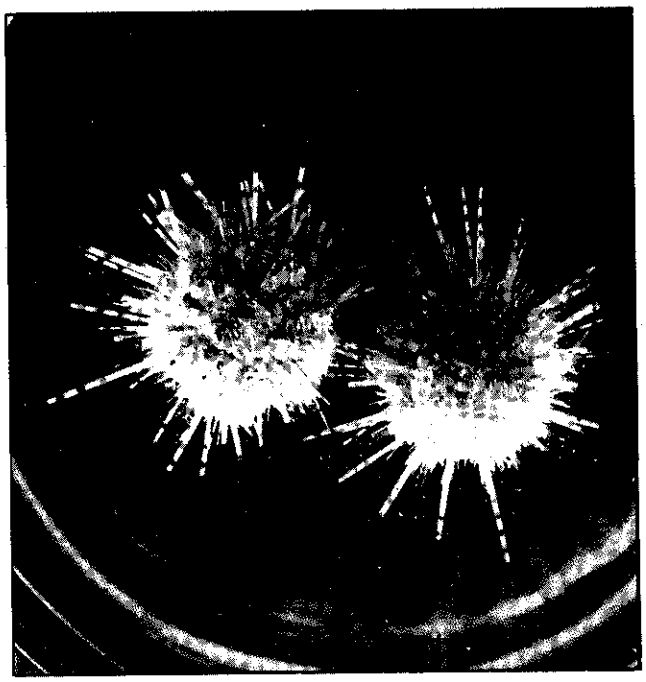
4.2 SURVEY OF BIODIVERSITY AND NATIONAL DATABASE

4.2.1 Current Status

Survey and inventorisation of the floral and faunal resources are carried out by the Botanical Survey of India established in 1890, and the Zoological Survey of India established in 1916. The Forest Survey of India established in 1981 assesses the forest cover, with a view to develop an accurate database for planning and monitoring purposes. The Wildlife Institute of India undertakes studies of endangered species of animals and critical ecosystems.

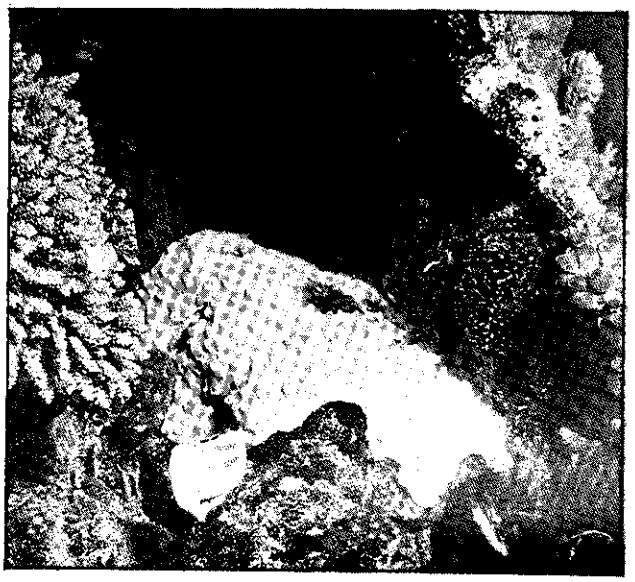
The Survey organisations have published over the years, documents on flora and fauna at country, state, and in some cases district levels and for selected ecosystems. Besides, extensive reports on inventories of resources indicating level of biodiversity in selected areas have also been brought out. The Surveys have also published Red Data Books on endangered species. The voucher specimens are preserved in Central National Herbarium (CNH) of BSI and National Zoological Collection (NZC) of ZSI.

The Forest Survey of India publishes every three years, a State of Forest in India report based on remote sensing and ground truth data.



The Fishery Survey of India is engaged in estimating and monitoring commercially exploitable coastal and marine fish species.

The survey and collection of genetic meterial from wild races and cultivars is vested with National Bureau of Plant Genetic Resources (NBPGR), an institute of Indian Council of Agricultural Research (ICAR).

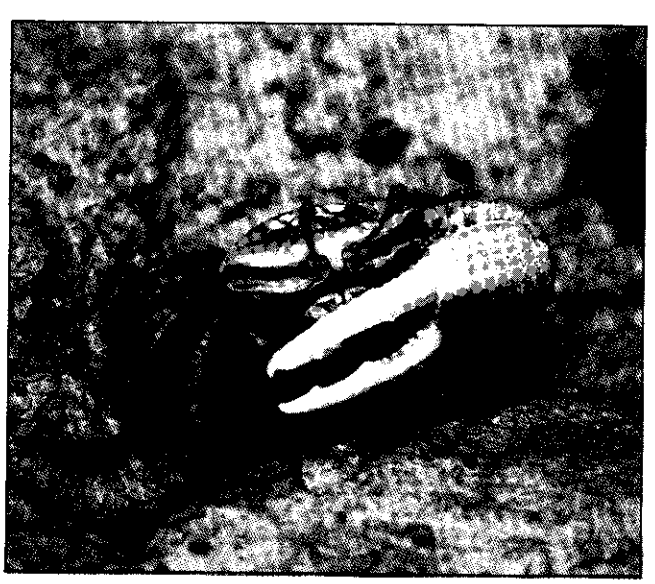


Monitoring of coastal and marine biodiversity is being done by organisations such as National Institute of Oceanography (NIO) and Central Marine Fisheries Research Institute (CMFRI). Other organisations such as Bombay Nutural History Society (BNHS), Salim Ali Centre for Ornithology and Natural History (SACON), Universities and other centres are producing information on biodiversity from time to time.

4.2.2 Gaps

The baseline data on species and genetic diversity, particularly intra-specific diversity, and their macro-and micro-habitats is inadequate. The BSI and the ZSI have been able to survey 70% of the total geographical area of the country. The areas not yet surveyed include the inaccessible Himalayan areas, Andaman and Nicobar Islands and Exclusive Economic Zone. These areas are supposedly rich repositories of endemic and other species and their survey may add species far more than the number recorded in rest of the 70% area. These areas need to be surveyed in order to develop a complete national database which would include listing of all species with their location, distribution, description, status, and their local uses, if any. For this purpose, the Survey organisations could network with other agencies, particularly universities and colleges, with a positive support from national funding agencies in terms of policy planning and funding.

In order to understand and monitor the trends in the changes in biodiversity over a period of time, there is a need to periodically repeat the surveys in the areas already surveyed. This would help in understanding the causes behind depletion of populations and thereby suggesting remedial measures. This would also enable in forecasting of changes in habitats, and their likely impact on



composition of flora and fauna. Surveys are also advocated keeping in view the fact that varieties with high landrace or wild relative contents have largely contributed to higher yields and therefore the option of strategic incorporation of more landraces in breeding programmes should not be lost. For many domesticated animals, the breed-wise census data is not available.

Certain groups of invertebrates amongst the fauna, namely nematodes, mites, insects, some lower groups of plants such as algae, fungi, bryophytes and lichens, and microorganisms are some of the poorly understood taxa, which merit attention on a priority basis.

Since the conservation of the entire range of species is neither practical nor possible, the Survey organisations may identify the keystone and umbrella species. Conserving such species ensures protection of all related species as well. Similarly, there is a need to develop models/packages for the conservation of endemic species. The process of preparation of red data books on endangered species of flora and fauna needs to be speeded up, and validated using the internationally recognised revised guidelines.

There is no uniformity in collection techniques storing, retrieving and dissemination of information, Another gap area which needs to be addressed is the decline in taxonomic expertise. Moreover, taxonomists are largely working in isolation, and hence networking among taxonomists is required.

4.2.3 Action Points

- Develop a national database of biodiversity with distributed information network.
- Review and restructure data formats.
- Intensification of survey, identification and inventorisation activities; involve other agencies, particularly universities and college in survey of flora and fauna.
- Undertake surveys on a priority basis, of islands, Himalayan region, marine and coastal areas.
- Undertake surveys of land races traditional cultivars of crops, wild relatives of crop plants and breeds of domesticated animals.
- Repeat the surveys periodically including in protected areas to monitor changes in populations and to identify threats, through remote sensing and other techniques.
- Develop dichotomous keys for type collections.
- Modernisation and strengthening of existing Survey and other organisations.
- Use modern taxonomic methods for describing/ identification of species.
- Prepare a directory of taxonomists in the country,
- Strengthen and build capacity for taxonomy and biosystematics, particularly for groups of plants, animals and microorganisms which are as yet inadequately understood.
- Study existing systems of documenting traditional knowledge, innovations and practices and create a viable documentation system.
- Complete the enlisting of endangered species of flora and fauna on priority using the revised internationally accepted criteria and to regularly update the lists.
- Identify keystone, umbrella and endemic species which need to be conserved on a priority basis, and develop models/packages for their conservation.
- Undertake the listing of sacred groves, sacred ponds etc and inventorise the components of biodiversity in these areas.

- Establish a national resources centre for D N A finger-printing.

4.3 *IN SITU* CONSERVATION

4.3.1 Current status

Approximately 4.2% of the total geographical area of the country has been earmarked for extensive *in situ* conservation of habitats and ecosystems. A protected area network of 85 National Parks and 448 Wildlife Sanctuaries has been created. The results of this network have been significant in restoring viable populations of large mammals such as tiger, lion, rhinoceros, crocodiles, elephants etc. Table 12 gives the state-wise details of these protected areas.

The Indian Council of Forestry Research and Education (ICFRE) has identified 309 forest preservation plots of representative forest types for conservation of viable and representative areas of biodiversity. 187 of these plots are in natural forests and 112 in plantations, covering a total area of 8,500 hectares.

A programme entitled "Ecodevelopment" for *in situ* conservation of biological diversity involving local communities has been initiated in recent years. The concept of ecodevelopment integrates the ecological and economic parameters for sustained conservation of ecosystems by involving the local communities with the maintenance of earmarked regions surrounding protected areas. The economic needs of the local communities are taken care of under this programme through provision of alternative sources of income and a steady availability of forest and related produce.

To conserve the representative ecosystems, a Biosphere Reserve programme is being implemented. Ten biodiversity rich areas of the country have been designated as Biosphere Reserves applying the UNESCO/MAB criteria. Details on these Biosphere Reserves are tabulated in Table 13. These reserves aim at conserving the biological diversity and genetic integrity of plants, animals and microorganisms in their totality as part of the natural ecosystems, so as to ensure their self-perpetuation and unhindered evolution of the living resources.

Programmes have also been launched for scientific management and wise use of fragile ecosystems. Specific programmes for management and conservation of wetlands, mangroves, and coral reef systems are also being implemented. National and sub-national level committees oversee and guide these programmes to ensure strong policy and strategic support.

Table 12 : Wildlife Sanctuaries and National Parks

State/Union Territory	Sanctuaries		National parks	
	Total No.	Area (sq. km.)	Total No.	Area (sq.km.)
Andaman & Nicobar Islands	94	455.56	8	1153.34
Andhra Pradesh	21	11832.54	4	372.23
Arunachal Pradesh	9	6177.45	2	2468.23
Assam	8	990.58	2	930.00
Bihar	19	3881.75	2	567.32
Goa	4	355.78	1	107.00
Gujarat	21	16970.16	4	479.67
Haryana	10	342.65	1	1.43
Himachal Pradesh	30	4702.87	2	1295.0
Jammu & Kashmir	15	10157.67	4	3900.07
Karnataka	20	4238.21	5	2471.98
Kerala	12	2143.36	3	536.52
Madhya Pradesh	32	10567.05	11	6485.72
Maharashtra	25	13995.49	5	958.45
Manipur	1	184.85	2	81.00
Meghalaya	3	34.21	2	267.48
Mizoram	3	560.00	2	250.00
Nagaland	3	24.41	1	202.02
Orissa	18	6214.96	2	1212.70
Punjab	6	294.82	0	
Rajasthan	22	5662.87	4	3856.53
Sikkim	4	92.1	1	850.00
Tamil Nadu	17	2671.03	5	401.63
Tripura	4	603.62	0	
Uttar Pradesh	29	8107.52	7	5429.83
West Bengal	15	1055.55	5	1692.65
Daman & Diu	1	2.18		
Delhi	1	13.20		
Chandigarh	1	25.42		
Dadra & Nagar Haveli				
Lakshadweep				
Pondichery				
Total	448	112,357.86	85	36,171.60

Six internationally significant wetlands of India have been declared as "Ramsar Sites" under the Ramsar Convention. Additionally, eleven wetlands of national importance have been identified for intensive conservation and management, the details of these are given in Table 14. The number can be enlarged based on need assessment.

Table 13 : Biosphere Reserves

Biogeographic Region	Name of the Biosphere Reserve & State/Union Territory	Area in sq. km.	Date of set up
Western Himalaya	Nanda Devi (Uttar Pradesh)	2236.74	18.1.88
North East India	Nokrek (Meghalaya)	80.00	1.9.88
	Manas (Assam)	600.00	14.3.89
	Dibru Saikowa (Assam)	765.00	28.7.97
	Dehang Dibang (Arunachal Pradesh)		
Gangetic Plains	Sunderbans (West Bengal)	9630.00	29.3.89
Coastal	Gulf of Mannar (Tamil Nadu)	10500.00	18.2.89
Western Ghats	Nilgiri (Karnataka, Kerala & Tamil Nadu)	5520.00	1.8.86
Islands	Great Nicobar (Andaman & Nicobar Islands)	885.00	6.1.89
Deccan Peninsula	Similipal (Orissa)	2750.00	21.6.94

Table 14 : Wetlands of National and International Importance

Wetland	State	Area (in ha)
*Chilka	Orissa	114,000
*Harike	Punjab	4,100
*Keoladeo Ghana	Rajasthan	2,873
*Loktak	Manipur	27,600
*Sambhar	Rajasthan	7,200
*Wular	Jammu & Kashmir	18,900
Ashtamudi	Kerala	3,200
Bhoj	Madhya Pradesh	33,000
Kabar	Bihar	6,738
Kanji	Punjab	3,000
Kolleru	Andhra Pradesh	90,000
Nalsarovar	Gujarat	18,400
Pichola	Rajasthan	1,000
Renuka	Himachal Pradesh	670
Sasthamkotta	Kerala	375
Sukhana	Chandigarh	170
Ujni	Maharashtra	35,700

*Ramsar sites

Under the World Heritage Convention, five natural sites have been declared as "World Heritage Sites", the names of which are given in Box 5.

The Tura Range in Garo Hills of Meghalaya is a gene sanctuary for preserving the rich native diversity of wild Citrus and Musa species. Sanctuaries for rhododendrons and orchids have been established in Sikkim. Large mammal species targetted projects based on the perception of threat to them have been under implementation (Box 6).

Box 5 : World Heritage sites

Site	Location
Kaziranga National Park	Assam
Keoladeo Ghana National Park	Rajasthan
Manas Wildlife Sanctuary	Assam
Nanda Devi National Park	Uttar Pradesh
Sunderban National Park	West Bengal

Box 6 : Specific animal species conservation projects

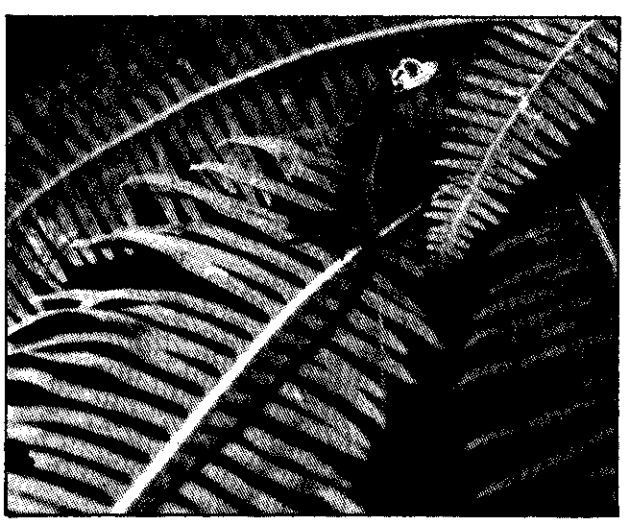
— Projects Hangul, 1970.
— Project Tiger, 1973.
— Manipur Brow-antlered Deer Conservation project, 1973.
— Crocodile Breeding Project, 1975.
— Project Elephant, 1991.

The Project Tiger, launched in 1973 has succeeded in stabilising and increasing the tiger population in the country.

The statement on 23 Tiger Reserves is tabulated in Table 15.

Table 15 : Tiger Reserves

Name	State	Area in Sq. km.
1. Bandipur	Karnataka	866.00
2. Corbett	Uttar Pradesh	1316.00
3. Kanha	Madhya Pradesh	1945.00
4. Manas	Assam	2840.00
5. Melghat	Maharashtra	1597.00
6. Palamau	Bihar	1026.00
7. Ranthambore	Rajasthan	1334.00
8. Simlipal	Orissa	2750.00
9. Sunderbans	West Bengal	2585.00
10. Periyar	Kerala	777.00
11. Sariska	Rajasthan	866.00
12. Buxa	West Bengal	759.00
13. Indiravati	Madhya Pradesh	2799.00
14. Nagarjunasagar	Andhra Pradesh	3568.00
15. Namdapha	Arunachal Pradesh	1985.00
16. Dudhwa	Uttar Pradesh	811.00
17. Kalakad Mundanthurai	Tamil Nadu	800.00
18. Valmiki	Bihar	840.00
19. Pench	Madhya Pradesh	758.00
20. Dampa	Mizoram	500.00
21. Panna	Madhya Pradesh	542.00
22. Bandhawgarh	Madhya Pradesh	1162.00
23. Taroba	Maharashtra	620.00
Total		33046.00



Project Elephant, launched in 1991-92 aims at ensuring long-term survival of viable population by restoring the lost and degraded habitats of elephant, mitigating man-elephant conflicts and establishment of a database on the migration and population dynamics of elephants. It integrates the concerns of improving the quality of life of people living around elephant habitats while maintaining viable population of elephants.

Rhinos have been given special attention in selected sanctuaries and national parks in the North-East and North-West India.

All these programmes, though focussed on a

single species, have a wider impact as they conserve habitats and a variety of other species in those habitats.

Several non-government organisations in the country are engaged in specific areas or target species based *in situ* conservation measures through external or national assistance or through a combination of assistance from both. An example is *in situ* conservation for medicinal plants by Foundation for Revitalisation of Local Health Traditions (FRLHT) in the southern states of the country. In addition, a large number of State Government organisations are engaged in developing strategies and undertaking *in-situ* conservation, for example, Tropical Botanic Garden and Research Institute (TBGRI) in Kerala.

4.3.2 Gaps

The current protected area network is unevenly distributed over States and biogeographic regions. For example, many biotic provinces are not adequately covered, Ladakh, South Deccan, Gangetic Plains, Assam hills, and Nicobar Islands have less than 1% of their total area under such protection, though these constitute some of the biodiversity rich areas of the country. The Wildlife Institute of India, based on a comprehensive review of the existing network argued for a need to identify new protected areas in different parts of the country. Many National Parks and Wildlife Sanctuaries are yet to complete legal procedures prescribed under the Wildlife (Protection) Act 1972 and in several areas, issues relating to settlement of rights are yet to be resolved. This impedes proper management of these areas, though steps are afoot to complete the process. Even the areas where legal measures have been completed, require consolidation and strengthening of efforts with a system of sharply focussed priorities. Formulation of management action plans needs to take these aspects into account. These projects are inadequate in essential equipment and professional staff and lack in maps and other requisite infrastructure base. Monitoring of activities and projects as a result is not upto the expectation.

As of now, attention in the protected areas is focussed on conservation of large mammals. Formally no attention is usually paid to conservation of plants in general and lower groups of plants and animals in particular. Very few protected areas undertake research activities, and where undertaken, such activities do not address the functional properties of ecosystems. Identification of indicator species which serve as early warning system of habitat changes is lacking. Consequently, there are gaps in information on several biological and managerial parameters.

In accordance with the present status of survey and data in the country, India has 26 centres of endemic species (Box 7). Barring three, all the other centres are not covered under any regulated measures. Only three centres fall within the protected areas.

Box 7 : Endemic centres of plants in India

1. Karakoram & Ladakh Kashmir Himalayas
2. Kumaon-Garhwal Himalayas
3. Siwaliks
4. Terai
5. Sikkim Himalaya
6. Arunachal Pradesh of Eastern Himalaya
7. Lushai hills
8. Tura-Khasi hills
9. Aravalli hills
10. Chotonagpur plateau
11. Panchmarhi-Satpura ranges
12. Simlipal & Jeypore hills
13. Baster & Korapur hills
14. Visakhapatnam hills & Araku Valley
15. Tirupati-Cuddappa hills
16. Marathwada hills
17. Saurashtra-Kutch
18. Mahabaleshwar-Khandala ranges of Western Ghats
19. Agumbe-Phonda ranges of Western Ghats
20. Ratnagiri & Kolaba ranges of Western Ghats
21. Nilgiris, Silent Valley & Wynad of Western Ghats
22. Anamalais of Western Ghats
23. Palni-Yercaud
24. Kalakad & Agastyamalai hills of Western Ghats
25. Andaman Islands
26. Great Nicobar Island

4.3.3 Action points

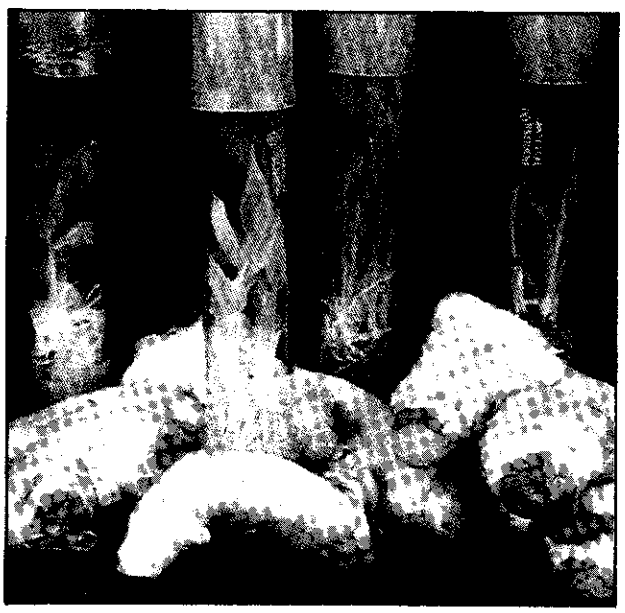
- Expand protected area network based on the recommendations of the Wildlife Institute of India, so as to cover all biogeographic zones of the country.
- Explore options for expanding/strengthening the network of protected areas through identification of buffer zones, corridors etc.

- Provide manpower, essential management tools, equipment, infrastructural facilities and requisite funds for ensuring effective management of protected areas.
- Expedite formulation of management plans for all protected areas based on survey of natural resources and socio-economic profiles in and around these areas.
- Develop and implement ecodevelopment projects adjacent to all the protected areas in

order to meet the demands of local people and also to involve them in conservation efforts.

- Establish self-sustaining monitoring system for overseeing the activities and effectiveness of the protected area network.
- Strengthen research programmes in protected areas, biosphere reserves and fragile ecosystems by involving local research institutions, college and universities, so as to develop baseline data on biological and managerial parameters, and functional properties of ecosystems.
- Device effective management and conservation techniques for the forest preservation plots to ensure conservation of representative areas of different forest types.
- Ensure conservation of biodiversity outside the protected area network, on private property, on common lands and water bodies.
- Ensure conservation of biodiversity rich areas which are prone to high risk of loss due to natural or biotic factors.
- Identify hot spots of agrobiodiversity under different agro-ecozones and cropping systems and strengthen research programmes for their conservation.
- Minimise and eliminate activities leading to loss of biodiversity, including habitat destruction, over-exploitation, pollution and introduction of exotics.
- Intensify measures for restoration of degraded habitats.
- Strengthen and reinforce impact assessment requirements and parameters for location of activities in or around biodiversity rich areas.
- Strengthen research programmes in designated areas for scientific management.
- Reintroduction and establishment of viable populations of threatened species.
- Intensify measures for restoration of degraded areas to meet demands of daily subsistence needs of local populations.

- Ensure that survey, collection and bioprospecting of biological resources is undertaken with minimal damage to the habitat.
- Provide incentives for *in situ* conservation whenever there is a threat of such conservation being endangered by other economically remunerative cultivars by people.
- Start mechanisms for inter-sectoral consultations to identify programmes and activities leading to habitat destruction and over exploitation of biological resources to design strategies of addressing these dangers.
- Initiate mechanisms for intersectoral consultations to understand the behaviour of exotic and alien species to understand their impact on habitats and biodiversity and to design strategies for safeguarding against adverse impacts.
- Reduce threats to biodiversity within protected areas arising out of inappropriate land use outside their boundaries.



4.4 *EX SITU* CONSERVATION

4.4.1 Current status

To complement *in situ* conservation, attention has been paid to *ex situ* conservation measures. According to currently available survey, Central Government and State Governments together run and manage 33 Botanical Gardens. Universities have their own botanic gardens. There are 275 zoos, deer parks, safari parks, aquaria etc. A Central Zoo Authority was set up by Government of India to secure better management of zoos. A scheme entitled Assistance to Botanic Gardens provides one-time assistance to botanic gardens to strengthen and institute measures for *ex situ* conservation of threatened and endangered species in their respective regions.

A great deal of attention has been paid to the genetic conservation of cultivated plants and domesticated animals. While zoological parks have been looked upon essentially as centres of education and recreation, they have played an important role in the conservation of species such as Manipur Thamin Deer and the White-winged wood duck. Notable examples of successful captive breeding are those of Gangetic gharial, crocodiles, turtles and white tiger.

Collection and preservation of genetic resources is done through the National Bureau of Plant Genetic Resources (NBPGR), New Delhi for wild relatives of crop plants, the National Bureau of Animal Genetic Resoruces (NBAGR), Karnal for domesticated animals; and the National Bureau of Fish Genetic Resources (NBFGR), Lucknow for economically valuable fish species. The Indian National Gene Bank of the NBPGR at present

comprises a seed repository holding nearly 1,45,000 accessions, a tissue culture repository maintains 800 accessions and 1,000 samples cryopreserved in liquid nitrogen. These Bureaus are assigned the task of collecting germplasm and maintaining germplasm banks, e.g., seed banks, field gene banks, etc. for short and medium term preservation. They also supply these on request to Indian and foreign agencies for research purposes only.

The Department of Biotechnology has initiated several important programmes of relevance to *ex situ* conservation such as germplasm facilities, tissue culture pilot plants, biocontrol agents, biofertilizers, clean technologies and bioinformatics.

Under the G-15 Gene Banks for Medicinal and Aromatic Plants (GEBMAP) initiative, three national gene banks have been established at Central Institute of Medicinal and Aromatic Plants (CIMAP) in Lucknow, NBPGR in Delhi and Tropical Botanic Garden and Research Institute (TBGRI) in Trivandrum.

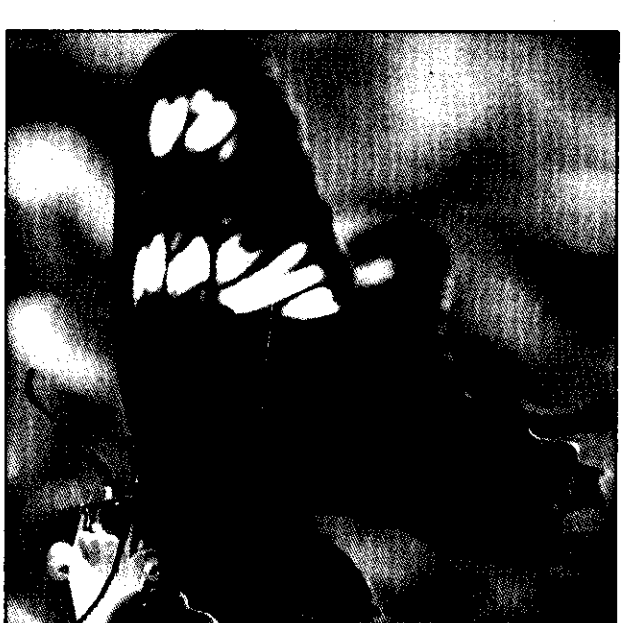
4.4.2 Gaps

In comparison to the large geographical area of the country, and its rich biological diversity in different biogeographic zones, *ex situ* conservation bases are less in extent. Some of these are inadequate in size and many do not have the requisite facilities to undertake conservation of threatened species. Moreover, many of these *ex situ* centres are involved in conservation activities in an implicit rather than an explicit manner, perhaps because their role is limited to recreation. Central Zoo Authority has been set up to oversee management of zoos, but there is no similar set up for botanic gardens.

Further, there is only one national botanic garden, the Indian Botanic Garden at Howrah. Considering the variety of phytogeographic regions, there is a need for setting up more such gardens in different regions. A National Botanic Garden for the Indo-Gangetic Plain region is being set up at NOIDA. Of late, botanic gardens are not attracting investments as priority area, because of a decline in the interest in taxonomy and biosystematics.

The current efforts of collecting and preserving the genetic resources in *ex situ* conditions are inadequate and are restricted mainly to improved high yielding varieties. Unfortunately, similar attention is not paid for conservation of traditional varieties/land races and breeds, particularly so in case of animals, many of which are therefore being replaced by hybrid breeds. Since these traditional varieties and breeds provide a valuable pool of genetic resources, it is necessary to conserve them.

Since a number of forest trees are commercially valuable either because of their timber or other minor produce *viz.*, gums, resins, soap nut, honey, 'imli', 'amla' etc., there is a need to identify and characterise the best or the elite varieties available which should be conserved on a priority basis.



4.4.3 Action points

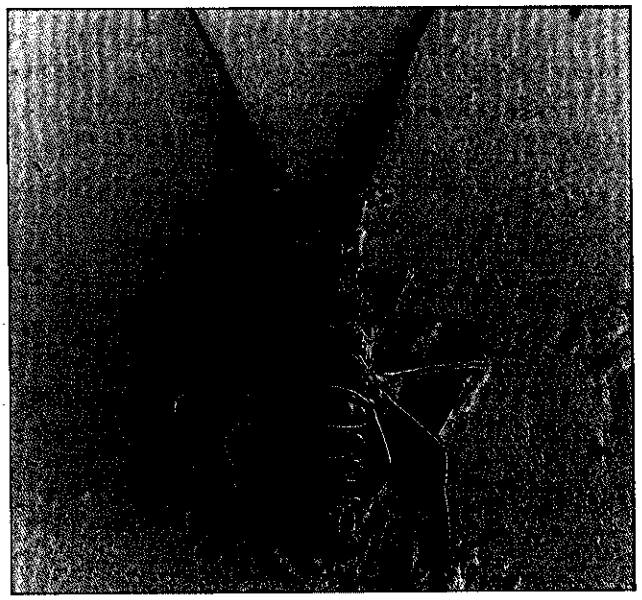
- Develop healthy linkages between *in situ* and *ex situ* conservation measures.
- Consolidate, augment and strengthen the network of *ex situ* centres of zoos, botanic gardens, herbaria, aquaria etc.
- Strengthen existing measures for conservation of crop and livestock diversity, giving special emphasis to conservation of traditional varieties and breeds.
- Accord priority to on-farm and on-orchard conservation programmes.
- Study feasibility of establishment of private zoological parks, botanic gardens and other *ex situ* facilites.
- Develop *ex situ* gene banks at field level as well as laboratory level.
- Encourage cultivation of plants of economic value and promote development of elite varieties of such plants.
- Undertake inter-sectoral studies to establish economic potential of *ex situ* conservation and design strategies for promoting such conservation.
- Explore possibilities of *ex situ* conservation in permafrost areas.
- As part of the national data base system, create a data base for *ex situ* collections/conservation.
- Establish a Central Authority for botanic gardens to secure their better management on the lines of Central Zoo Authority.
- Provide for training of personnel and mobilise financial resources to strengthen captive breeding programmes for endangered species of animals.

4.5 SUSTAINABLE USE OF BIOLOGICAL DIVERSITY

4.5.1 Current status

Sustainable use of biological diversity is emphasised in policy statements of the Government, notably the National Conservation Strategy and the Policy Statement on Environment & Development, the National Forest Policy, and the National Wildlife Action Plan. Several initiatives have been taken to implement various aspects of these policy statements. Sustainable utilisation underscored in these policy statements recognises the interdependence of local communities and people on biological resources, and emphasise the need to draw upon the existing resources keeping long term conservation in view. In accordance with appreciation of the needs and the local situations, pressure from biodiversity rich areas and resources is to be diverted by bringing additional areas under green cover to satisfy local demands, by encouraging environment friendly substitutes to meet the needs, by promoting energy-efficient devices, by creating awareness and an environment to restrict use and extraction of only desired part of component rather than the entire organism. Remedial actions for restoration of degraded areas have been undertaken through ecorestoration programmes by involving local people. Special attention has been given to coastal zone through Coastal Zone Regulation Rules, 1991 under Environment Protection Act.

To adopt economically effective and socially viable incentives for conservation and sustainable use of biological diversity, strategies such as use of items like wood substitutes, alternative energy sources (biogas, wind mills, solar cookers, wave energy, fuel efficient stoves, etc.), establishment of nurseries, tree planting , stall feeding, water harvesting, and pollution abatement measures are being implemented.



4.5.2 Gaps

Current efforts at promoting conservation and sustainable use notwithstanding, a need to further integrate the sustainable use concept in all the relevant economic sectors such as animal husbandry, fisheries, forestry, industry etc. still persists. Whether this need can be met through imposition of disincentives for non-sustainable use in these sectors or through some regulatory systems, is an issue which bears serious analysis and assessment. It appears that techniques of valuing biodiversity, however imperfect, need to be applied while preappraising project ideas. At present, medicinal plants and marine organisms are largely extracted from natural habitats for preparation of drugs and pharmaceutical products. There is an urgent need to develop packages of practices for cultivating farming the widely used medicinal plants and marine organisms, sponges, soft corals, horse shoe crabs etc. This would prevent rapid depletion of natural species and subsequent extinction from wild habitats.

India is rich in both coded and uncoded systems of practices and use of biological resources which mostly have scientific foundations. Often in a bid to have quick results and also satisfy the bulk

demand, scientific methods related to extraction and utilisation of resources are either deliberately ignored or neglected on account of ignorance. Ministries and Departments in-charge of scientific validation and popularisation of such knowledge systems have at best functioned somewhat patchily till now. Coordinated approach appears to be an immediate need.

4.5.3 Action points

- Secure integration of biodiversity concerns wherever needed into intersectoral policies and programmes to identify elements having adverse impact on biodiversity and design policy guidelines to address such issues and make valuation of biodiversity an integral part of preappraisal of projects and programmes to minimise adverse impacts on biodiversity.
- Promote sustainable use of biodiversity in sectors such as agriculture, animal husbandry, fisheries, forestry, industry etc.
- Initiate capacity building at grassroot level for participatory decision making to ensure eco-friendly and sustainable use of natural resources.
- Encourage/revise traditional sustainable uses of biodiversity and devise mechanisms for providing tangible benefits to local communities for their efforts.
- Study issues relating to utilisation of natural resources in representative areas to identify incentives and disincentives in conservation and sustainable use to promote strategies favourable to conservation and sustainable use of biodiversity.
- Encourage farming of medicinal plants and culture of marine organisms exploited for drugs to prevent their unsustainable extraction from the wild.
- Develop suitable mechanisms for protection of knowledge, and related rights including Intellectual Property Rights.

Initiate capacity - building for enhancing bio-relevance and biodiversity significance of resources management interventions in private and common property resources endowed with biodiversity potential.

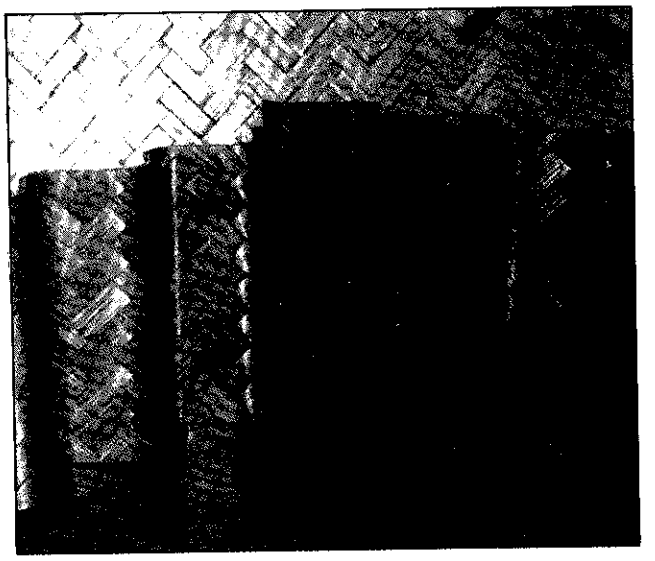
Facilitate revival of indigenous traditions of organic farming for various crops without endangering food production and productivity.

4.6 INDIGENOUS KNOWLEDGE SYSTEMS, PRACTICES, INNOVATIONS AND BENEFIT SHARING

4.6.1 Current Status

Indigenous knowledge systems are both coded and non-coded and are formal and informal. Coded systems include treaties on Ayurveda, Unani and Sidha systems of medicine and health care. There may be some lesser known descriptions of other uses in ancient texts. A wealth of information is non-coded which is in the form of local knowledge

systems and practices. That the potential of such local applications and practices both for the local people and for society in general, is substantial has been proved time and again by widely used products developed on their basis. These products may sometimes be limited to a region while others may cross regional boundaries and find usage all over the country. Development of products and processes beyond national boundaries has also been traced to the leads provided by these in quite a few cases already. The actual number of such products is difficult to guess at present for want of a system which obliges such users to disclose origin of resource information on usage etc. An integrated multidisciplinary and multi-institutional All India Coordinated Research Project on Ethnobiology initiated in 1982 by the Ministry of Environment and Forests, has documented uses of biological resources by ethnic communities in India. The documentation, as the name suggests, is only limited to ethnic or to use a more popular term, tribal communities. It does not include a vast wealth of other local uses and practices. The Wealth of India Series, a dictionary of Indian raw materials and industrial products covering plant species, animals and animal products and minerals brought out by the Council of Scientific and Industrial Research (CSIR), has included description of prevalent usage of various plants and other elements of bioresources amongst the local people. This series has a substantial documentation of local indigenous knowledge systems, innovations and practices. However, it does not identify the area or the people who are the creators and holders of such knowledge systems. Taxonomic descriptions and Flora and Fauna series published by Botanical Survey of India and Zoological Survey of India, respectively, also include information about locally prevalent uses, practices, etc. of the described species. These series also do not identify the holders and creators of such practices and knowledge systems. Dispersed efforts are currently afoot in various parts of the country to document such non-coded knowledge systems. Government agencies, non-government organisations and universities are currently doing such documentation.



4.6.2 Gaps

As already noted, local communities in general possess a wealth of information on the traditional uses of biological resources, much is still undocumented and hence, there is a threat of extinction through non-use on account of substitution effect of modern products or non-transfer of information to successive generations particularly if the information is held by an individual or a family. This traditional knoweldge has the potential of being translated into commercial benefits. This should however be accompanied with sharing of the benefit accruing from commercial utilisation of the local knowledge with the communities/people/individuals responsible for creating, refining and using this knowledge. What should be the nature of entitlements, and share in benefits to compensate these people for the use of their knowledge systems, innovations and practices is still a subject under review. Documentation of knowledge systems and practices and innovations has to be sensitive to the needs of protecting intellectual property rights (IPRs) of these people, even though the subject of such IRPs is not yet fully resolved.

4.6.3 Action Points

- Document traditional knowledge on conservation and upgrade sustainable use of biodiversity available with local communities keeping the sensitivity of intellectual property rights protection in mind. In this regard, examine the utility of community biodiversity registers.
- Engage and revive sustainable traditional and other folk uses of components of biodiversity and promote tangible benefits to local communities for conserving traditional knowledge and practices.
- Examine feasibility of a system which could provide protection to these knowledge systems so as to ensure benefits to the community.
- Create a documentation system of benefit sharing and practices for wider use.
- Create people's awareness about the need to conserve, protect and gainfully use these knowledge systems securing benefits, wherever due.
- Institute suitable mechanisms and systems to negotiate benefits on behalf of local people, communities, and/or create capability amongst local people to negotiate benefits for themselves.

4.7 PEOPLES PARTICIPATION

All the ecosystems described in Chapter 1 are subject to conjunctive use by the people. Hence, it is axiomatic that participation of people in issue related to these ecosystems is essential to ensure their conservation and sustainable utilisation. Practically, all the Ministries and Departments of the Government having programmes relating to use of air, land and water, have components of people's participation. Programmes aiming at rural development, infrastructure development in rural areas, drought prone area development, desert area development, hill areas development, flood prone area development etc., emphasise involvement of people in implementation to secure long term stake building of the people in such programmes. The National Forest Policy (1988) formally initiated a new approach in the management of forests by involving people in planning afforestation and management of degraded forest areas. The policy has subsequently been implemented through Joint Forest Management (JFM) concept. States of the country have evolved their respective parameters for securing Joint Forest Management through joint committees of Government officials and local people. The 73rd and 74th Amendments to the Constitution of India have legally broadened the pace for people's participation decentralising management and control for various programmes pertaining to management and use of local resources to the local bodies.

Informed decisions on the part of the people in the use of various elements which directly impinge upon biodiversity *per se* is an essential ingredient of a meaningful participation of people in conservation and sustainable utilisation of biodiversity. Such informed decisions would include considerations such as long term impacts of such

uses on soil microbial biodiversity and soil nutrients, harvesting of components of coastal and marine biodiversity, fish and other marine resources, forest

resources with sensitivity to long term sustainability of such utilisation, as well as other biodiversity. People use components of biodiversity and the elements of the environment, namely, air, land and water for earning livelihoods and for various other purposes. Aquaculture, agriculture, animal husbandry, forestry operations, some of the major areas of economic activities for people at large, directly depend on use of biodiversity. A large number of people act as individual decision makers in these sectors. Often their decisions lack sensitivity towards short-term and long-term impacts of their decisions on ecological parameters and components of biodiversity. For example, impacts of agricultural and other land use decisions on soil microbial biodiversity and soil nutrients hardly ever form part of the consideration. Consequently, damage to biodiversity at all the three levels, namely, genetic level, species level and ecosystem level takes place.

People's participation profile under the biodiversity action plan, therefore, needs to include participation of people in decision making, management and utilisation at both the levels — at the level of private individual oriented activities and at the level of public or government promoted activities.

Not many documented examples of benefit sharing with the communities are as yet available. One recent example has been that of the Tropical Botanical Garden and Research Institute (TBGRI). The Institute has developed a model for sharing of benefits accruing from use of indigenous knowledge with the holders of this knowledge. Seeds of a herb *Trichhopus zeylanicus* growing in Agastyamalai region were found to be used by Kani tribe living in and around the region as an antifatigue and restorative agent. Based upon this information, TBGRI developed a drug 'Jeevni' from this plant and 2-3 other plants in combination. This steroid-free drug has been tested and found to be comparable to Korean ginseng. The technique for drug manufacture was transferred to a private firm.

Coimbatore Ayurveda Pharmacy, following CSIR norms of technology transfer. 50% of the license fee received and 2% of the royalties on sale will go to the Kani tribal community through Tribal Welfare Department of the State Government.

4.7.1 Action Points

- Strengthen participatory appraisal techniques to promote biomass production by urban local bodies, to reduce biomass pressures on rural common property resources, within the framework of Panchayati Raj Institutions.

- Strengthen participatory rural appraisal techniques and encourage formation of local institutional structures for planning and management of natural resources ensuring participation of women.

- Strengthen community land management system and institute systems for ensuring suitable access to community property resources.

- Recognise and integrate traditional knowledge and practices into biodiversity conservation and management of common property resources.

- Devise methods (e.g., the agricultural extension network) for the speedy effective transmission of relevant technical knowledge and information.

- Devise ways and means to meet the subsistence needs of local people by activities such as :

- promoting fodder production on village wastelands and developing fuelwood plantations

- Introducing fuelwood saving devices (e.g. for economic fuel consumption & smokeless stoves)

- promoting use of non-convention sources of energy (e.g., biogas, solar, wind)

- increasing sustainable access to fuelwood through joint forest activities

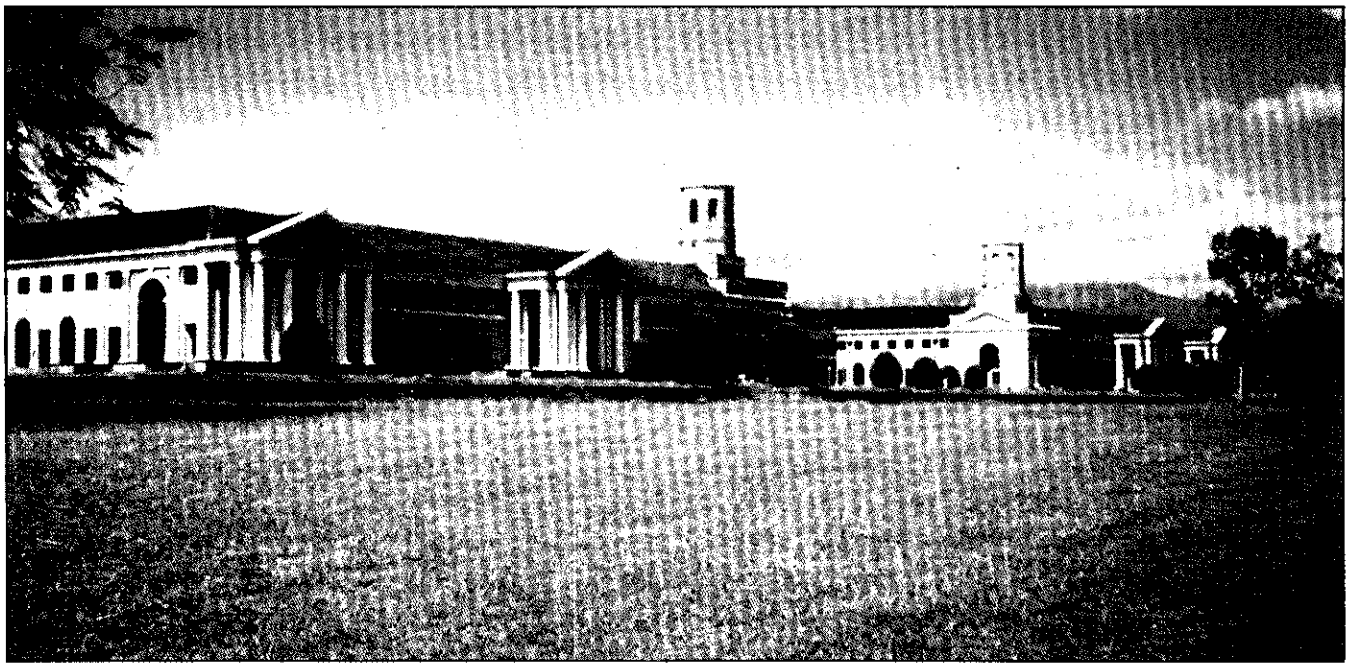
- providing small scale irrigation schemes

- encouraging use of biofertilisers and biopesticides etc. for increasing agricultural productivity

- introducing crop protection measures (e.g., electric fencing)

- Preserve and strengthen traditional, religious, ethical and cultural methods of conservation (e.g., sacred groves, worshipping plants and animals).

- Create and involve communities in field lab situations to upgrade and value add to their knowledge and technologies.



4.8 INSTITUTIONAL FRAMEWORK

4.8.1 Current status

At the Central Government level, Ministry of Environment & Forests is the focal point for implementation of the Convention on Biological Diversity as well as the nodal Ministry for all environment and forest related matters.

The main activities of the Ministry include conservation and survey of flora, fauna, forests and wildlife, prevention and control of pollution, afforestation and regeneration of degraded areas and protection of environment.

The Ministry of Agriculture is responsible for conservation of domesticated biodiversity, fishery resources, protection of forests through control of shifting cultivation, soil conservation and watershed management. The Department of Science and Technology is concerned with the technology for environment protection. The responsibility of regeneration of biomass outside recorded forest areas lies with the Ministry of Rural Development. The matters related to energy conservation and development of alternative sources are dealt with by the Ministry of Power, Ministry of Industry and Ministry of Non-Conventional Energy Sources. The monitoring of water quality and the environmental impact assessment for water resource projects is the responsibility of Ministry of Water Resources. The Ministry of Urban Development is concerned with solid waste collection and disposal in urban areas. While the trade related aspects of biological resources (e.g. TRIPS in the WTO) are being dealt with by the Ministry of Commerce, the patent act and other IPRs are the concern of the Department of Industrial Development and Policy.

A large number of institutions, which are affiliated with some of these Ministries/ Departments, are involved in the work related to various aspects of biological diversity.

At the provincial level, all the States and the Union Territories have departments looking after environment and forests, collectively or singly. In

addition, most of the States have State Pollution Control Board, State Wildlife Advisory Board, State Committee on Biosphere Reserves etc. Some of the States also have specialised institutes, e.g., the Kerala Forest Research Institute and the Tropical Botanic Garden and Research Institute in Kerala; the Environmental Protection and Coordination Agency in Madhya Pradesh, and Gujarat Ecology Commission in Gujarat.

A number of professional academic bodies in the country have been contributing actively through research and training on biodiversity related aspects.

Many non-government organisations (NGOs) and voluntary agencies in India play an active role mainly for raising public awareness of the importance and threats to the biological wealth of the country. Some of the NGOs, however, are also active in research, monitoring and public information.

4.8.2 Gaps

Institutional structures include administrative, legal and financial mechanisms and systems. While some of these have been discussed elsewhere under respective subject heads, it is necessary to take note of these systems here to have a total picture of the institutional system. Mandates and activity profiles of existing institutes such as Indian Council of Forestry Research and Education, Wildlife Institute of India, National Bureau of Plant Genetic Resources, National Bureau of Animal Genetic Resources, National Bureau of Fish Genetic Resources, Botanical Survey of India and Zoological Survey of India need to be continuously reviewed and revised to include adequate coverage of biodiversity concerns and issues.

A study of ecosystems such as grasslands and deserts, with a view to find suitable administrative, legislative and policy instruments in accordance with need requirements, need to be undertaken, as these ecosystems have as yet not received adequate attention and coverage.

Sensitivity to conservation issues and decision making has been absent or insufficient as a result of non-accounting of intrinsic value of biodiversity and non-visibility of serious damage caused to ecosystems and ecological balance in the immediate and the long run.

Human resource development for scientific management of biodiversity has suffered because

of inadequate infrastructure for research and development, the shortage of organisations capable of imparting technical skills at the local and regional levels, the limitations of education and public awareness through formal and non-formal means, and insufficient training for policy makers, administrators, trainers, educators, students, local self-government authorities and grassroot level workers. Some of these issues have been discussed under respective captions of Research and Development, Survey etc.

On the fiscal front, the task of incorporating biodiversity concerns in development projects requires much larger levels of financial investments. Considering the limited public investments currently made available for biodiversity, there is a need to attract private and external sources of financing. The inadequacy of funding and the lack of a variety of fiscal instruments further compound the problems arising from deficiencies of skilled human resources and organisations and inadequacy of environmental education network.

4.8.3 Action points

- Strengthen BSI and ZSI to augment their capabilities, including manpower and support training of personnel in identified areas where (a) no expertise is available (b) inadequate expertise is available so as to intensify surveys, inventorisation and monitoring.

- Strengthen the three Bureaus of ICAR (NBPGR, NBAGR and NBFGR) in respect of infrastructure and manpower so as to enlarge and expand their domain of activities covering other domesticated plants and animals as well and augment research to bring additional species for potential culture. Strengthen the existing Centres of Excellence in environment for undertaking biodiversity related work, e.g., documentation of traditional knowledge, traditional conservation and use practices etc.

- Expand the network of botanical gardens and zoological parks, to represent all the biogeographic regions, and to improve the facilities of the existing gardens and parks to undertake research with adequate manpower, library and laboratory facilities.

- Encourage decentralised micro-level planning under "Panchayat Raj" system for conservation of natural resources including biodiversity as envisaged in 73rd and 74th amendments of the Constitution.

- Initiate actions to reorient all natural resources use and development policies, including agriculture, industry, forestry, fisheries, mining etc. to integrate biodiversity concerns.

- Promote intersectoral and interdepartmental coordination and cooperation to ensure that activities undertaken by different sectors and departments are mutually supportive to the cause of biodiversity conservation and sustainable use.
- Evolve suitable mechanisms to coordinate activities related to conservation, agriculture, animal husbandry, forestry, fisheries, wildlife etc.
- Capacity-building programmes for local communities be initiated in the areas of natural resources mapping to facilitate formulation of locally designed biodiversity conservation plan.
- Ensure active support of public and private sectors for conservation and sustainable use of biodiversity.
- Develop a system of natural resource accounting reflecting the ecological as well as economic values of biodiversity.
- Devise measures for generating resources, such as a cess on industrial uses of biodiversity, collection of fees, royalties etc. for conservation and sustainable use of biodiversity based on critical analysis of the issues involved, and explore the possibility of creating a Biodiversity Fund for this purpose.
- Develop in-house monitoring for biodiversity programmes starting from village/block level local bodies, District level, State and Central Governments. In addition, encourage ex-house monitoring through independent agencies.
- Assess the utility of traditional fiscal instruments like seigniorage rates, grazing fees from the view point of sustainable utilisation of biodiversity.
- Depending upon the feasibility of study, develop systems to return a part of the revenues generated in protected areas, zoological parks, botanical gardens, aquaria etc. for improving their management to conserve biodiversity.
- Earmark at least 1% of State and Central Government resources for biodiversity and to enhance these allocations from time to time.
- Factoring the element of biodiversity conservation while considering extending fiscal concessions including taxes, cesses and charges to natural resources using sectors on the economy.
- Review and revise regulations that govern the ownership, access and management of natural resources.

4.9 EDUCATION, TRAINING AND EXTENSION

4.9.1 Current status

Education training and extension has so far received attention on general environmental issues including conservation issues. Conservation and sustainable utilisation of biodiversity has an integrated comprehensive theme for these three activities, though related issues have been covered in the past. Hence, the need to look at the on-going education, training and extension programmes profile to incorporate assigned directed focus to conservation of biodiversity and sustainable utilisation of its components.

The Ministry of Environment & Forests interacts actively with the University Grants Commission (UGC), National Council of Education, Research & Training (NCERT) and the Ministry of Human Resources Development (MHRD) for introducing and expanding environmental concepts, themes, issues etc. in the curricula of schools and colleges.

In order to generate awareness regarding the need to conserve and sustainably utilise biological

resources, the communication media such as TV, Radio and Press are being utilised. The education system, both formal and non-formal, is also mobilised to this end.

For education, awareness, research and extension development on forestry issues, the Indian Council of Forestry Research and Education (ICFRE), which is an autonomous institution of the Ministry, is the focal point. The major areas of ICFRE's forestry extension programmes includes transfer of technology, creation of public awareness, extension of technical support to State Forest Departments, NGOs etc. These activities are undertaken through organisation of short term courses and seminars, publication of brochures, books and pamphlets, production of films and other audio-visual programmes, adoption of villages for developing social forestry and agro-forestry models and transfer of technology from the laboratory to field.

The Forest Research Institute (FRI) is a deemed University for imparting education and creating awareness on various aspects of environment and forestry. The Indian Institute of Forest Management (IIFM) is another autonomous body of the Ministry for imparting education and training in forest management. The Wildlife Institute of India (WII) imparts training on wildlife management through organisation of short term courses, seminars and workshops.

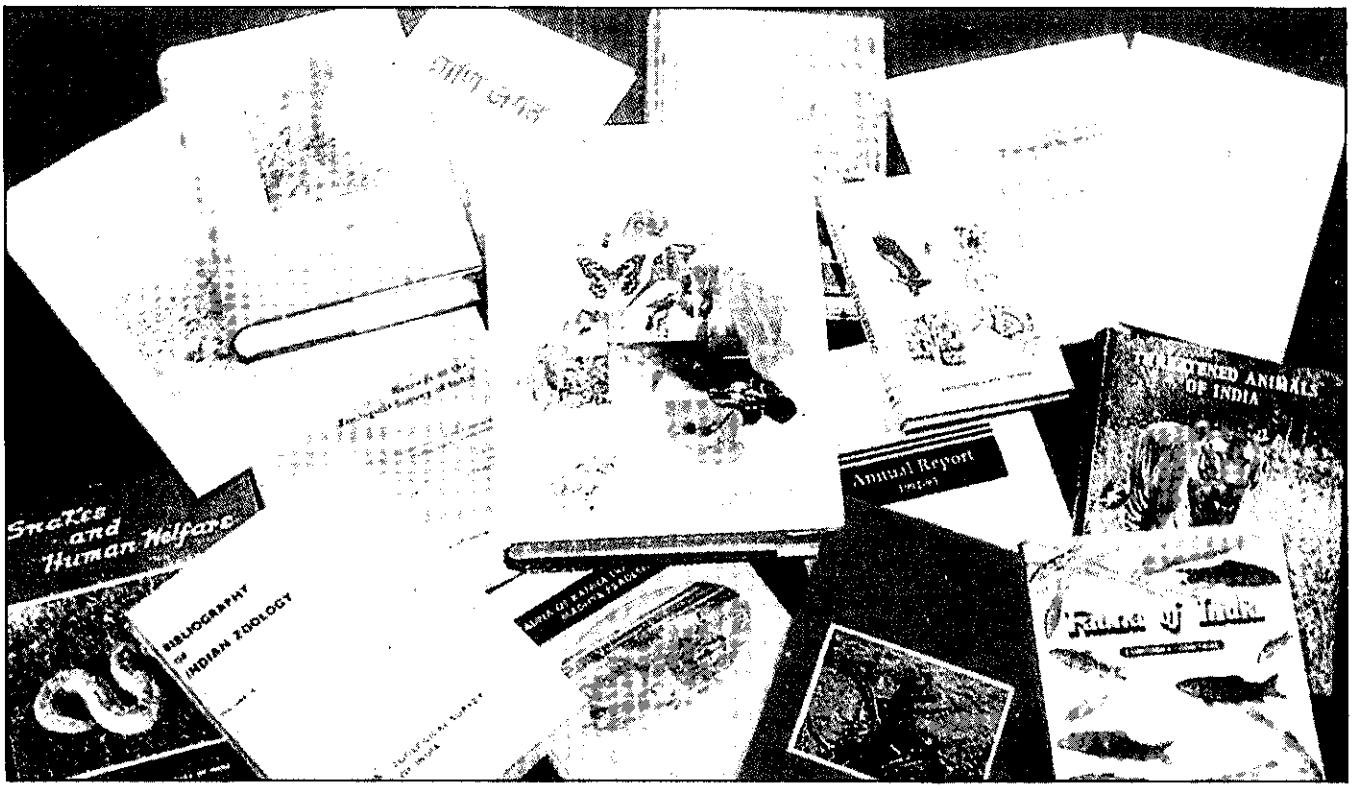
The Botanical Survey of India conducts short term courses on field survey, herbarium methodology and Flora writing at its Southern Circle office in Coimbatore. The Survey also provides resource persons for training teachers and other members of Eco-clubs and participants in ecodevelopment programme.

The Zoological Survey of India conducts training programme in the areas of (i) Environmental Education and Wildlife Conservation (ii) Ornithology (iii) Parataxonomy (iv) Identification

of Insects and Mites (v) Community Biodiversity — all contributing to the conservation of biodiversity and largely catering to the needs of NGOs. It has also biannual programme for training on EIA specially for ecological impacts. ZSI actively collaborates with WWF-India and CEE in teachers' training programme and provides resource persons for training programmes organised by NGOs. ZSI has also signed a MOU with SACEP to assist seven South Asian countries in assessing faunal diversity in each country.

The Centre for Environment Education, Ahmedabad and CPR Environment Education Centre, Chennai, the Centres of Excellence supported by the Ministry, organise activities aimed at creating environmental awareness among all sections of the society, especially the students and the teachers. These Centres are also fully involved in the activities of the UGC, MHRD and NCERT related to formal environmental education.

The National Museum of Natural History (NMNH) is devoted to environmental education and creation of conservation awareness among the public through exhibit galleries, mobile museum, discovery room, and various other activities. CEE is working as a nodal point for Environmental Education for South Asia as a partner with SACEP.



On non-formal education and awareness, the National Environment Awareness Campaigns are organised annually, under which NGOs, schools, colleges, research institutions, women and youth organisations are supported to organise a variety of activites aimed at creating awareness on environmental issues among different target groups.

Target groups for education, training and extension include students, public at large, teachers, functionaries of the Government in various sectoral departments, and funtionaries of the Government directly involved in programmes of conservation, management and utilisation of biodiversity. Students and teachers are two of the important target groups.

4.9.2 Gaps

Since a number of organisations/agencies are working on various aspects of biodiversity, the information on the subject is scattered. The different sectoral networks could therefore be linked to establish a nationwide information system with a uniform format for collection, retrieval and dissemination of data. The current efforts for environmental education and awareness should be strengthened to highlight the importance of conservation and sustainable use of biodiversity. Keeping in view the need for more specialists on specific aspects of biodiversity, the university and professional curricula have to be suitably reoriented, and the university departments have to be accordingly strengthened. School teachers and students could be effectively involved for documenting local biodiversity and traditional conservation practices. For generating public awareness, the audio, visual and the print media could be more effectively used. The use of other means such as posters, playcards etc. in public places, special publicity boards at main roads leading to Sanctuaries, National Parks, Botanical Gardens, Zoological Parks, Natural Landscapes, World Heritage Sites etc. can also be explored. There is a

need not only to strength the inservice training and orientation courses for personnel engaged in conservation programmes, but also develop special orientation programmes for politicians, lawyers, judges, economists, custom officials etc.

4.9.3 Action points

- Promote through both formal and non-formal means of environment education, the importance of conservation and sustainable use of biodiversity.
- Develop and include in the primary and secondary school curricula and undergraduate college curricula the importance of and the need for conserving biodiversity.
- Produce field guides and identification keys in Hindi, English as well as in regional languages to facilitate identification and conservation of key groups of plants and animals.
- Design and implement awareness programmes particularly for rural women, and also absorb their wisdom; women's organisations such as Women's Council and Mahila Mandals could be used for this purpose.
- Biodiversity conservation theme be suitably incorporated in school and college curricula and in relevant disciplines at higher levels.
- Incorporate a module on conservation and sustainable utilisation of biodiversity in foundational and professional training in All India Services, State Services and other services.
- Design mechanism of transferring technological packages developed by institutions such as Indian Council of Forestry Research and Education, Wildlife Institute of India, National Bureau of Plant Genetic Resources etc. to people at large.
- Commission an All India Coordinated Project on Taxonomy to fill up the gap areas.

- Develop training programmes for sustainable use of bioresources at village level.
- Carry out awareness programmes amongst Panchayati Raj Institution functionaries on the objectives, scope and obligations arising from the Convention on Biological Diversity.
- Develop mechanisms for training in parataxonomy involving local communities and NGOs.
- Create Chairs in Taxonomy in universities, institutions etc.
- Develop special orientation programmes for

politicians, lawyers, judges, economists, custom officials, police and other relevant groups.

- Strengthen extension programmes on biodiversity issues for conservation professionals, NGOs and for those in public and private sectors.

- Promote networking of biodiversity extension/ training programmes with ongoing programmes in participatory forest management and tribal development.

- Develop a structured publicity programme for enhancing the awareness for biodiversity conservation through audio, visual and print media.

4.10 RESEARCH AND DEVELOPMENT ACTIVITIES

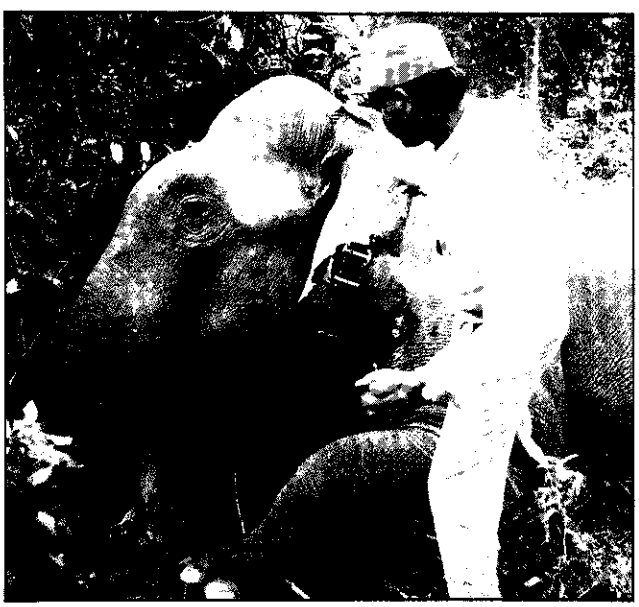
4.10.1 Current status

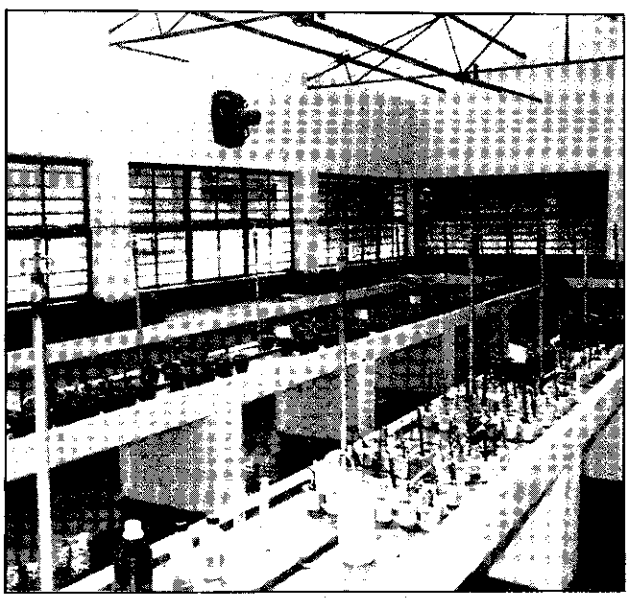
The Ministry of Environment and Forests, Department of Agricultural Research and Education, Department of Agricultural Cooperation, Department of Animal Husbandry and Dairying, Department of Science & Technology (DST), Department of Biotechnology (DBT), Department of Ocean Development, Department of Space, Department of Scientific and Industrial Research and Ministry of Health are the principal Departments/ Ministries which have R&D initiatives and support research activities related to biodiversity. Many of these Departments and Ministries have a host of subject-specific or goal-specific organisations. The organisations under Indian Council of Agricultural Research (ICAR), Council of Scientific & Industrial Research (CSIR) and Ministry of Environment and Forest are listed in Boxes 8, 9 and 10, respectively.

In semi-government sector, universities and deemed universities such as Indian Institutes of Technology, Indian Institutes of Management, Indian Institute of Science etc. are doing pioneering research work. Some of such research programmes are funded by the UGC, CSIR, DST, DBT, MOEF etc.

Some organisations under the State Governments, such as Kerala Forest Research Institute, and Tropical Botanic Garden and Research Institute, are undertaking R&D on biodiversity.

Some important NGOs engaged in research related to biodiversity are given in Box 11.





Box 8 : R&D organisations under Indian Council of Agricultural Research (ICAR)

1. Central Agricultural Research Institue, Port Blair
2. Central Arid Zone Research Institute, Jodhpur
3. Central Avian Research Institute, Izzatnagar
4. Central Inland Capture Fisheries Research Institute, Barrackpore
5. Central Institute for Cotton Research, Nagpur
6. Central Institute of Research on Buffaloes, Hissar
7. Central Institute for Research on Goats, Makhdoom
8. Central Institute of Agricultural Engineering, Bhopal
9. Central Institute of Brackishwater Aquaculture, Madras
10. Central Institute of Fisheries Education, Mumbai
11. Central Institute of Fisheries Technology, Kochi
12. Central Institute of Freshwater Aquaculture, Bhubaneswar
13. Central Institute of Horticulture for Northern Plains, Lucknow
14. Central Marine Fisheries Research Institute, Kochi
15. Central Plantation Crops Research Institute, Kasaragod
16. Central Potato Research Institute, Shimla
17. Central Research Institute for Dryland Agriculture, Hyderabad
18. Central Research Institute for Jute & Allied Fibres, Barrackpore
19. Central Rice Research Institute, Cuttack
20. Central Sheep & Wool Research Institute, Avikanagar
21. Central Tobacco Research Institute, Rajamundry
22. Central Tuber Crops Research Institute, Thiruvananthapuram
23. Cotton Technological Research Laboratory, Mumbai
24. Directorate of Oilseeds Research (ICAR), Hyderabad
25. Directorate of Pulses Research (ICAR), Kanpur
26. Directorate of Rice Research (ICAR), Hyderabad
27. ICAR Research Complex for North Eastern Hill Region, Shillong
28. Indian Agricultural Research Institute, New Delhi
29. Indian Grassland and Fodder Research Institute, Jhansi
30. Indian Institute of Horticultural Research, Sadashivnagar
31. Indian Institute of Sugarcane Research, Lucknow
32. Indian Lac Research Institute, Ranchi
33. Indian Veterinary Research Institute, Izzatnagar
34. National Academy of Agricultural Research Management, Hyderabad
35. National Bureau of Animal Genetic Resources, Karnal
36. National Bureau of Fish Genetic Resources, Lucknow
37. National Bureau of Plant Genetic Resources, New Delhi
38. National Centre for Mushroom Research and Training, Solan
39. National Dairy Research Institute, Karnal
40. National Research Centre for Citrus, Nagpur
41. National Research Centre for Groundnut, Junagadh
42. National Research Centre for Integrated Pest Management, Faridabad
43. National Research Centre for Mithun, Shillong
44. National Research Centre for Sorghum, Hyderabad
45. National Research Centre for Soyabean, Indore
46. National Research Centre for Spices, Calicut
47. National Research Centre on Camel, Bikaner
48. National Research Centre on Coldwater Fisheries, Haldwani
49. National Research Centre on Equines, Hissar
50. National Research Centre on Yak, Dirang
51. Sugarcane Breeding Institute, Coimbatore
52. Vivekananda Parvatiya Krishi Anusandhan Shala, Almora

Box 9 : R&D Organisations under Council of Scientific and Industrial Research (CSIR)

1. CSIR Centre for Biochemicals, Delhi
2. CSIR Complex, Palampur
3. Central Drug Research Institute, Lucknow
4. Central Food Technological Research Institute, Mysore
5. Central Fuel Research Institute, Dhanbad
6. Central Institute of Medicinal & Aromatic Plants, Lucknow
7. Central Salt and Marine Chemical Research Institute, Bhavnagar
8. Centre for Cellular and Molecular Biology, Hyderabad
9. Indian Institute of Chemical Biology, Jadavpur
10. Institute of Microbial Technology, Chandigarh
11. National Botanical Research Institute, Lucknow
12. National Environment Engineering Research Institute, Nagpur
13. National Institute of Oceanography, Goa
14. National Institute of Science, Technology and Development Studies, New Delhi
15. Regional Research Laboratory, Bhopal
16. Regional Research Laboratory, Bhubaneswar
17. Regional Research Laboratory, Jammu Tawi
18. Regional Research Laboratory, Jorhat
19. Regional Research Laboratory, Thiruvananthapuram

Box 10 : Organisations of Ministry of Environment and Forests (MOEF) undertaking R&D

1. Botanical Survey of India, Calcutta
2. Central Pollution Control Board, Delhi
3. Centre for Ecological Research and Training, Bangalore
4. Centre for Environment Education, Ahmedabad
5. Centre for Mining Environment, Dhanbad
6. Forest Survey of India, Dehradun
7. Govind Ballabh Pant Himalayan Paryavaran Vikas Sansthan, Kosi, Almora
8. Indian Council of Forestry Research & Education, Dehradun
9. Indian Institute of Forest Management, Bhopal
10. Indian Plywood Industries Research Institute, Bangalore
11. Institute of Arid Zone Forestry Research, Jodhpur
12. Institute of Deciduous Forests, Jabalpur
13. Institute of Forest Genetics & Tree Breeding, Coimbatore
14. Institute of Moist Deciduous Forests, Jorhat
15. Institute of Wood Science & Technology, Bangalore
16. National Museum of Natural History, New Delhi
17. National Zoological Park, New Delhi
18. Padmaja Naidu Himalayan Zoological Park, Darjeeling
19. Salim Ali Centre for Ornithology & Natural History, Coimbatore
20. Wildlife Institute of India, Dehradun
21. Zoological Survey of India, Calcutta

Box : 11 : Some Non-governmental organisations engaged in research

1. M. S. Swaminathan Research Foundation (MSSRF), Chennai
2. Foundation for Revitalisation of Health Traditions (FRLHT), Bangalore
3. World Wide Fund for Nature (WWF), India
4. SRISTI, Ahmedabad
5. Research Foundation for Science, Technology and Natural Resource Policy, New Delhi
6. Bombay Natural History Society, Mumbai
7. Kalpavriksha, New Delhi.

4.10.2 Gaps

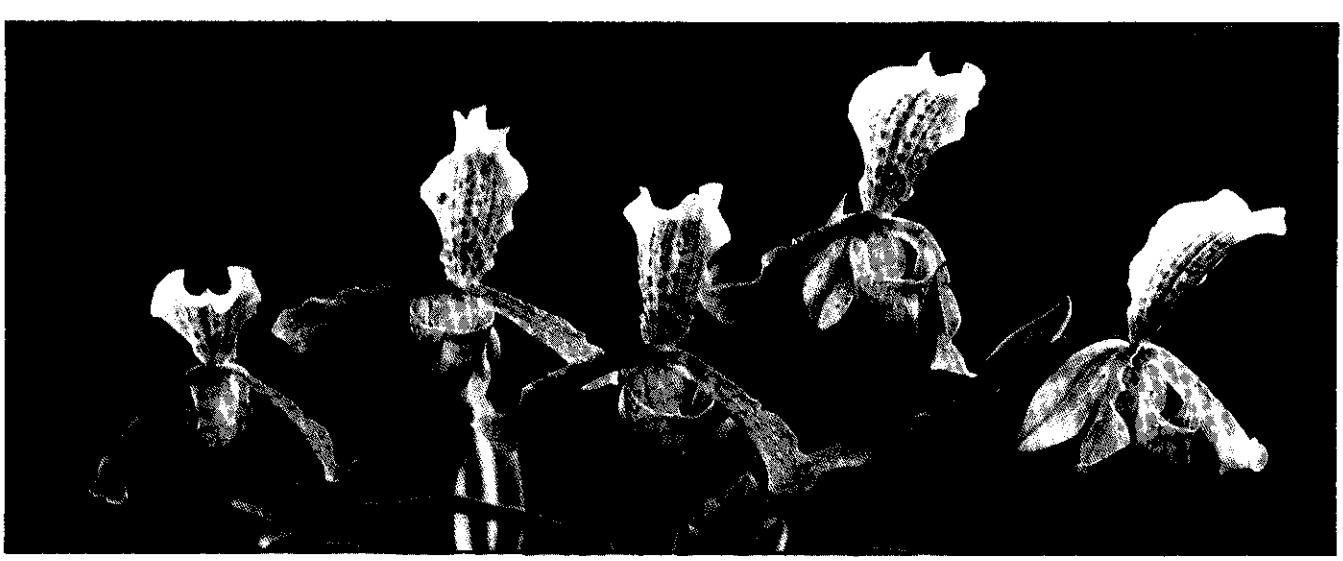
There is a lack of coordination among the various organisations undertaking research on biodiversity. Some ecosystems are well-studied, while others have not received similar attention. Likewise, research on species diversity is widespread, whereas genetic diversity has not been studied adequately. Further, as yet even the parameters for research activities are not well defined, at least in some cases. Even where the R&D parameters are well defined and sharply focussed, the studies take a long time to conclude. The findings of research projects take even longer to be integrated into policy making.

Some of the significant areas where there are major gaps in R&D are : bioprospecting, molecular characterisation and upgradation of technologies.

The participation of industry and other private sector in R&D is as yet not substantial.

4.10.3 Action points.

- Identify a coordinated agency for R&D work pertaining to biodiversity.
- Develop research plans on priority areas such as molecular characterisation, bioprospecting and upgradation of technologies.
- Devise mechanisms to fully gear up the participation of private sector in R&D activities.
- Promote research on evaluation of threats to biodiversity.
- Accord priority to research in hot spot areas for understanding the ecological principles for conserving the endemic species.



- Promote basic and applied research for different types of ecosystems and species, with special emphasis on hitherto unexplored/under explored areas and lesser known groups of plants and animals, e.g., lower groups.

- Encourage research on microrganisms with special reference to their role in various functional aspects of ecosystems such as energy flow, nutrient cycling, decomposition etc.

- Promote and strengthen infrastructure leading to development of techniques for sustainable use, including harvest or economically important components of biodiversity, e.g., wildlife ranching, horticulture propagation etc.

- Develop appropriate biotechnologies for utlisation of biodiversity components, which are ecologically sound and economically viable.

- Enhance research efforts on modified habitats such as agro-ecosystems, organic farming, use of biofertilisers and biopesticides and integrated pest management.

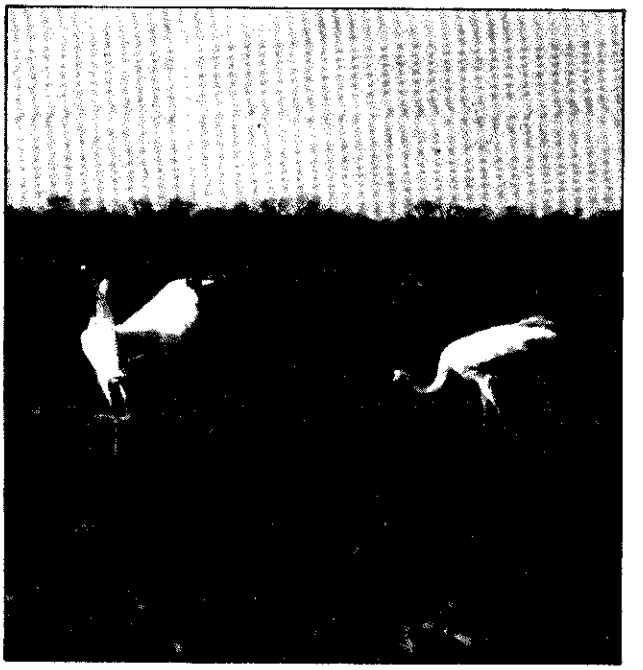
- Promote research on evaluation of impacts of developmental activities on components of biodiversity, and ecosystems as a whole.

- Set up regional centres of excellence of biosystematic studies on representative ecosystems to promote and pursue survey activities.

- Establish Centres of Excellence for taxonomic research in priority areas.

- Set up regional centres for microbiological research and centres to establish a microbial inventory for survey of bio-activity and future uses through publicity.

- Undertake periodic review of R&D activities.



4.11 INTERNATIONAL COOPERATION

4.11.1 Current status

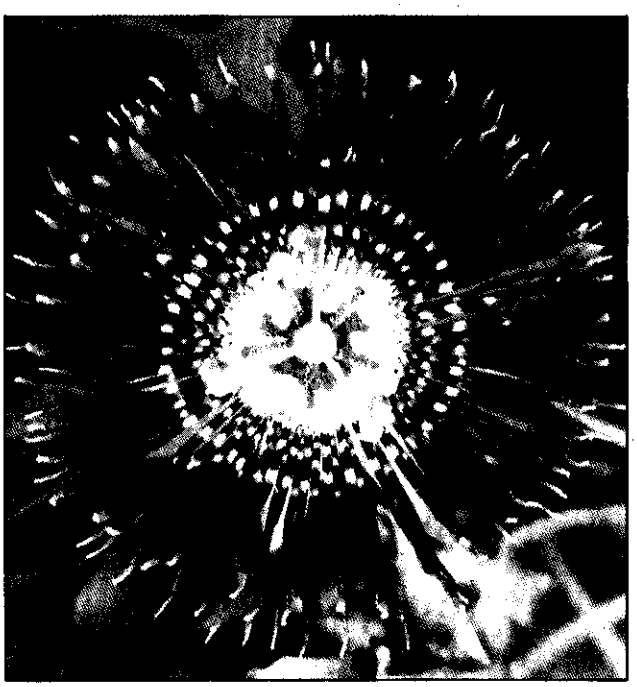
India is a Party to a number of multilateral environmental treaties. These are:

- Convention on Biological Diversity 1992.
- Convention on International Trade in Endangered Species of Wild Fauna and Flora 1973.
- Ramsar Convention on Wetlands of International Importance especially as Water Fowl Habitat 1971.
- Convention concerning the Protection of World Cultural and Natural Heritage 1972.
- Convention on Conservation of Migratory Species of Wild Animals 1979.
- Convention on Conservation of Antarctic Marine Living Resources. 1980.
- Convention on the Law of the Sea 1982.
- International Tropical Timber Agreement 1983.
- Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal 1989.

- Montreal Protocol on Substances that Deplete the Ozone Layer 1987.
- Framework Convention on Climate Change 1992.
- Convention on Desertification 1994

For steering and supervising the process of implementing the Convention on Biological Diversity, the Conference of the Parties (CoP) is the supreme decision making body. In order to provide the CoP with scientific, technical and technological advice, the Subsidiary Body for Scientific, Technical and Technological Advice (SBSTTA), was established. As per Article 20 of the Convention "the developed country Parties shall provide new and additional financial resources to enable developing country Parties to meet the agreed full incremental costs to them". At present, the Global Environment Facility (GEF) is the institutional structure on an interim basis for the financial mechanism of the Convention.

The Ministry of Environment and Forests in the Government of India cooperates actively on environmental issues with the United Nations Environment Programme (UNEP), United Nations Development Programme (UNDP), South Asia Cooperative Environment Programme (SACEP) and International Centre for Integrated Mountain Development (ICIMOD). India is also a State Member of the International Union for Conservation of Nature and Natural Resources (IUCN).



India is a member of the South Asian Association for Regional Cooperation (SAARC), which is the forum for promoting regional cooperation in this region. Technical discussions on environmental related matters are considered under the SAARC Technical Committee on Environment and Meteorology.

4.11.2 Gaps

Concerted efforts are required to improve bilateral and multilateral cooperation, as also cooperation with UN agencies and other international organisations on issues related to biodiversity. India shares a number of components of biodiversity with neighbouring countries, hence there is an urgent need to promote regional cooperation to evolve strategies for effective implementation of the provisions of the Convention, without undercutting each others interests.

4.11.3 Action points

- Further consolidate and strengthen global cooperation, especially with UN agencies and other international bodies on issues related to biodiversity.
- Promote regional cooperation especially with neighbouring countries through fora like SAARC, ASEAN, ESCAP etc. which share components of biodiversity across their boundaries for effective implementation of suitable strategies for conservation of biodiversity.
- Within the provisions of the Convention on Biological Diversity, promote bilateral cooperation leading to conservation and sustainable use of biodiversity.
- Develop programmes/projects for accessing funds for conservation and sustainable use of biodiversity from external funds for conservation through bilateral, regional and other multilateral channels.

CHAPTER 5

The subject of biodiversity is cross-sectoral in nature. Besides, State Governments, local institutions and people play a major role in conserving and sustainably utilising biodiversity. Equitable sharing of benefits also require informed and vigilant action at all levels. Implementation of the action plan will therefore naturally be heavily dependent on the involvement of central sector ministries/departments and other organisations both Government and Non Government, research and development institutions, academic institutions for subjects and areas pertaining to them.

For implementation and monitoring of the Action plan, there shall be a supervisory committee under the chairmanship of the Secretary, Environment & Forests with the Inspector General of Forests, Secretaries of other concerned Central Ministries, representatives of State Environment and Forest Departments, NGOs and a few experts as members. Experts on specific subjects may be co-opted where required. Similar management arrangements shall be made at the State level.

All India coordinated projects on various themes and subjects, e.g., taxonomy, coastal and marine biodiversity, national data base, will be formulated and implemented to secure full utilisation of available infrastructure and funds with augmentation and further inputs and funds wherever the need is established. Sources of domestic as well as external funding will be explored and availed of.

LIST OF PHOTOGRAPHS

FRONT COVER (Clockwise)
Upperhill Ecosystem
Coral
Thunia marshiliana Orchid
Mangrove Ecosystem
Bird – Chestnut headed Bee-eater
Royal Bengal Tiger
Endangered Pitcher Plant

SECOND COVER
A pair of open Bill Stork Chick at Kulik Bird Sanctuary, West Bengal

INSIDE PAGES (Sequence wise)
Neora Valley National Park
Chital Herd at Kanha National Park
Silk Worm
Basaka (Medicinal Plant)
Wild Elephant Herd, Garo Hills, Meghalaya
Flowering Jarul Tree (Lagerstromia Spp.)
Shola of Western Ghats
Peacock
Cobra Lily
Red Panda
Leopard Cat
Himalayan Fern
Median Egret
Fruit
Lion at Gir National Park
Great Indian Bustard
Coastal Ecosystem
Desert Ecosystem
Neora Valley National Park
Tropical Rain Forest
Dry Decidious Forest
Gujrat Saline Area with Babul Shrubs
Stilt Roots of Mangrove Eco-system
Wetland Eco-system at Kulik Bird Sanctuary, West Bengal.
Wetland of Rashikbeel Eco-Tourism Complex, North Bengal
Mangrove Ecosystem
Hental (Phoenix paludosa)
Coral
Desert Ecosystem
Sea Crab
Magnolia
Mugger Crocodile on river bank, Corbett National Park
Pangolin
Leather Back Sea Turtle
Soil Erosion
Plastic pollution and Bio-Diversity Degradation of Himalayas
Vateria metacarpa tree
Mangrove Degradation
Pair of Hoolock Gibbon
Pin tail
Brahma Kamal
Echinodermata
Ribbon Fish
Cinchona Tree
Sea Urchin
Coral
Red Fiddler Crab
Pitcher Plant
Elephant Herd in Corbett
Tiger in Water, Bandhavgarh Tiger Reserve
Rhino at Jaldapara Wildlife Sanctuary
Brow Antlered Deer, Kaibul Lamjao National Park, Manipur
Lizard
Tree Fern
Himalayan Monal, Singhalila National Park
Yellow Raspberry
Lion Tailed Macaque
Tissue Culture of Plant
Male Rhino in Zoo
Botanical Garden
Butterfly at Bhitarkanika
Cultivation of Oyster Mushroom
Cray Fish
Strobulus Flower
Bamboo Roofing -
Forest Nursery
Sea Grass
Glorisa superba (Glory Lily)
Himalayan Newt, Zorpukhri, Darjeeling
Forest Research Institute, Dehradun
Grass Hopper
Peltophorum pterocarpum(Radha Chura)
Black Partridge, Corbett National Park
Student at Exhibition
Teachers in Nature Trail
ZSI Publications
Adult Education at Mizoram
Radio Collaring of Elephant, Gorumara National Park
Plant Culture in Laboratory
Ladies Slipper Orchid
Siberian Crane at Bharatpur Bird Sanctuary, Rajasthan
Passion Fruit Flower
Ashoka

THIRD COVER
A colourful Kusum Tree

BACK COVER (Clockwise)
Coral Fish
Demoiselle Crane
Brow Antlered Deer
Marine Ecosystem
Spectacled Monkey
Legume Flower
Spider Weaving
King Cobra
Cochlospermum gossypium Flower

Photo Credits

Ministry of Environment & Forests
Zoological Survey of India
Botanical Survey of India
Pronab Basu
S. Pal Chowdhury
Adland Publicity Pvt. Ltd.

Layout, Artwork & Printed by **Adland Publicity Pvt. Ltd.**
17, Camac Street, Calcutta-700 017, Phone. : 247-6693