CHAPTER II

BIODIVERSITY - GLOBAL ISSUES

Nature has provided us with bountiful gifts in the form of biodiversity, with which humans have experimented\(^1\). Local or Indigenous peoples’ lives are based on the resources found in their local environment. They have experimented and learnt to use these gifts of nature: for instance plants and animals, as food. Through a keen sense of observation of the ecosystem they have cultivated new varieties of crops. In addition they have also used wild biota in health care. The TK has been passed on from one generation to another by word of mouth. This oral tradition is alive even today.

Biodiversity is the sum of organisms that include plants, animals, microorganisms and the ecosystems they live in. These natural resources are gifts of nature that are important for humans and for the functioning of ecosystems. The local/Indigenous peoples have been custodians of diversity so far\(^2\). Through an understanding of the natural processes they have been able to use and share the natural resources wisely Gift giving and receiving, however, is thwarted by the exchange value system.

Biodiversity\(^3\), which refers to the variability among living organisms from all sources, including terrestrial, marine and other aquatic eco-systems\(^4\) including diversity within species\(^5\), between species and ecosystems. Biodiversity\(^6\) has been defined as ‘the totality of genes, species, and eco systems in a region of the world\(^7\). It is characterized as the variety and variability of life, the diversity of genes, species, and ecosystems; in nutshell the variety and variability in plants, animals and microorganisms on our planet. Express in simple terms, biodiversity is the total array of all
living organisms whether plants, animals or microorganisms, and includes diversity within species, between species and among ecosystems. It includes all life forms on the earth and is a life support system, which is essential for the normal functioning of ecosystems and the biosphere as a whole. It is clear that biodiversity is dynamic in nature.

The biodiversity today has resulted over billions of years of evolution and provides a large number of goods and services that sustain our lives. It provides genetic resources for food and agriculture, and therefore, constitutes the biological basis for world food security and support for human livelihood.

Of the estimated 5.50 million species of the world’s biota, only 1.7 million have been described to date. The distribution of these resources is highly uneven. About seven per cent of the world’s total land area is home to half of the world’s species with the tropics alone accounting for 5 million. As many as 44 per cent of all species of vascular plants and 35 per cent of all species in four vertebrate groups are confined to 25 hotspots comprising only 1.4 per cent of the land surface of the earth.

Of a list of 25 hotspots over the world, India figures with two hotspots; the Western Ghats and the Indo-Burma region covering the Eastern Himalayas. Although both the Himalayas and the Indo-Burma hotspots are considered data-deficient, existing knowledge about plant and animal biodiversity provide some indication of their value. In case of the Himalayas, of the 10,000 species of plants known from the region, about 3160 (32 per cent) are endemic (including 71 genera and 5 families that are endemic). On the other hand, in the Indo-Burma hotspot, 7000 (52 per cent) of 13,500 vascular plant species known from the region are endemic.

India is considered to be the centre of origin of 30,000-50,000 varieties of crop plants and ranks seventh in terms of contribution to world’s agriculture. It is also the home land of many cultivated species and wild relatives of crop plants. The country has about 15,000 medicinal plants.
that include 7000 plants used in Ayurveda, 700 Unani, 600 in Siddha, 450 in Homeopathy and 30 in modern medicines.

1. Importance of Biodiversity

The stability of a particular ecosystem depends on its ‘diversity’. More the interdependence in an ecosystem, greater the chances that it will be able to compensate for changes brought in it. As the environment is a complex web of relationships and interdependencies, the interdependent living creatures and non-living surroundings must co-exist. The modern era has witnessed a growing conflict between economic and technological advancement on the one hand, and the quality of the environment on the other. This growing conflict is sharply focusing on the exhaustibility on the other. This growing conflict is sharply focusing on the exhaustibility of the limited natural resources which cannot be further augmented, and the overdose of economic exploitation which is further causing depletion of natural resources, at times irreversibly.

On the one hand over basic natural resources become scarce because of the burgeoning population growth, on the other, the rapid scientific and technological advancements are causing various unintended side effects ranging from massive distortions imposed on national resources from poorly planned developmental projects and programmes, as well as from lack of attention to long term concerns due to commercial and vested interests.

Thus, concern for environment is essentially a perspective to ensure that national development proceeds along rational and sustainable lines. Environmental conservation is, in fact the very basis of all development.

2. Value of Biodiversity

Biodiversity is an elementary requirement for the long term sustainability of the environment, continuity of life on the earth and the maintenance of its integrity. Biodiversity is
ultimately linked with the survival of human beings since it constitutes a sustained life support on
the earth including, among others, the fixation of solar energy, regulation of water-flow, protection
of soil and recycling of nutrients. The fundamental needs of man (food, clothing, shelter) and range
of products (pharmaceuticals, pesticides, fertilizers etc.) together with expansion of recently
emerging scientific frontiers (genetic engineering, tissue culture etc.) are all met by rich and varied
potential of bio-resources.

The value of bio-diversity can be explained under the following heads:

2.01. To Meet Survival Needs

Perhaps the most important value of biodiversity, particularly in a country like India is that
it meets the basic survival needs of a vast number of people. Even today there are any numbers of
traditional communities which depend, wholly or partially on the surrounding natural resources for
their daily natural need for food, shelter, clothing, household goods, medicines, fertilizers,
entertainment, etc.

2.02. Aesthetic Value

Each species and ecosystems adds to the richness and beauty of life on Earth. Once a species
becomes extinct, it is gone for ever. A natural ecosystem once destroyed is impossible to recreate.
The value people attribute to the aesthetic function of nature is partly reflected in the number of
people who visit areas of natural beauty. This function near or within a dense human settlement is
best seen at the Sanjay Gandhi National Park on the outskirts of Bombay, which receives traffic of
15 lakhs (1.5 million) visitors every year.
Each species is of potential value to humans. So are healthy ecosystems. The global collection of genes, species, habitats, ecosystems is a resource that provides for human needs now, and is essential for human survival in the future. Humans depend on other species for all of their food and for many medicines and industrial products. Up to 80 per cent of the people in the developing countries depend on TRM for primary health care, most of which is derived from plants and some from animals and mineral sources. About 20,000 species of plants are used for medicinal purposes in these countries. Nearly one-quarter of all prescription drugs used in the developed world are based on plants, including 21 indispensable mainstream drugs. These include aspirin from the plant *Filipendula ulmaria* and quinine from the bark of several species of the *Cinchona* tree. In addition, plants contain complex chemical structures which may be impossible to synthesize in a laboratory and which might provide important clues for new medicines. Genetic diversity is important in breeding crops and livestock. The loss of crop species has severe implications for global food security. Crop breeders need a diversity of crop varieties in order to breed new varieties that resist evolving pests and diseases. Many crops have been ‘rescued’ with genetic material from wild relatives or traditional varieties. Sugar cane in India, for example, was prone to the red rot disease which limited its commercial production. Resistance to the disease was acquired from the genes of the wild cane *Saccharum spontaneum* from Indonesia. Genes from a wild rice from India resurrected rice cultivation in many parts of Asia in the early 1970’s. Scientists at the International Rice Research Institute (IRRI) searched 6,723 samples for genes resistant to the wide spread grassy stunt virus. They found it only in one- a single sample of *Oryzania indica* collected from eastern UP in 1963. The strain of rice evolved by using that sample is now widely grown all over South and South-East Asia.
2.04. Ethical Value

Each species is unique and has a right to exist. Each species is worthy of respect, regardless of its worth to human beings. This point of view was recognized in the World Charter for Nature, adopted by the United Nations (UN) in 1982\(^{30}\).

2.05. Ecological Services

Species evolve to fill particular *niches* (roles in an ecosystem or habitats). Many species depend on each other in intricate ways for survival. Specific life forms present in a particular habitat in providing conditions for other life forms to live in the environment\(^{31}\). Destroying one species can lead to further extinctions or changes. The primary indirect value of biodiversity lies in the services provided by the ecosystems and *taxa* (distinct groups of organisms) by maintaining an intricate network of life forms\(^{32}\). Some efforts have been made to put a monetary value on such services. In India an attempt at valuing the ecosystem services, such as protecting against soil erosion, purifying the air etc., provided by a medium-sized tree over a period of 50 years worked out to be roughly Rs. 15,70,000\(^{33}\). The US Army Corps of Engineers realized that retaining a wetland complex outside Boston, Massachusetts, resulted in an annual saving of $17 million in flood protection alone\(^{34}\). Similar costing studies have not yet been carried out in India\(^{35}\).

2.06. Religious, Spiritual and Other Cultural Uses

Biodiversity in India, particularly, is important for its religious, spiritual and other cultural uses\(^{36}\). Many plants and animals have ritual significances. Among auspicious flowers offered in temples are *Hibiscus* offered to the goddess Kali and *Datura* flowers to Siva. In some parts of India such as Gujarath, *Sami* (*Prosopisspicigera*) is used in sacrificial fires\(^{37}\). Various plant and animal species are considered sacred on account of their association with different deities. Some animal
species are termed *vahanas* or vehicles of deities and are hence venerated. Important among these are the bull for Siva and the rat for Ganesha and the lion for Durga.

Entire ecosystems have also been utilized for cultural and spiritual purposes. Sacred value was attached to patches of forests believed to be the abode of gods and ancestors, and utilized only for prayer and related rituals. A network of such sacred groups is still in evidence in some parts of India.

2.07. Medicinal Value

Traditional Medicine in India has relied heavily on the rich biodiversity of the region. Three traditional systems of medicine are widely prevalent in the country—Ayurveda, Siddha and Unani. The Ayurvedic system subscribes to the view that there is no plant on the Earth which is not a medicine. The story goes that Brahma ordered the sage Jivaka to find a tree or a herb which had no medicinal property. Jivaka wandered for eleven long years in search of such a plant but could not find one. When he returned and informed Brahma of his failure, much to his surprise Brahma recognized him as a great physician. Ayurveda has given to the world the drug reserpine used as a tranquilizer and for the treatment of hypertension, anxiety and schizophrenia. Reserpine is extracted from the forest shrub *Rauvolfiaserpentina*.

3. Levels of Biodiversity

There are three broad levels of biodiversity:

- genetic variation within species (which includes variations within individual members of that species)
- the variety of species within a habitat or an ecosystem
- the variety of habitats on the planets
These three levels of biodiversity can be grouped under the following hierarchically related levels.

3.01. Genetic Biodiversity

Genetic Biodiversity pertains to the variation of genes within a species. This constitutes distinct population of the same species or genetic variation within population or varieties within a species. Each variety within a species increases its ability to adapt to pollution, diseases and other changes in the environment. When these varieties or population of these species are destroyed, the genetic diversity within the species is diminished. The loss of genetic diversity has far more serious implications than the extinction of species. Each living species contains a unique reservoir of genetic material that has evolved over thousands of years, and cannot be retrieved or duplicated. This genetic material is characteristic of the population and not of just a few individuals. This is the diversity of the basic units of hereditary information (genes) within a species, which are passed down the generations. Genetic diversity results in variations. It is this type of diversity that gives rise to several ‘varieties’ of rice and wheat. Some variations are easy to see, for example, size or colour, some, such as taste or flavor, can be perceived by other senses and some are invisible, such as susceptibility to disease.

3.02. Species Biodiversity

Species biodiversity refers to variety of species within regions. Such diversity can be reassured on the basis of the number of species in the region. Species is the unit used to classify the millions of life forms on Earth. Each species is distinct from every other species. Horse and Donkeys are distinct species, so are lions and tigers. What unites members of a species is the fact that they can produce fertile offspring.
Species diversity is usually measured in terms of the total number of species within a defined area\textsuperscript{51}. Species diversity is the most commonly used level for describing the biodiversity of countries. Based on this level a few countries have been termed ‘mega diversity’ countries. These countries are Australia, Brazil, China, Colombia, Ecuador, India, Indonesia, Madagascar, Malaysia, Mexico, Peru and Zaire\textsuperscript{52}.

3.03. Ecosystem Biodiversity

Ecosystem biodiversity relates to the variety of habitats, biotic communities and ecological processes in the biosphere. This is more difficult to measure than species or genetic diversity due to the boundaries of communities and ecosystems being elusive\textsuperscript{53}. An ecosystem is a set of life forms (plants, animals and micro-organisms) interacting with one another and with the non-living elements (air, soil, water, minerals etc.) of their environment\textsuperscript{54}.

Ecosystem diversity is therefore the diversity of habitats (i.e., place or site where an organism or a population of organisms naturally occurs), which include the different life forms within. Ecosystem diversity can refer to two phenomena. It can refer to the variety of species within different ecosystems, i.e., the more abundant the species within an ecosystem is considered to be. Ecosystem diversity, more commonly and correctly refers to the variety of ecosystems found within a bio-geographically or political boundary.

3.04. Domesticated Biodiversity

Domesticated biodiversity is the result of\textsuperscript{55};

- The manipulation by humans of genetic diversity within species to produce new varieties of crops and new breeds of domestic animals, and
Adaptation of crops and domestic animals to different climatic and geographical conditions

Since the dawn of agriculture, people in different parts of the world developed different plant and animal varieties to meet certain needs and conditions. These included higher productivity, better taste, resistance to pests or disease, and the ability to withstand adverse conditions like floods, draught or frost. Different crop varieties and livestock breeds are adapted to different environmental conditions. For example, a species of rice grown in the hills could develop characteristics to suit the region, such as the ability to tolerate cooler temperatures of the uplands. The same species grown in the plains would evolve characteristics such as stalks more resistant to the stronger winds that blow across the plains, or develop roots and leaves adaptive to more or less rainfall and sunlight. Thus two varieties of rice would evolve. A conservation programme called Navadanya has identified over 150 different varieties of rice in the Western Ghats alone, each variety often from a different ecosystem or eco zone.

Innovation and scientific endeavor are very much part of traditional societies. According to Pereira, the Warli tribals of Maharashtra grow several varieties of rice of different water and soil conditions. These varieties have varying periods of maturity, are resistant to different diseases, and are used during different cultural events. New varieties developed by scientists often rely on the characteristics obtained from traditional varieties. India also has several breeds of cattle, poultry and other domesticated animals. The Kankrej cow, for example, is adapted to survive in semi-arid conditions. India’s eight breeds of buffaloes represent the entire range of the genetic diversity of buffaloes in the world. India’s ‘Murrah’, ‘Nili-Ravi’ and ‘Surti buffalo’s are being used to improve the breed of buffaloes in many countries.
3.05. Micro-organism Biodiversity

Micro-organisms or microbes include bacteria, virus, protozoa, yeast, fungus, etc., and form a vital part of life on earth. Bacteria are the oldest life forms on earth. They were part of the earth’s atmosphere 3.8 billion years ago. Microbes play an important role in various bio-geo-chemical cycles. They live in the digestive tracts of most animals (including humans and insects) where they breakdown the food and facilitate digestion.

Microbes that live in the roots of leguminous transform atmospheric nitrogen and make it available to the plants. The soil contains thousands of species of microbes which decompose dead organic matter and help maintain soil structure. Some microbes make enzymes. While most microbes are very useful, some can also be deadly- causing diseases like cholera and tuberculosis among humans.

Extinction of species occurs when a species fails to replace its number. This failure is generally caused by stressful change or a new element in the environment. Most of the changes impacting species are due to human use and alteration of habitat. Although extinction is a natural phenomenon, but man made imbalances cause faster depletion. Evolutionary process is natural, whereas intrusions of human being accelerate the declining rate. In a reasonably stable biosphere, the evolutionary rate and extinction rate are approximately equal. Extinction is normally linked with, if not caused by a new species.

4. Status of Biodiversity in India

India has tremendous biodiversity, genetic as well as species and ecosystems. It contains over 5 per cent of the world’s biodiversity on 2 per cent of the earth’s surface. This diversity can be attributed to the vast variety of landforms and climates resulting in habitats ranging from tropical to temperate, and from alpine to desert. The number of plant species in India is estimated to be over
45,000 representing about 7 per cent of the world’s flora. These include over 15,000 flowering plants of which 4,900 species are endemic to the country. India is also considered one of the world’s eight centres of origin of cultivated plants. India has 51 species of cereal and millets, 104 species of fruits, 27 species of spices and condiments, 55 species of vegetables and pulses, 24 species of fibre crops, 12 species of oil seeds, and various wild strains of tea, coffee, tobacco and sugarcane.

Several hundred species of wild crop relatives are distributed all over the country, especially in the western and eastern Himalaya, the Western Ghats and the Malabar Coast, north-eastern India, the Gangetic Plains, and in the eastern part of the Deccan Plateau which is a major centre for wild rice. ‘Citrus Indica’ the most primitive species of ‘citrus plants’, is found in the Tura hills in Meghalaya. It is believed that the cultivated varieties of ‘citrus’ in India were perhaps developed from this endangered species.

India’s faunal wealth is equally diverse. The total number of animal species is estimated at 81,000, representing about 6.4 per cent of the world’s fauna. India’s known animal diversity includes about 57,000 insects, 2,546 fish, 204 amphibians, 428 reptiles, 1,228 birds and 372 mammals; it also includes about 20,000 invertebrates. The ancient practice of domesticating animals has resulted in India’s diverse livestock, poultry and other animal breeds. India has 26 breeds of cattle, 40 of sheep, 20 of goats, 8 of camels, 6 of horses, 2 of donkeys and 18 of poultry. India has contains vast microbial diversity. Although exact numbers of viruses, microscopic algae and other microscopic organisms are not known, India has at least 850 species of bacteria and 12,500 of fungi.

4.01. Wetlands in India

India has a rich variety of wetland habitats. The total area of wetlands (excluding rivers) in India is 58,286,000 ha. or 18.4 per cent of the country, 70 per cent of which comprises areas under...
paddy cultivation. A total of 1,193 wetlands, covering an area about 3,904,543 ha, were recorded in a preliminary inventory coordinated by the Department of Science and Technology, of which 572 were natural. India’s most important wetland areas are Chilka Lake (Orissa) and Keoladeo National Park (Bharatpur)- have been designated under the Convention of Wetlands of International Importance (Ramsar Convention) as being especially significant waterfowl habitats. The country’s wetlands are generally differentiated by region into eight categories; the reservoirs of the Deccan Plateau in the south, together with the lagoons and the other wetlands of the southern west coast; the vast saline expanses of Rajasthan, Gujarath, and the Gulf of Kachchh; freshwater lakes and reservoirs from Gujarath eastwards through Rajasthan (Keoladeo Ghana National Park) and Madhya Pradesh; the delta wetlands and lagoons of India’s east coast (Chilka Lake); the fresh water marshes of the Gangetic Plain; the floodplain of the Brahmaputra; the marshes and swamps in the hills of north-east India and the Himalayan foothills; the lakes and rivers of the montane region of Kashmir and Ladakh; and the mangroves and other wetlands of the island arcs of the Andamans and Nicobars.

4.02. Forests in India

India possesses a distinct identity, not only because of its geography, history and culture but also because of the great diversity of its natural ecosystems. The panorama of Indian forest ranges from evergreen tropical rain forest in the Andaman and Nicobar Islands, the Western Ghats and the North-eastern states, to dry alpine scrub high in the Himalaya to the north. Between the two extremes the country has semi-evergreen rain forests, deciduous monsoon forests, thorn forests, subtropical pine forest in the lower montane zone and temperate montane forest.

One of the most important tropical forest classifications was developed for Greater India and later republished for present-day India. This approach has proved to have wide applications outside India. In it 16 major forest types are recognized, sub divided into 221 minor types.
Structure, physiognomy and floristic are all used as characters to define the types<sup>83</sup>. The main areas of tropical forests are found in the Andaman and Nicobar Islands; the Western Ghats, which fringe the Arabian Sea coastline of Peninsular India; and the greater Assam region in the north-east. Small remnants of rain forest are found in Orissa state. Semi-evergreen rain forest is more extensive than the evergreen formation partly because evergreen forests tend to degrade to semi-evergreen with human interference<sup>84</sup>. There are substantial differences in both the flora and fauna between the three major rain forest regions<sup>85</sup> <sup>86</sup>. The Western Ghats Monsoon forests occur both on the western (coastal) margins of the Ghats and on the eastern side where there is less rain fall. These forests contain several tree species of great commercial significance (e.g., Indian Rose Wood, *Dalbargialattifolia*, Malabar Kino (*Pterocarpusmarsupium*), and Teak (*Terminaliacrenulatea*), but they have now been cleared from many areas<sup>87</sup>. In the rain forest there is an enormous number of tree species. At least 60 per cent of the trees of the upper canopy are of species which individually contribute not more than one per cent of the total number. Clumps of bamboo occur along streams or in poorly drained hallows throughout the evergreen and the semi-evergreen forests of the south-west India, probably in areas once cleared for shifting agriculture<sup>88</sup>. The tropical vegetation of north-east India (which includes the states of Assam, Nagaland, Manipur, Mizoram, Tripura and Meghalaya as well as the plain regions of Arunachal Pradesh) typically occurs at elevations up to 900m. It comprises evergreen and semi-evergreen rain forests, moist deciduous monsoon forests, riparian forests, swamps and grasslands. Evergreen rain forests are found in the Assam Valley, the foothills of the eastern Himalayas and the lower parts of the Naga Hills, Meghalaya, Mizoram, and Manipur where the rain fall exceeds 2300mm per annum. In the Assam Valley the giant *Dipterocarpusmacrocarpus* and *Shoreaassamica* occur singly, occasionally attaining a girth of up to 7m and a height of up to 50m. The monsoon forests are mainly moist *Sal Shorearobusta* forests, which occur widely in this region. The Andamans and Nicobar Islands have tropical evergreen rain <sup>89</sup>forests and tropical semi-evergreen forests as well as tropical moist monsoon forests. The tropical evergreen rain forest is only slightly is less grand in stature and rich
in species than on the mainland. The dominant species is *Dipterocarpus grandiflorus* in hilly areas, while *Dipterocarpus grandiflorus kerrii* is dominant on some islands in the southern parts of the archipelago. The monsoon forests of the Andamans are dominated by *Pterocarpus balvergioides* and *Terminalia spp*.\(^{90}\)

### 4.03. Marine Environment in India

The near shore coastal waters of India are extremely rich fishing grounds\(^{91}\). The total commercial marine catch for India has stabilized over the last ten years at between 1.4 and 1.6 million tonnes, with fishes\(^{92}\) from the clupeoid group (e.g. Sardines (*Sardinella*) Indian shad (*Hilsa*) and whilebait (*Stolephorus*) accounting for approximately 30 per cent of all landings. Coral reefs\(^{93}\) occur along only a few sections of the mainland, principally the Gulf of Kutch, off the southern mainland coast, and around a number of islands opposite Sri Lanka. This general absence is largely due to the presence of major river systems and the sedimentary regime on the continental shelf. Elsewhere, corals are also found in Andaman, Nicobar and Lakshadweep Island groups although their diversity is reported to be lower than in south-east India.

Five species of marine turtle occur in Indian waters; Green turtle (*Cheloniamydas*), Loggerhead (*Carettacaretta*), Olive Ridley (*Lepidochelysolivacea*), Hawksbill (*Eretmochelys imbricate*) and Leatherback (*Dermochelyscoriacea*). Most of the marine turtle populations found in the Indian region are in decline. The principal reason for the decrease in numbers is deliberate human predation. Turtles are netted and speared along the entire Indian coast\(^{94}\).

In South-East Indian the annual catch is estimated at 4,000-5,000 animals, with *C.mydas* accounting for about 70 per cent of the harvest. *C. caretta* and *L.olivacea* are the most widely consumed species\(^{95}\). *E. imbricata* is occasionally eaten but it has caused deaths and so is usually caught for its shell alone. *D. coriacea* is boiled for its oil which is used for caulking boats and as protection from marine borers. Incidental netting is widespread. In the Gulf of Mannar turtles are
still reasonably common near sea grass beds where shrimp trawlers operate, but off the coast of Bengal the growing number of mechanized fishing boats has had the effect of increasing incidental catch rates.

4.04. Centres of Plant Diversity in India

In 1951, Russian scientist N.Y. Vavilov classified the world’s crop producing regions into eight centres of plant origin. Of these areas of crop genetic diversity, India was central to what he called the ‘Hindustan Centre of Origin’. Vavilov’s terminology was well justified, for this region was produced a significant share of the major crops used the world over. At least 166 species of crops (6.7 per cent of total crop species in the world) and 320 species wild relatives of cultivated crops species are believed to have originated here. The Green Revolution in the late 1960’s and the 1970’s enabled India to increase agricultural productivity dramatically and made itself sufficient in food. This was possible through the use of High Yielding Varieties (HYVs) of crops. But if India continues to favour HYVs to the exclusion of all other varieties it will lose the rich diversity for which it was known. HYVs favour genetic uniformity which makes the crop vulnerable to pests and diseases. Indigenous varieties have been noted to have a greater ability to withstand adverse conditions like draught, floods, soil imbalances and diseases.

5. Loss of Biodiversity

During the last 200 million years, as part of the process of evolution 100 to1,000 species face extinction every century. In recent centuries human activities have accelerated the extinction of species. Today the extinction rate is 1,000 to 10,000 times higher than the natural rate. More than 700 species of vertebrates, invertebrates and vascular plants have become extinct since AD 1600. Untold numbers probably become extinct without ever being identified or described.
Some of the habitats richest in biodiversity, such as tropical rain forest, are being destroyed because of human activities. The destruction of a habitat could lead to extinction of species that lived there and can live nowhere else. Over the last few decades India has cut down at least 50 per cent of its forest, polluted over 70 per cent of its water bodies, built or cultivated over much of its grassland and degraded many coastal areas\(^\text{100}\). At least 10 per cent of India’s recorded wild flora (mainly flowering plants) and possibly a larger percentage of its wild fauna are threatened. Although how many are on the verge of extinction, no one knows.

Loss of biodiversity \(^\text{101}\) takes place when unique habitats or ecosystems are reduced or degraded, and also when species become extinct in the wild\(^\text{102}\). Some famous examples of Indian animal species that have become extinct are the Cheetah\(^\text{103}\)\(^\text{104}\) and the Pink-headed Duck, Jerdon’s Courser,\(^\text{106}\) Asiatic Lion,\(^\text{107}\) and Black-necked Crane\(^\text{108}\). The Forest Owelette (Atheneblewitti) is also known to have disappeared. At least 20 higher plants are known to have become extinct in India\(^\text{109}\).

5.01. Causes of Loss of Biodiversity

The direct factors leading to the loss of biodiversity include habitat fragmentation, invasion by introduced species, pollution, global climate change, overexploitation of species, ignorance about ecosystems, unplanned development, economic systems and policies, inappropriate legal and institutional systems, global trading systems, and certain agricultural and forestry practices\(^\text{110}\). But the route of the problem of biodiversity loss lies in the way we live. Biodiversity is essential for sustainable development, but finding sustainable ways of living is essential for conservation of biodiversity.
5.01.01. Habitat Fragmentation

Large areas rich in biodiversity have been reduced to small pockets. This fragmentation has occurred as agricultural fields, roads and housing, industrial, hydro-electric and other projects have come up in biodiversity-rich areas. Fragmentation of forests, for example, has severely affected the elephant population in India. Elephants move long distances to ensure that they get adequate water and the choicest plant material available for food. In south India the elephant habitat has been reduced by at least 10 per cent because of the conversion of natural forest to commercial monoculture plantation of eucalyptus, wattle, teak and silver oak for timber or pulp wood. In north Bengal the conversion of natural forest to plantations has reduced the elephant habitat by approximately 30 per cent. As these forest areas get smaller, they are also over utilized by the elephants. At the same time the conversion of elephant habitat to other land uses blocks the elephants’ traditional migratory path. This is one reason why these animals increasingly raid agricultural fields, leading to conflict between elephants and people.

5.01.02. Introduced Species

Introduction of non-native species (also known as ‘alien’ or ‘exotic’ species), deliberately or accidentally, has been a major threat to biological diversity worldwide as the introduced species has often flourished at the cost of the local species. One of the best-known examples of the disastrous effects of introducing an alien species is that of rabbits in Australia. India’s biodiversity, too, has been affected by introduction of alien species. Several exotic animals and plants introduced in the Andaman and Nicobar Islands are posing a threat to the local species of fauna and flora. Among the most disruptive is perhaps the Spotted Deer (*Axis axis*), introduced by the British earlier the century. The deer have proliferated on these islands as they have no predators except crocodiles and humans. Their large numbers seemed to be affecting forest regeneration as they over
exploit certain forest species for food. The deer are also causing crop damage in the fields of island settlers.

5.01.03. Overexploitation of Plant and Animal Species

Many species have been overexploited by humans, some times to the point of extinction. Some species are overexploited for food and shelter. Marine fauna, in particular, is under great threat from overexploitation largely as a result of mechanized fishing and increasing international fishing operations in Indian waters\textsuperscript{116}. Killing for precious commodities, such as ivory, and trapping of birds and mammals as collector’s items, curiosities and for rearing as pets, has threatened other species as well. Various reptiles and amphibians have been exploited for both skin and meat. The trade in live birds for falconry and as ornamental cage-birds has also been led to a decline in bird species in India.

5.01.04. Pollution of Soil, Water and Atmosphere

Pollution affects the functioning of ecosystems and may reduce or eliminate sensitive species. Little evidence, or data, of air pollution causing a serious decline in the number of species is found in India. However, in one of Poland’s national parks, 43 species of fauna and flora were lost in part due to severe air pollution\textsuperscript{117}. Some studies have been carried out in India on effects of pesticide pollution on species. A long-term study in Keoladeo National Park in Rajasthan showed high levels of pesticide residues in Sarus Cranes. These toxic residues could lead to a high mortality rate among the cranes and eventually a decrease in their population\textsuperscript{118}.

Other preliminary studies point to the role of pesticides in the high mortality rates among birds of prey such as the Peregrine Falcon and the Osprey\textsuperscript{119}. Pesticides are known to persist in the body of animals and are passed on along the food chain to the next consumer causing further harm\textsuperscript{120}.
Water pollution also affects biodiversity. In India industrial effluents are destroying coral reefs and other marine life. About 40 tons of tar balls (by products of petroleum refining) are deposited in Goa’s beaches every year. These tar balls are washed ashore during the monsoons. A thin film of oil spreads across the water surface reducing the penetration of sunlight. This affects the plant life by reducing their photosynthetic activity. The impermeable oil film also reduces the exchange of gases leading to disruption or respiration, thus killing aquatic organisms.

5.01.05. Global Climate Change

Global warming\textsuperscript{121}, a side effect of air pollution, may play havoc with the world’s ecosystems in the coming decades. Several hypotheses have been proposed on how the increase in global temperatures could affect biodiversity. Many species that cannot adjust to warmer temperatures are likely to become extinct. Rare and isolated species will be most at risk, being most sensitive to any atmospheric change. Some habitats such as islands and coastal systems, which are at risk of flooding and submergence, will suffer particularly high losses of biodiversity.

5.01.06. Unplanned Development

Large-scale development projects have contributed substantially to the loss of forests. Between 1951 and 1980, 5,02,000 hectares of forests were diverted for river valley projects in India\textsuperscript{122}. For instance, the 11 dams constructed on the Periyar River in Kerala not only caused submergence of large tracts of forest but also gave rise to settlements and roads in the forest area. It is estimated that 60 per cent of the river’s catchments cover is badly fragmented, severely affecting the biodiversity\textsuperscript{123}. The enormous demand for minerals in a rapidly industrializing economy has meant that large areas of forest have been destroyed for mining. In Goa, for example, mining covers 500 sq.km. or 14 per cent of the state’s total area. Nearly six hundred mining concessions are in force in the 350 sq.km. of this area which lie within forest areas rich biodiversity\textsuperscript{124}. Coral reefs, known for the rich biodiversity they harbor, have suffered a similar fate. The coral reefs off
Gujarat’s coast offer an example. They were dredged from 1947 for use as raw material in cement manufacture, until the company’s lease to the coral islands was cancelled in the mid-80.

5.01.07. Economic Systems and Policies

Economic system and policies that fail to value the environment and its resources contribute to the loss of biodiversity. Biologically diverse natural systems are most often undervalued in monetary terms and, as a result, are converted into agricultural lands or developed for housing or industrial activities that seemingly have more direct economic benefits. Wetlands in India, such as ponds in urban areas, are being converted for housing and commercial projects every day. In developing countries particularly, the short-term pressure to address development concerns decreases the value of the future relative to the present. So it is pertinent to look at ways to address these real needs while conserving biodiversity.

5.01.08. Inflexible or Inappropriate Legal and Institutional Systems

Although laws to protect biodiversity exist, loss of biodiversity continues. This may be because rarely is a cross-sectoral approach adopted which combines ecological and economic realities. Over centralization of planning hinders local participation which might have brought knowledge, insight and experience of the local environments into the planning process. Customary Law, which by and large promoted the sustainable use of biological resources, is being replaced by a less effective legal system. The Wild Life (Protection Act) 1972, for example, curtails rights of local communities to land in and around protected areas, particularly national parks. These communities have for generations depended upon the surrounding forests for many of their basic survival needs. Curtailment of their access to fuel wood, food, fodder and many other forests products leads to strife between park authorities and the local people. This makes conservation efforts ineffective.
5.01.09. Agricultural and Forestry Practices

Over the ages, farmers have bred and maintained a tremendous diversity of crop and livestock varieties\textsuperscript{125}. The broad genetic base provided insurance against pests, diseases, and adverse climatic conditions. But in the last few decades, prompted by the growing demand for food and by market forces, modern agriculture has moved towards fewer crop varieties which are high yielding and respond better to water, chemical fertilizers and pesticides. Indigenous breeds of cattle have been replaced by cross-breeds and exotics for their higher milk yields. Stability and diversity are thus being replaced by uniformity and productivity. Similarly forestry has also promoted monocultures, leading to substantial loss of biodiversity. In many parts of India commercial plantations of single species have replaced several other species. South India abounds in teak monocultures. Many southern deciduous and even some evergreen forests on the hills of north-eastern and southern India have been replaced by tea and coffee plantations.

5.01.10. Unsustainable Natural Resource Consumption

If the current demographic trend continues, human population will continue to grow for at least the next half century and probably longer, barring catastrophe. The current world population of 5.5 billion will probably double over the next 50 years\textsuperscript{126}. India’s population will cross 1.5 billion by the year 2025. As numbers increase and new technologies develop, humanity continues to find more ways to consume the Earth’s natural resources\textsuperscript{127}.

5.01.11. Inequities

Inequities in the ownership, management and flow of benefits from the use and consumption of biological resources encourage unsustainable exploitation which leads to loss of biodiversity\textsuperscript{128}. Substantial areas in India significant for their biodiversity (except in the north-east) are owned by the State or Centre as Reserved Forests, Protected Forests, National Parks and Sanctuaries\textsuperscript{129}. In the
past local communities living within or around these areas derived benefits from, and in turn were also the local custodians of, some of the areas. With the curtailment of their traditional rights and benefits, the communities are beginning to wonder who benefits from the protection of these areas. This conflict is now being seen in several of India’s protected areas. These areas, rich in biodiversity and particularly wildlife, have been ‘kept aside’ for conservation.

5.01.12. Global Trading Systems

Trading systems that favour the growth of monocultures, usually to produce crops for export on a large scale, can have negative effects on biodiversity\textsuperscript{130}. For example, many tropical countries, encouraged by international lending institutions, have supported the planting of extensive areas of agricultural land with sugarcane, bananas, or pulp trees, to produce commodities for export in order to expand the economy. The root causes of biodiversity loss are interconnected. Development and environment goals are undeniably linked. Development planning must recognize ecological, social and economic sustainability. The challenge is to find means to faster development that will break the vicious cycle of poverty, population growth and natural resource degradation on the one hand, and alter the unsustainable and environmentally damaging patterns of consumption on the other.

5.02. Measuring Loss of Biodiversity\textsuperscript{131}

It is extremely difficult to measure loss of biodiversity\textsuperscript{132}. Let us take one kind of biodiversity- species diversity. First, the total number of species is unknown. The total of 10 million species is an estimate. Biologists think there are between 5 million and 30 million species. Second, many species are tiny and inconspicuous- microbes and some insects. Third, many species live in remote or inaccessible areas. Some species have been known to local people for centuries, but perhaps have never been studied and named by modern- day scientist. One way to estimate biodiversity loss is to measure loss of specific habitats. Those habitats are;
The term ‘wetland’\textsuperscript{133} groups together a wide range of inland, coastal and marine habitats which share a number of features, the one unifying feature being the abundance of water for at least part of the year. The single term encompasses a diversity of habitats ranging from rivers, floodplains, rain-fed lakes and ponds to mangroves, swamps and salt marshes\textsuperscript{134}. India, with its varied terrain and climate, supports a rich diversity of inland and coastal wetland habitats. Two directories of wetlands of India have been compiled- one by the Ministry of Environment, Government of India, and the other by WWF-India. A total of 21 wetlands have been declared as National Wetlands. These wetlands have been identified by the National Committee on Wetlands, Mangroves and Coral Reefs for intensive conservation\textsuperscript{135}. One of the most important wetlands in India is the Keoladeo National Park in Bharatpur, Rajasthan, which is a manmade wetland. Among the various migratory species of birds that visit this Park almost every winter is the endangered ‘Siberian Crane’ (Grus leucogranus). Another important wetland is the Chilka, the largest (1,100 sq.km) brackish-water lake in India, situated in Puri and Ganjam districts of Orissa\textsuperscript{136}. The rate of loss of wetlands cannot be quantified in most countries. This is because the definition of a wetland remains ambiguous and there is very little monitoring of wetlands. However, loss of wetlands has been relatively well documented in some Western Countries\textsuperscript{137}. ‘Wetland Loss in Selected Industrialized Countries, 1950-80’ shows that the United States and several European countries have lost substantial portions of their wetlands in just 30 years\textsuperscript{138}. Wetland habitats in India have been destroyed by draining and land filling, and severely distributed by over exploitation of fish resources, pollution, choking by exotic weeds and other human pressures. A rough estimate indicates that one- third of Indian wetlands have already been wiped out or severely degraded.
The loss of forest habitat has probably received the most publicity. Temperate forests in industrialized countries and tropical forests of south and south-east Asia, tropical South America and central and west-central Africa have all declined\textsuperscript{139}. It is difficult to measure deforestation or other forms of habitat loss precisely. Recent studies of global deforestation are based in part on satellite imagery, but most figures are estimates. About a century ago forest covered over 40 per cent of India’s land. In recent decades the country has lost a considerable part of its forest cover, but it is difficult to estimate exactly how much. Satellite data indicate India’s forest cover as between 12 and 19 per cent of the total land area. These figures vary depending upon different definitions of what constitutes a forest, different interpretation techniques and the accuracy of interpretation.

A Government assessment claims that satellite imagery has shown a slight increase in India’s forest cover compared with an early survey in 1989\textsuperscript{140}. This increase may well have been because of an increase in plantations, and regenerating forest and Jhum fields. However, several studies show that natural forest in India continues to be degraded and lost\textsuperscript{141}. To estimate how many species are affected by loss of habitats, scientists take into account the relationship between the size of an area and the number of known species it holds. For example, a recent analysis of tropical forest habitat concluded that at current rates of deforestation, 4 to 8 per cent of rainforest species would be sentenced to extinction by 2015, and 17 to 35 per cent by 2040\textsuperscript{142}. ‘Sentenced to extinction’ means that the species is likely to lose the ability to breed and reproduce in the future because it lacks the minimum requirement of area for habitat, food sources, or breeding conditions necessary for a viable population of the species.

Conserving biodiversity is not just a matter of protecting wild life in nature reserves. It is also about safeguarding the natural systems of the Earth and all our life-support systems, purifying the water, recycling oxygen, carbon and other essential elements, maintaining the fertility of the soil, providing food from the land, freshwaters and seas, yielding medicines, and safeguarding the genetic richness on which we depend in the ceaseless struggle to improve our crops and livestock. Unless the structure, functions and diversity of the world’s natural system is protected, on which depends all life-support systems, development will undermine itself and fail.

Efforts to conserve biodiversity are:

- International Conservation Strategies, and
- National Conservation Strategies

Biodiversity should be preserved as the heritage of all humans. All species have a right to exist. This is most often the perspective of industrialized countries looking at biodiversity loss in tropical countries. One strategy looking at this perspective sets as priority conserving ‘hotspots’ around the globe. Eighteen hotspots have been identified. These are areas characterized by high concentrations of endemic species and experiencing unusually rapid rates of habitat modification or loss. Fourteen of the eighteen hotspots are in the tropics. The goal is to conserve as much biodiversity as possible given limited financial resources. Most often the problems pertaining to the conservation of nature and natural resources go beyond political boundaries—the acid rain produced in one country affects forests in another; animal and plant products are smuggled across international borders. In situations such as these, cooperation between nations is essential. With this in view, several treaties and agreements come up from time to time which are conceived and coordinated at the international level. A few important ones are listed below:
6.01. The Biodiversity Convention

The Convention on Biological Diversity focuses\textsuperscript{146} not only on the conservation of biodiversity, but also on the sustainable use of biological resources and equitable sharing of benefits arising from their use. It was signed by many countries in 1992 at the United Nations Conference on Environment and Development (UNCED) held in Brazil. By January 1996 more than 170 countries had signed it, and more than 130 had formally ratified it. India ratified the convention in February 1994.


CITES was, until the establishment of the Biodiversity Convention, the most widely accepted international treaty on the conservation of natural resources\textsuperscript{147}. It was drawn up in 1973 and came into force in 1975. The Convention attempts to prevent commercial trade in species of wild life which are in danger of extinction, and to control the trade in species which might become so if their trade was allowed to continue unchecked. India is a signatory to this Convention.

6.03. The Convention of Wetlands of International Importance

This Convention, also known as the Ramsar Convention, was signed in Ramsar (Iran) in 1971 and came to force in December 1975\textsuperscript{148}. It provides a framework for international co-operation for the conservation of wetland habitats. It places general obligations on contracting countries relating to the conservation of wetlands which have been designated to the ‘List of Wetlands of International Importance’. India is a signatory to this Convention\textsuperscript{149}. Six Ramsar sites are located in India. They are Wular Lake (Jammu and Kashmir), Sambhar Lake (Rajasthan), Keoladeo National Park (Rajasthan), Harike Lake (Punjab), Chilika Lake (Orissa) and Loktak Lake (Manipur)\textsuperscript{150}. 
6.04. The Convention Concerning the Protection of the World Cultural and Natural Heritage

This Convention, more commonly known as the World Heritage Convention, was adopted in Paris in 1972, and came into force in December 1975. Its rationale\textsuperscript{151} is that individual countries contain sites with elements of natural and cultural heritage that are of such ‘outstanding universal value’ that safeguarding them should be the concern of the international community. Sites, which must be nominated by the signatory nation, are evaluated for their world heritage quality before being designated by the International World Heritage Committee. India houses five world heritage sites. They are Keoladeo National Park (Rajasthan), Manas National Park (Assam), Kaziranga National Park (Assam), The Sunderbans National Park (West Bengal), Nanda Devi National Park (Uttar Pradesh).

6.05. Convention on the Conservation of Migratory Species of Wild Animals, 1979

The Convention on the conservation of migratory species of Wild Animals\textsuperscript{152} was adopted at a conference held at Bonn from 11 to 23 June, 1979, to implement recommendation of the Action Plan adopted by the United Nations Conference on the Human Environment (Stockholm, 1972). In addition to adopting the Convention, the conference adopted resolution on financial matters and on assistance to developing countries.

This Convention is unique in three respects\textsuperscript{153};

- it covers an unusually broad range of threats to listed species,
- its provisions are ‘unusually rigorous in their restrictions’, and
- it establishes a precedent in international wild life law for providing subsidiary agreements which focus attention and efforts on particular species.
6.06. Agenda 21

Agenda 21 is also concerned with the rate of reduction of biological diversity and calls upon the nations to work for its conservation and development. Agenda 21 is a detailed blue-print for action to be taken up to the year 2000 and beyond by the Governments, development agencies and various UN Organizations and other Non-Governmental Organizations (NGOs). These voluminous blue-print contains every topic related to the environment. The objectives of this ‘Action Plan’ are intended to improve the conservation of biological diversity and the sustainable use of biological resources, as well as support the CBD.

7. Biodiversity: National Conservation Strategies

Several measures have been taken and continue to be taken at the national level to protect biodiversity. These include legal measures, In-situ and Ex-situ conservation efforts, documenting of indigenous knowledge, and the application of science and technology.

India has several Acts in force which have a bearing on the conservation of biodiversity. Some of these Acts are:

7.01. Biological Diversity Act, 2002

India is a party to the CBD which came into force in December 1993. The recognition of the rights of local and indigenous community over their knowledge, innovations, and practices related to biological resources under Article 8(j) of the Convention on Biological Diversity, 1993 has been considered water shed in International law. The CBD offers opportunity to India to realize the benefit of these resources. India has already enacted an Act to provide for protection of biological diversity, sustainable use of its components, and equitable benefit sharing arising out of the use of biological resources. It addresses the basic concerns of access to, collection and utilization of biological resources and knowledge by foreigners and sharing of benefits arising out of such access.
The legislation also provides for a National Authority, which will grant approvals for access, subject to conditions, which ensure equitable sharing of benefits. The main intent of this legislation is to protect India’s biodiversity and associated knowledge against their use by individuals or organizations without sharing the benefits arising out of such use and also to check bio-piracy. The legislation provides for a federal management structure with the National Biodiversity Authority (NBA) at the apex and Biodiversity Management Committees (BMCs) at local community level. The BMC and the NBA is required to consult BMC in decisions relating to the use of biological resources or related knowledge within their jurisdiction.

The legislation also provides for promotion of conservation, sustainable use and documentation of biodiversity. Prior approval of NBA would be required for applying for any form of IPR within or outside India for an invention based on research or information on biological resource obtained from India. The Act also provides other forms of benefits sharing which are progressive in so far as they prioritize non-financial benefits such as transfer of technology, which are more long-lasting than financial compensation.

This Act is an attempt to put into operation the two provisions of the CBD, i.e., sovereign rights of the countries of origin over their biodiversity resources and acceptance of the need to share benefits flowing from commercial utilization of biodiversity resources with the holders of Traditional Knowledge, even if it is in the public domain or held as a part of an oral tradition.

7.02. The Environment (Protection) Act, 1986

This Act relates to general measures to protect the environment, such as restriction on industrial and other processes or activities in specified areas. It also deals with prevention of and control over the manufacture, use, release and movement of hazardous substances. Environmental (Protection) Act, 1986 also includes seven schedules laying down the standards for quality of
environment and for emission or discharge of environmental pollutants, and nine notified rules on handling and management of various hazardous substances\textsuperscript{163}.

7.03. Fishery Act, 1897

This Act prohibits the use of explosives and poisons for fishing. It also regulates fishing in private waters.

7.04. The Indian Forest Act, 1927

The need to consolidate the commercialization of the Indian forests led to the enactment of Indian Forest Act, 1927\textsuperscript{164}. The Act aims at consolidating the law relating to forests, transit of forest produce and the duty leviable on timber and other forest produce, in reality, this Act consolidates, with minor changes, the provisions of the Indian Forest Act, 1878 and in spite of its colonial policies, it is still in operation. It deals with the setting up and management of reserved, protected and village forests, and controls the movement of forest produces.

7.05. The Forest (Conservation) Act, 1980

The Forest (Conservation) Act, 1980\textsuperscript{165} aims at putting restriction on the de-reservation of forests or regulating conversion of forest land for non-forest purposes. The massive industrialization coupled with rapid increase in population and consequent urbanization are factors requiring more and more land which could be only secured on pain of extinction of tracts of forests. This Act primarily focuses on prohibiting or regulating non-forest use of forest lands.


This Act\textsuperscript{166} deals with the restriction and prohibition of hunting of animals, and with the protection of specified plants. It also deals with the setting up and management of sanctuaries and
national parks, setting up of the Zoo Authority, control of zoos and captive breeding. The Act also controls trade and commerce in wild animals, animal articles and trophies.

8. Constitutional Parameters

The Constitution of India is amongst few Constitutions in the world that contains specific provisions on environmental protection. Article 48 A was added to the Directive Principles of State Policy in the wake of the Stockholm Declaration, 1972. The Directive Principles of State Policy together with fundamental duty contained in Article 51 A (g) explicitly enunciate the national commitment to protect and improve the environment. Despite some semantic variation in the language of the two Articles, the national commitment expressed in them has been repeatedly highlighted by the courts. As a result of highly creative interpretations, right to healthy environment, like so many other rights has been included in the right to life guaranteed under Article 21 of the Constitution. Articles 21, 48A, 47 and 51A(g) comprehend right to hygienic environment protection and Government as well as Municipality are obliged to maintain and protect environment, man-made as well as natural.

9. In-situ Conservation

India has a long history of In-situ conservation (i.e., conservation in the natural habitat) of wild species of flora and fauna by establishing protected areas throughout the country. Today India has about 500 national parks and sanctuaries. National parks are legally granted a high degree of protection. No human habitation, private land holding or traditional human activity such as firewood collection or grazing is allowed within the park. Sanctuaries are accorded a lesser level of protection and certain types of activities are permitted within these areas. A third category of protected areas is the Biosphere Reserve. The biosphere reserve programme was first recommended in 1973 by an expert panel of the UNESCO-sponsored programme on Man and Biosphere. The idea was to declare a very large area as a reserve where wildlife would be protected,
but local communities would be allowed to continue to live and pursue their traditional activities within the reserve. Commercial activities and projects like big dams and industries, however, would not be allowed. The Government of India set up seven biosphere reserves\(^{171}\). But these reserves have no legal standing, as they are not mentioned in the Wildlife (Protection) Act, 1972, as a legal category of protected areas. Very little has so far been done to properly plan or implement the objectives of this category of protected areas. Several projects have also been launched in the country to save specific wild faunal species \textit{In-situ}. The best known of them all is Project Tiger\(^{172}\).

\textbf{10. Ex-situ Conservation}

The \textit{Ex-situ} conservation of plants and animals (i.e., preserving them away from their natural habitat) is being carried out in several kinds of institutions such as zoological parks, botanical gardens, forestry institutions and agricultural research centres. The collection and preservation of the genetic material of crops, domestic animals and birds, and fish species is being done through the National Bureau of Plant Genetic Resources in New Delhi, the National Bureau of Animal Genetic Resources at Karnal, and the National Bureau of Fish Genetic Resources in Allahabad respectively. These bureaus collect germplasm (genetic material that comprises the physical basis of the inherited qualities of an organism) form within and outside the country. They also supply germplasm on request to Indian and foreign agencies for research.

\textbf{11. Saving Indigenous Knowledge}

People and communities in close touch with nature have a wealth of knowledge that needs to be recognized, recorded, understood, tested and validated. Tribal and agricultural people are not only familiar with the local plant and animal species but also understand the ecological interactions of various components better than many trained natural scientists\(^{173}\). They know which varieties of their crops are resistant to common plant diseases and pests, which can withstand drought or floods, which are more productive, which taste better or have a better flavour, and which have a ritual or
religious significance. Many organizations in India have recognized this and are working towards recording this knowledge. The Foundation for the Revitalization of Local Health Traditions (FRLHT) based in Bangalore, in collaboration with the Centre for Ecological Sciences, Bangalore, and the World Wide Fund for Nature-India, has prepared a format for a Community Register for documenting indigenous knowledge at the national level.

The relationship of plants (in particular) with humans is now studied under the name of ethno-botany. The Indian subcontinent is one of the greatest repositories of ethno-botanical knowledge. This knowledge, which may have been acquired by local communities over time, is passed down from generation to generation. Interestingly, during the last few decades, a succession of so-called ‘wonder drugs’ have been derived from plants whose medicinal properties have been known to local communities for a long time. Biotechnology has opened up a range of opportunities. Through this branch of science new medical discoveries are being reported every day. The synthesis of human insulin to treat diabetes is one such discovery. Through genetic engineering, which is a sub discipline of biotechnology, genes can be manipulated and transferred across species. This has proved a boon for agriculture as crops can be made resistant to pests and disease by this process.

12. Conclusion

Thus, it is an obligation for each generation to maintain the productive capacity of land, air, water and wildlife in a manner which leaves its successors some choice in the creation of a healthy environment. The physical environment is a dynamic, complex, and inter-connected system in which any action in one part affects the other. There is also the interdependence of living things, harmonious development recognizes this unity of nature, and man. Such planning is possible only on the basis of a comprehensive appraisal of environmental issues particularly, economic, and ecological. It is necessary therefore to introduce the environmental aspect into our planning, legislation, and development. Along with effective conservation and rational use of natural
resources and related Traditional Knowledge thereof, protection, and improvement of human environment is vital for national wellbeing.
The concept of biodiversity though known to man since he started observing living beings around him the world abruptly became in a buzz-word especially during the last few decades. The concept of biological diversity means the variety of life-forms in a given region, ecological roles they play and genetic diversity they contain. See B.A. Wilcox, “In-situ Conservation of Genetic Resources: Determinants of Minimum Area Requirements” Proceedings of the World National Parks Congress, Indonesia: IUCN (1984). In short, biodiversity is the measure of the world’s variety of genes species, and ecosystems. According to McNeely, biodiversity only really came into the public vocabulary around 1988. However, widely agreeable and uniform meaning of biodiversity is still elusive because of its divergent conceptualized framework emanating from four levels of biodiversity (i.e. ecosystem diversity, generic diversity, species diversity and genetic diversity (variety in one species)). But, common usage of species diversity come to be generally, well recognized. Species diversity has also been described at three spatial scales: (i). within habitat (alpha) diversity connotes simply the number of species (or other components of species diversity, (ii) between-habitat (beta) diversity reflects the way in which organisms respond to environmental heterogeneity and (iii). Geographical (gamma) diversity refers to the number of species within a region (large-scale phenomenon). See J.A. McNeely, Biodiversity Conservation and the Role of Global Community India: Worldwide Fund for Nature 9 (1994)

British ecologist Arthur Tansley defined the term ‘ecosystem’, describing it as “The whole system, including not only the organism-complex, but also the whole complex of physical factors forming what we call the environment”. Tansley regarded ecosystems not simply as natural units, but as mental isolates. See A.G. Tansley, “The Use and Abuse of Vegetational Terms and Concepts” 16 Ecology 284 (1935) Tansley later defined the spatial extent of ecosystems using the term ecotype. See A.G. Tansley, The British Islands And Their Vegetation U.K.: Cambridge University Press (1939). The term ecosystem refers to the combined physical and biological components of an environment. An ecosystem is generally an area within the ‘natural environment’ in which physical factors of the environment, such as rocks and soil, function together along with interdependent organisms, such as plants and animals, within the same habitat to create a stable system. Ecosystems can be permanent or temporary. Ecosystems usually form a number of food webs. Ecosystem is a functional unit consisting of living things in a given area, non-living chemical and physical factors of their environment, linked together through nutrient cycle and energy flow. Ecosystem can be divided as;

1. Natural
   a). Terrestrial Ecosystem
   b). Aquatic Ecosystem
      i). Lentic, the ecosystem of a lake, pond or swamp.
      ii). Lotic, the ecosystem of a river, stream or spring.
2. Artificial, environments created by humans.

Central to the ecosystem concept is the idea that living organisms interact with every other element in their local environment. Eugene Odum, a founder of ecology, stated; “Any unit that includes all of the organisms (i.e: the ‘community’) in a given area interacting with the physical environment so that a flow of energy leads to clearly defined trophic structure, biotic diversity, and material cycles (i.e.: exchange of materials between living and nonliving parts) within the system is an ecosystem.” See, E.P. Odum, Fundamentals of Ecology New York: Saunders (1971).
human ecosystem concept is then grounded in the deconstruction of the human/nature biotype and the premise that all species are ecologically integrated with each other, as well as with the abiotic constituents of their biology. Examples of ecosystems are; Agro-ecosystems, Agro ecosystem, Aquatic ecosystem, Chaparral, Coral reef, Desert, Forest, Greater Yellowstone Ecosystem, Human ecosystem, Large marine ecosystem, Littoral zone, Lotic, Marine ecosystem, Prairie, Rainforest, Riparian zone, Savanna, Steppe, Subsurface, Thaautrophic Microbial Ecosystem, Taiga, Tundra, and Urban ecosystem. See J.P. Grime, “Biodiversity and Ecosystem Function: The Debate Deepens” 277 Science 1260 (1997)

5 In biology, a species is; a taxonomic rank (the basic rank of Biological classification) or a unit at that rank (in which case the plural is ‘species’. This is sometimes abbreviated: ‘spec.’ or ‘sp. singular, or ‘spp.’ plural). There are many definitions of what kind of unit a species is (or should be). A common definition is that of a group of organisms capable of interbreeding and producing fertile offspring of both sexes (except in the case of asexually reproducing species), and separated from other such groups with which interbreeding does not normally happen. Other debatable definitions may focus on similarity of DNA or morphology. Some species are further subdivided into subspecies, and here also there is no close agreement on the criteria to be used. A usable definition of the word ‘species’ and reliable methods of identifying particular species is essential for stating and testing biological theories and for measuring biodiversity. Traditionally, multiple examples of a proposed species must be studied for unifying characters before it can be regarded as a species. It is generally difficult to give precise taxonomic rankings to extinct species known only from fossils. Some biologists may view species as statistical phenomena, as opposed to the traditional idea, with a species seen as a class of organisms. In that case, a species is defined as a separately evolving lineage that forms a single gene pool. Although properties such as DNA-sequences and morphology are used to help separate closely-related lineages, this definition has fuzzy boundaries. See K. De Queiroz, “Species concepts and species delimitation” 56(6) Syst. Biol. 879 (2007). However, the exact definition of the term ‘species’ is still controversial, See C. Fraser, E.J. Alm, M.F. Polz, B.G. Spratt, and W.P.Hanage “The Bacterial Species Challenge: Making Sense of Genetic and Ecological Diversity” 5915 Science 741 (2009) and this is called the species problem. Biologists have proposed a range of more precise definitions, but the definition used is a pragmatic choice that depends on the particularities of the species concerned. See K. Queiroz, “Ernst Mayr and The Modern Concept of Species” 102 (Suppl) Proc. Natl. Acad. Sci. 6600 (2005). The question of how best to define ‘species’ is one that has occupied biologists for centuries, and the debate itself has become known as the species problem. Darwin wrote in chapter II of On the Origin of Species. See Darwin, On the Origin of Species (1859). “No one definition has satisfied all naturalists; yet every naturalist knows vaguely what he means when he speaks of a species. Generally the term includes the unknown element of a distinct act of creation.” (Ibid) But later, in The Descent of Man, when addressing “The question whether mankind consists of one or several species”, Darwin revised his opinion to say; “It is a hopeless endeavor to decide this point on sound grounds, until some definition of the term ‘species’ is generally accepted, and the definition must not include an element which cannot possibly be ascertained, such as an act of creation.” See Darwin, The Descent of Man (1871). The modern theory of evolution depends on a fundamental redefinition of ‘species’. Prior to Darwin, naturalists viewed species as ideal or general types, which could be exemplified by an ideal specimen bearing all the traits general to the species. Darwin's theories shifted attention from uniformity to variation and from the general to the particular. Once our attention is redirected to the individual, we need another way of making generalizations. We are no longer interested in the conformity of an individual to an ideal type; we are now interested in the relation of an individual to the other individuals with which it interacts. To generalize about groups of interacting individuals, we need to drop the language
of types and essences, which is prescriptive (telling us what finches should be), and adopt the language of statistics and probability, which is predictive (telling us what the average finch, under specified conditions, is likely to do). Relations will be more important than categories; functions, which are variable, will be more important than purposes; transitions will be more important than boundaries; sequences will be more important than hierarchies. This shift results in a new approach to ‘species’; Darwin concluded that species are what they appear to be: ideas, which are provisionally useful for naming groups of interacting individuals. “I look at the term species”, he wrote, “as one arbitrarily given for the sake of convenience to a set of individuals closely resembling each other ... It does not essentially differ from the word variety, which is given to less distinct and more fluctuating forms. The term variety, again, in comparison with mere individual differences, is also applied arbitrarily, and for convenience sake.” See Darwin, *On the Origin of Species* (1859). Practically, biologists define species as populations of organisms that have a high level of genetic similarity. This may reflect an adaptation to the same niche, and the transfer of genetic material from one individual to others, through a variety of possible means. The exact level of similarity used in such a definition is arbitrary, but this is the most common definition used for organisms that reproduce asexually (asexual reproduction), such as some plants and microorganisms. This lack of any clear species concept in microbiology has led to some authors arguing that the term ‘species’ is not useful when studying bacterial evolution. Instead they see genes as moving freely between even distantly-related bacteria, with the entire bacterial domain being a single gene pool. Nevertheless, a kind of rule of thumb has been established, saying that species of *Bacteria or Archaea* with 16S rRNA gene sequences more similar than 97 per cent to each other need to be checked by DNA-DNA Hybridization if they belong to the same species or not. See E. Stackebrandt and B.M. Goebel, “Taxonomic Note: A Place for DNA-DNA Reassociation and 16S Rrna Sequence Analysis In The Present Species Definition In Bacteriology” 44 *Int. J. Syst. Bacteriol* 846 (1994). This concept has been updated recently, saying that the border of 97 per cent was too low and can be raised to 98.7 per cent. See E.Stackebrandt and J. Ebers, “Taxonomic Parameters Revisited: Tarnished Gold Standards” 33 *Microbiol. Today* 152 (2006). The commonly used names for plant and animal taxa sometimes correspond to species. For example, ‘lion’, ‘walrus’, and ‘Camphor tree’ each refers to a species. In other cases common names do not: for example, ‘deer’ refers to a family of 34 species, including ‘Eld's Deer’, ‘Red Deer’ and ‘Elk’ (Wapiti). The last two species were once considered a single species, illustrating how species boundaries may change with increased scientific knowledge. Because of the difficulties with both defining and tallying the total numbers of different species in the world, it is estimated that there are anywhere between 2 and 100 million different species. See David L. Hawksworth, “The Magnitude of Fungal Diversity: the 1.5 million Species Estimate Revisited” 105(12) *Mycological Research* 1422 (2001) 6 According to Grumbine ‘biodiversity’ refers to multiple levels of biological organization; the genetic diversity within populations, the numbers and kinds of species and populations, the diversity of ecosystem, as well as the ecological patterns and process that knit these different levels together into functional wholes through space and time. See R.E. Grumbine, “Cooperation or Conflict?: Interagency Relationship and the Future of Biodiversity for US Parks and Forests” 15 *Environmental Management* 27 (1991). Biodiversity is comprehensive way of approaching conservation blending facets of information, knowledge, awareness, and ethics into a complex mixture of protected areas, agriculture, forestry, economics, Intellectual Property Rights (IPRs), trade etc. It culminated into the Convention on Biological Diversity (CBD) signed in June 1992 at the Earth Summit in Rio De Janeiro, Brazil, under the aegis of the United Nations Conference on Environment and Development (UNCED). The convention laid tremendous stress on global biological diversity and emphasized the importance of preserving it for posterity. The Convention on Biodiversity defines biological diversity to mean the variability among living organism from all sources including *inter alia,*
terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are parked. This includes diversity within species, between species and of ecosystems. See Prof. M. A. Khan, “Biodiversity Erosion: Global Environmental Challenge” Prof. M. A. Khan and Prof. S. Farooq (Ed) In Environment, Biodiversity and Conservation New Delhi: APH Publishing Corporation (2000)

7 WRI, IUCN, UNEP (1992); The nature and content of the term “Biological Diversity” has been subjected to different connotations. Some ecologists concentrate on the species of plants and animals which live in a particular community. In such cases they exclude the genetic components and use the term ‘species richness’ instead of the term ‘diversity’. See generally, Cynthia Cartson, “NEPA and the Conservation of Biological Diversity” 19(1) Environmental Law 15 (1988), Robert Fischman defines the term as, “what is biological diversity? It is the variety of biological entities inhabiting earth wild plants, animals, microorganisms, domesticated animals and cultivated plants and even genetic material such as seeds and germplasm”. Robert L. Fischman, “Biological Diversity and Environment Protection: Authorities to Reduce Risk” 22(2) Environmental Law 437 (1992). “Biological Diversity is the full range of genetic diversity (species, subspecies and distinct biological populations of plants and animals) in which the plants and animals occur; “the variety and variability among living organisms and the ecological complexes in which they occur”. See US Congress, Office of Technology Assessment, Technologies to Maintain Biological Diversity 3 March (1987) “The sum total of all the plants, animals, fungi and microorganisms in the world, or particular area; all of their individual variation; and all of the interactions between them”, (Convention on Biological Diversity(1992)) ’Biological Diversity’ means the variability among living organisms from all sources, indicating, inter-alia, terrestrial, marine and other aquatic eco systems and the ecological complexes of which they are part; this indicates diversity within species, between species and of ecosystems’; Biodiversity components can be categorized into five head as wild fauna, wild flora domesticated fauna (livestock), domesticated flora (crops and other cultivated plants) and genetic materials (seeds, eggs, germplasm, semen, etc). See Ashih Kothari and Shekhar Singh, Legal Provisions Relating to Biodiversity in India New Delhi: 11PA (1992)

8 Globally, 1.4 million life forms have been named and described by science. Biological estimates suggest that the number of species may be 10 times those described so far. Plant and animal species from major families are still being discovered in rainforests. Over 300 new fish species have been described from the Amazon region. Amphibians have recently been reported from the Sathyamangalam forests in Tamil Nadu. It is estimates that 15,000-20,000 species of tropical flowering plants are yet to be documented. But then, this diversity is being eroded on an unprecedented scale. During the last 200 million years about 100 species became extinct in each century due to the natural evolutionary process. See Supra n. 3.


10 India is one of the world’s 12 Mega-Biodiversity Centres, and the subcontinent one of the six Vavilovian centers of origin of species and over 89,000 species of animals have been documented here, comprising some 6.5 per cent of all known wildlife. The faunal diversity comprises inter alia 2,500 fishes, 150 amphibians, 450 reptiles, 1,200 birds, 850 mammals and 68,000 insects. Although India is designated as a mega-biodiversity area, it also has two of the world’s most threatened ‘hot spots’, the Eastern Himalayan region and the Western Ghats. See Supra n. 3.

Global threat to biological diversity has been recently recognized by environmentalists all over the world. The world’s biodiversity is under tremendous attack by human activities. The depletion of biological diversity is closely linked with the human development process. With the rapid destruction of world’s biological diversity, especially of the developing countries, many environmentalists believe that about one million species of animals and plants out of a total of 10 to 30 million of the earth’s biological diversity may perish within the next 20 to 30 years. Regrettably, much of these vast natural resources are still not documented, hence magnitude of the problem and the likely catastrophe cannot be measured or predicted precisely. However there is no denying the realization that accelerating loss of biological resources poses grave threat to the sustainability of natural systems. Each day, perhaps each hour, we are causing the extinction of at least one plant or animal species. Hundreds of thousands of square kilometers of forests, grassland, wetland, and other natural habitats are being converted into human use areas. The impacts of natural habitat destruction are felt not just by wildlife, but also by the millions of people who depend directly on natural resources for their livelihood. These ‘ecosystem people’ have becomes victims of large scale depredation and denudation of their habitats. Tremendous diversity of crops and livestock developed and maintained by traditional communities is also facing erosion by modern agricultural practices. World trade is wild life and its products represent another manifestation of commercial overuse responsible for the extinction of wild life. It has been mentioned in a report that in spite of long years of existence of the Convention on International Trade in Endangered Species (CITES), 1973, each year smugglers take millions of tropical birds, fish, plants, butterflies from impoverished to wealthy lands. See “The State of the World’s Birds” Birdlife International IUCN (2004). Besides the habitat destruction, biologists believe that more than one third of the vertebrates on the endangered species list are there primarily because of the practice of hunting for trade. Till now approximately 1.75 million living species have been scientifically identified. A conservative estimate of the total number of species, including the unknown and undocumented, has been put to 13.6 million, which may even go up to about 100 million species. Of this vast natural resource, a very large chunk belongs to tropical forests located in the continent of Asia, Africa and Latin America, mostly in the developing countries. The massive depletion of this vast resource, mostly because of human activities, is a cause for concern to the international community. See Supra n. 14.

Ibid


Ibid

J.A. McNeely, Economics and Biological Diversity Gland: IUCN (1988)
Excessive commercial demand from a rapidly expanding pharmaceutical industry, for which no collection regulations exist, affects medicinal plants of various taxa. *Dioscoreadelloidea* (yam), a species that grows in north-east India is a major source of diosgenin used in the manufacture of contraceptive pills. This species has declined in the wild due to over collection. Also threatened in India is the forest shrub *Rauwolfia serpentina* (Sarpagandha or Indian snakeroot). It has been used in the country for over 4,000 years to treat snake bite, nervous disorders, dysentery, cholera and fever. About 50 years ago and extract (Reserpine) from this plant became the base for modern tranquillizers. See R.K. Arora and E. R. Nayar, “Distribution of Wild Relatives and Related Rare Species of Economic Plants in India” in S.K. Jain and P.R. Rao (Ed) *An Assessment of Threatened Plants in India* Calcutta: Botanical Survey of India (1983)

Overseas Development Administration (ODA), “Biological Diversity and Developing Countries: Issues and Option” UK: ODA (1991)


All forms of life on earth, whether microbes, plants, animals, or human beings, contain genes. Genetic diversity is the sum of genetic information contained in the genes of individual plants, animals, and micro-organisms. Each species is the storehouse of an immense amount of genetic information in the form of traits, characteristics, etc. The number of genes ranges from about 1000 in bacteria to more than 400 000 in many flowering plants. Each species consists of many organisms and virtually no two members of the same species are genetically identical. An important conservation consequence of this is that even if an endangered species is saved from extinction it has probably lost some of its
internal diversity. Consequently, when populations expand again, they become more genetically uniform than their ancestors. There are mathematical formulas to express a genetically effective population size that explain the genetic effects on populations that have gone through a bottleneck before expanding again such as the African cheetah or the North American bison. Subsequent inbreeding in small populations may result in: a) reduced fertility and b) increased susceptibility to disease. Genetic differentiation within species occurs as a result of sexual reproduction, in which genetic differences between individuals are combined in their offspring to produce new combinations of genes or from mutations causing changes in the DNA. Genetic diversity is usually mentioned with reference to agriculture and maintaining food security. This is because genetic erosion of several crops has already occurred leading to the world’s dependence for food on just a few species. Currently, a mere 100-odd species account for 90 per cent of the supply of food crops, and three crops—rice, maize, and wheat—account for 69 per cent of the calories and 56 per cent of the proteins that people derive from plants. See P.H. Raven, “Defining Biodiversity” Nature Conservancy 11 (1994)

Today the extinction rate is approximately 40,000 times higher than this background rate due to human depredations. For the first time an enormous proportion of terrestrial plant species that form the basis of land ecosystems remains threatened. Previous mass extinctions had no palpable effect on terrestrial plants. But today, one fifth of all plant species on land face annihilation in the next 20 years. A disappearing plant can take with 10-30 dependent species such as insects, higher animals, and even other plants. According to one estimate, we may already be losing 100 species a day. Supra n. 3

48 Ibid
51 Ibid
52 Ibid
53 Ibid
56 Ibid
57 Ibid
58 Ibid
60 “Cultivating Diversity: Biodiversity Conservation and the Politics of the Seed” Report No.1 Research Foundation for science, Technology and Natural Resources Policy, Dehra Dun (1993)
61 W. Perreira, “The Sustainable Life Style of the Warlis” 19(1,2) India International Centre Quarterly 189 (1992)
64 Ibid
India is the seventh largest country in the world and Asia’s second largest nation with an area of 3,287,263 sq. km. The Indian main land stretches from 8 4’ to 37 6’ N latitude and from 68 7’ to 97 25’ E longitude. It has a land frontier of some 15,200 kms and a coast line of 7,516 km. (Government of India, Research and Reference Division, Ministry of Information and Broadcasting (1985)) India’s northern frontiers are with Xizang (Tibet) in the Peoples Republic of China, Nepal and Bhutan. In the north-west, India borders on Pakistan; in the north-east, China and Burma; and in the east Burma. The southern peninsula extends into the tropical waters of the Indian Ocean with the Bay of Bengal lying to the south-east and the Arabian Sea to the south-west. Physically the massive country is divided into four relatively well defined regions- the Himalayan Mountains, the Gangetic river plains, the southern (Deccan) plateau and the islands of Lakshadeep, Andaman and Nicobar. The Himalayas in the far north include some of the highest peaks in the world. The highest mountain in the Indian Himalayas is Khangchenjunga which is located in Sikkim on the border with Nepal. To the south of the main Himalayan massif lie the Lesser Himalaya, rising to 3,600-4,600 m, and represented by the Pir Panjal in Kashmir and Dhaula Dhar in Himachal Pradesh. Further south, flanking the Indo-Gangetic Plain, are the Siwaliks which rise to 900-1,500 m. The northern plains of India stretch from Assam in the east to the Punjab in the west (a distance of 2,400 km) extending south to terminate in the saline swamp plants of the Rann of Kachchh (Kutch) in the state of Gujarat. Some of the largest rivers in India including the Ganga (Ganges), Ghaghara, Brahmaputra, and the Yamuna flow across this region. The delta area of these rivers is located at the head of the Bay of Bengal, partly in the Indian state of West Bengal but mostly in Bangladesh. The plains are remarkably homogenous topographically; for hundreds of kilometers the only perceptible relief is formed by floodplain bluffs, minor natural levees and hollows known as ‘spill patterns’ and the belts of ravines formed by gully erosion along some of the larger rivers. In this zone, variation in relief does not exceed 300 meter but the uniform flatness conceals a great deal of pedological variety. The agriculturally productive alluvial silts and clays of the Ganga-Brahmaputra delta in north-eastern India, for example, contrast strongly with the comparatively sterile sands of the Thar Desert which is located at the western extremity of the Indian part of the plains in the state of Rajasthan. The climate of India is dominated by the Asiatic monsoon, most importantly by rains from the south-west between June and October, and drier winds from north between December and February. From March to May the climate is dry and hot. See FAO/UNEP, “Tropical Forest Resources Assessment Project” Technical Report No.3 Rome: FAO (1981)

At least 10 percent of India’s recorded wild flora and possibly more of its wild fauna are on the list of threatened species; many are on the brink of obliteration. Of the wild fauna, 80 species of mammals, 47 of birds, 15 of reptiles, three of amphibians, and a large number of moths, butterflies, and beetles are endangered. The cheetah (Acinonyxjubatus) and the pink-headed duck (Rhodonessacaryophyllacea) are amoung species that have become extinct. There must be many more that have been annihilated, unrecorded either because they were not that spectacular or because their existence remained unknown. Ibid
Other notable marine areas are seagrass beds, which although not directly exploited are valuable as habitats for commercially harvested species, particularly prawn, and mangrove stands. In the Gulf of Mannar the green tiger prawn *Penaeus semisulcatus* is extensively harvested for the export market. Seagrass beds are also important feeding areas for the dugong *Dugong dugon*, plus several species of marine turtle. See S. Okasha, “Does Diversity Always Grow?” 466(No. 7304) *Nature* 318 (2010)

Indian coral reefs have a wide range of resources which are of commercial value. Exploitation of corals, coral debris and coral sands is widespread on the Gulf of Mannar and Gulf of Kutch reefs, while ornamental shells, chanks and pearl oysters are the basis of an important reef industry along the south-east coast, notably at Tuticorin, Madras and Mandapam. Commercial exploitation of aquarium fishes from Indian coral reefs has gained importance only recently and as yet no organized effort has been made to exploit these resources. Reef fisheries are generally at the subsistence level and yields are unrecorded. See N. Myers, “The Biodiversity Challenge: Expanded Hot-Spots Analysis” 10(4) *Environmentalist* 243 (1990)


The primary cause for the erosion of diversity is human greed. Never before has one species influenced the environmental conditions all over the planet to such a magnitude as today. The human species now uses 40 percent of the planet’s annual net photosynthesis production. The consumption of two fifths of the planet’s net food resources by one species is incompatible with biological diversity and stability. Loss and fragmentation of natural habitats, overexploitation of plant and animal species, industrial effluents, climate change, and above all, the greed of man are causing the erosion. Supra n. 3

See Appendix 1, Red Data Books

The Cheetah (Acinonyx jubatus), a spotted big cat, came to India by way of the north-western passes. It established itself in the plains and lower hills of northern and central India, and as far southwards as Mysore in the Deccan. For centuries the Cheetah has been tamed and trained by humans and used in hunting. However the degradation of Cheetah habitat and subsequent depletion of its prey, along with the hunting of Cheetah as game, led to the extinction of this animal in India. The last authentic record of the Cheetah in India is from 1948 when Maharajah of Korwai (in Bastar, Madhya Pradesh) shot three juvenile males for sport one night in the glare of the head lights of his car. This has actually been recorded by a photograph in the journal of the Bombay Natural History Society. See, R. E. Hawkins, Encyclopaedia of Indian Natural History New Delhi: Oxford University Press (1986)

See Tarique Aziz, “Cheetah- Comeback” 6(1) WWF India Quarterly 8 (1995)

The Pink-headed Duck (Rhodonessa caryophyllacea) once inhabited the swampy grasslands and forests of east and north-east India. This bird was trapped to be sold alive as an ornamental pet, and was also hunted for food. Conversion of its swampy habitat to agricultural fields perhaps hastened its extinction. The last authentic sighting was in 1935 in Bihar. All that remains of this species today are about 80 skins in museums around the world. See Tikadar, Threatened Animals in India Calcutta: Zoological Survey of India (1983)

Jerdon’s or the Double-banded Courser (Cursorius bitorquatus) was first recorded for science by Dr. T.C. Jerdon, after whom the bird was named. He sighted the bird in 1848 in the Eastern Ghats of India. There is also a record of the bird being sighted in 1871 near the Godavari river valley in northern Andhra Pradesh. The last presumably authentic sighting was in 1900 in the Pennar river valley near Anantpur. Ornithological survey is conducted in 1929-31 and 1933-34 covered the known range of the Jordon’s Courser but failed to spot the bird. Two special explorations were organized by the Bombay Natural History Society (BNHS) in 1975 and 1976 in collaboration with the Smithsonian Institution (USA) and World Wildlife Fund- India respectively to look for this bird, but to no avail. These failed attempts led several authors to declare the Jerdon’s Courser extinct. However, considering the vastness of its potentially suitable habitat, it seemed improbable that the bird should have become extinct. The famous ornithologists Salim Ali and Dillon Ripley included on illustration of the bird in their book A Pictorial Guide to the Birds of the Indian Subcontinent in the hope that it might help someone identify the bird someday. In May 1985 as part of a research project funded by the US Fish and Wildlife Service, BNHS decided to survey the Pennar river valley in southern Andhra Pradesh to try to determine whether the Courser was indeed extinct in these areas. After eighty six years in January 1986, the Jerdon’s Courser was finally re sighted in the Lankamalai Hills. See supra n. 94

One of the most threatened species of animals in India is the Asiatic Lion (Panthera leo persica). This sub species of lion once ranged through semi-arid tracks from Greece to North-East India. In the not too distant past, the Asiatic Lion roamed over a wide stretch of the northern and central parts of the Indian sub-continent. Today the Gir forest in Gujarat
is the last refuge of this lion. Up to the turn of this century the shooting lions for game continued unabated. At one stage the population of this species had dipped to a dangerous low of 15 animals. Because of the timely intervention and conservation measures, its population, according to a lion census conducted by the Gujarat Forest Department in May 1995, stands at over 300. However, the species is still vulnerable as the entire population exists in only one pocket in the country. A single epidemic or any other disaster may well wipe out this species from the face of the earth!. To guard against such a fate, efforts are under way to find an alternate home for the Asiatic Lion where a small population could be relocated. *Ibid*

107 The Black-necked Crane (Grus nigricollis) was the last of the world’s cranes to be discovered by modern-day scientists. The local communities have, however known about them for ages. These cranes were first sighted in 1876 by the Great Russian naturalist-explorer Count Przewalski near Lake Koko Nor in north-eastern Tibet. This is the only mountain-crane species in the world. This crane’s habitat encompasses some of the most impenetrable areas on Earth, physically and politically. The crane’s breeding areas stretch from Ladakh in the west, all along the north of the Himalaya in areas bordering the upper Brahmaputra river basin (Bango River) in southern Tibet. *See Centre for Environment Education, Bio Diversity* Delhi: Oxford University Press (1997)

108 *Supra n. 95*

109 *Ibid*

110 *Supra n. 96*

111 *Ibid*


113 The introduction of exotic species can pose a threat to indigenous diversity. Invasive alien species include plants, animals and pathogens that are non-native to an ecosystem and that may cause economic or environmental harm or adversely affect human health. According to CBD reports, invasive alien species have contributed to nearly 40 per cent of all animal extinction. Introduced fish species threaten to decimate the diverse fish fauna of big African lakes. Exotic weeds such as lantana and parthenium pose forest management problems. *See Supra n. 3*


115 *Ibid*

116 *Id. at.30*


120 Global warming and climate change pose threats to plant and animal species as many organisms are sensitive to carbon dioxide concentration in the atmosphere that may lead to their disappearance. Pesticide, troposphere ozone, sulphur and nitrogen oxides from industries also contribute to the degradation of natural ecosystems. Poaching puts pressure on wild animals. Elephants are being hunted for their tusks; the tiger is being shot for its skin. Nature is beautifully balanced; each little thing has its own place, its duty and special utility. Ecosystem stability is a compelling reason for preserving biodiversity. All living organisms are an internal part of the biosphere and provide invaluable services. These include the control of pests, recycling of nutrients, replenishment of local climate and control of foods. *See Supra n. 3*
Growing population, as well as growing aspirations and consumption-oriented lifestyles of a growing number of people, will make this consumption unsustainable after a point. In addition to rapid population growth, a change in consumption patterns all over the world is causing loss of biodiversity. Greater demand for food, excessive consumption patterns all over the world is causing loss of biodiversity. Greater demand for food, excessive consumption of minerals and other non-renewable resources, and gross overuse and waste of energy, especially by the industrialized nations, aggravate these problems. In India, consumption patterns, particularly of natural resources, differ widely among different income groups. Consumption by about 50 per cent of the population accounts for a large portion of the country’s use of energy, minerals and chemicals. This consumption encourages the over-exploitation of these resources. The trend is dangerous because the rising demand for minerals, for instance, has led to the de-notification of some protected areas in the country to permit exploitation of the mineral reserves lying within these areas. The growing pressure on natural resources has affected the poorest people the most. Commercial markets for wood and paper products support commercial forestry but deprive those who depend on a variety of non-timber forest products from natural forests. Commercial demand for crop residue as fodder, and as fuel along with animal dung, deprives the poor of fuel and fertilizer. Poverty in the urban and cash-driven rural economies compels those who cannot meet their basic survival needs through purchase to rely on a fast-depleting natural resource base. The vicious cycle of uneven consumption patterns and population growth ultimately leads to exhaustion of renewable resources on which local populations depend. See Ibid


Ibid


Ibid


Wetlands have extremely high biological productivity. A large percentage of the world’s marine fish catch reproduces in these areas. Humans use several wetland plants and animals for food, and reeds and canes as materials for buildings, furniture-making and basket weaving. The papyrus swamps of Egypt provided the first material for paper; peat has been mined from peat-bogs for fuel; and floodplains provide grazing grounds for cattle. Wetlands also provide other services. They play a key role in ground water recharge. Wetland plants cleanse polluted water by absorbing nutrients from it there by minimizing eutrophication and restoring clarity to the water. Mangroves along tropical coasts act as natural barriers against sea intrusion. Wetlands are also important habitats for wild life. Some important wetland species are the Indian One-horned Rhino (Rhinoceros unicornis) found in Assam and West Bengal, and now reintroduced into Dudhwa National Park in Uttar Pradesh; Brow-antlered Deer (Cervuseldieldi) found in Manipur;
Greater Adjutant Stork (Leptitiosdubius) found in Assam; and the White- winged Wood Duck (Cairina Scutalata) See “India’s Wetlands, Mangroves and Coral Reefs” WWF (1992)

134 See Ibid
135 Supra n. 128
136 Ibid
137 Ibid
138 Supra n. 130
139 Ibid
140 Supra n. 128
142 Ibid

Conserving is a socio-economic and ecological paradigm concerning sustainable use of natural resources. It has been defined thus; conservation is concerned with the utilization of resources- the rate, purpose, and efficiency of use. Conservation has received many definitions because it has many aspects. It concerns issues arising between groups, and involves public and private enterprise. Conservation receives impetus from the social conscience, aware of an obligation to future generations and is viewed differently according to one’s social and economic philosophy. To some extent the meaning of conservation changes with time and place. It is understood differently when approached from the natural sciences and technologies than when it is approached from the social sciences. Conservation implies limits on resource utilization, both renewable and non-renewable, because excessive stress on bio-physical environment for short-term gain is ultimately counter-productive and human survival can only be ensured by preserving the basic resource base. In other words, it signifies controlled use of resources in a manner that environmental quality, ecosystems, genetic and species diversity are not degraded irreversibly to signal a catastrophic end to all life forms on earth. Massive deforestation, the resultant depletion of biodiversity and environmental degradation are issues of grave concern to the international community, which is engaged in evolving sound measures and strategies to tackle this problem. The objective is to attain the goal of sustainable development through sustainable use of natural resources. In wider sense, conservation means both preservation of the current states of resources-base and improvement in the depleted state as well. The Legal Experts Group of the World Commission on Environment and Development (WCED) defined conservation as, Management of human use of a natural resource or the environment in such a manner that it may yield the greatest sustainable benefit to present generations while maintaining its potential to meet the needs and aspirations of future generations. It embraces preservation, maintenance, sustainable utilization, restoration and enhancement of a natural resource or the environment. The linkage between Conservation and Sustainable Development is clear, so is the wider connotation of the term implying both preservation and enhancement. See WCED, Legal Principles Para (i) (1986). A clear enunciation of integration between sustainable development and conservation is found in the Brundtland Report when it states that ‘sustainable development requires the conservation of plant and animal species’ See WCED, Our Common Future (1987). Eradication of poverty (social equity) and conservation of biodiversity are integral to ‘sustainable development’, has been emphasized by Supreme Court in Vellore Citizens Welfare Forum v. Union of India (AIR 1996 (7) SC 375). The Court observed, “During the two decades from Stockholm to Rio ‘sustainable development’ has come to be accepted as a viable concept to eradicate poverty and improve the quality of human life while living within the carrying capacity of the supporting eco-system”. Id. at 384. The 1972 Stockholm Declaration for the first time integrated the conservation priorities with the sustainable use of natural resources, the emerging paradigm
of conservation, when it called for flora and fauna, to be safeguarded for the benefit of present and future generations through careful planning or management and maintenance of the earth’s capacity to produce renewable resources. (Principles 2 and 3 of Stockholm Declaration (1972)) The conceptual basis of conservation initially emerged as a balanced approach to the management and conservation of natural resources implying a realization of controlled use, (The origin of inter-governmental environmental action can be traced to 1947 UN resolution (Economic and Social Council-ECOSOC) convening the 1949 UN Conference on the Conservation and Utilization of Resources (UNCCUR), which reflected an awareness of the need for international action to establish a balanced approach to the management and conservation of natural resources. The range of topics discussed at this conference amplifies that relationship between conservation and development was clear at this stage itself. Following this, the UN and its specialized agencies addressed issues relating to conservation of flora and fauna. In 1962, the General Assembly adopted a resolution on the relationship between economic development and environmental protection. Thus, prior to the 1972 Stockholm Conference, the developments suggested that a limitation on the right of states to use their resources at will was already emerging. Developed into a concern for over exploitation of nature as a limitation on the right of the states to use their natural resources at will, more explicitly expressed in the form of a prudent, rational, or sustainable use of resources. The considerations of equity (both inter and intra-generational) came into reckoning and started shaping the future direction of environmental law, when environment-development perspective, particularly after the Stockholm Conference, became the focus. This trend blossomed into an all-encompassing principle of sustainable development. Long term global conservation policies are largely promoted by international agencies such as IUCN, UNEP and WWF. Broad policies are contained in documents such as the World Conservation Strategy (IUCN, UNEP, WWF (1980)), Caring for the Earth (IUCN, UNEP, WWF (1991)) and Global Priorities for the Year 2000 (WWF (1994)), etc. Whereas, the World Conservation Strategy emphasizes integration of conservation objectives into the economic development process, the document Caring for the Earth recognizes that people can utilize natural resources within the limits of the earth for a decent standard of living, and thus have a right to derive economic and other benefits from wild resources. This implies a human centered conservation approach, which indicates that contemporary conservation ideology represents a shift from traditional approach of predominant concern for nature preservation to sustainable use of natural resources with stronger emphasis on livelihood and, in more general terms, human welfare. As part of this shift the emerging trend now is that people, instead of being a threat to nature in the traditional mould, are viewed as potential partners in conservation and sustainable development. The Preamble of the ASEAN, Agreement on the Conservation of Nature and Natural Resources for South East India (1985) states that, “...the relationship between conservation and socio-economic development implies both that conservation is necessary to ensure sustainability of development and that socio-economic development is necessary for achieving conservation on a lasting basis”. Thus, “...as a basic principle, states are under an obligation to ensure that the conservation of natural resources and environment is treated as an integral part of the planning and Implementation of Development Activities”. See RodaMushkat, “International Environmental Law in the Asia Pacific Region: Recent Developments” 20 California Western International Law Journal 30 (1989-90)

144 Ibid
146 The Convention provides for comprehensive preservation of biological diversity with triple objectives of conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of benefits out of the utilization of genetic resources. Thus, it covers ecological, economic and social aspects of biodiversity. In
fact, the three aspects are so inextricably woven that any one inheres the other two. For example, sustainable use of components of biodiversity (economic aspect)...species, genetic and ecosystems...will lead to ecological stability and maintenance of ecological diversity (ecological aspect), and also ensure fair and equitable sharing of benefits (social aspects). A critical examination of the term ‘sustainable use’ will reveal that it has been used with great deal of flexibility encompassing all the three components, as explained above, to denote that biodiversity essentially involve three aspects. This is an improvement on the then existing notion of ‘sustainable use’, which had a restricted meaning in that it focused on adoption of standard governing the rate of use or exploitation of specific natural resources rather than on their preservation for future generations. The Preamble lists the guiding principles followed by 42 Articles and 2 Annexure. Article 1 deals with the objectives of the Convention and Article 2 define some of the terminology used in the document. A perusal of objectives reveals that the Convention is unique in that for the first time, the true value of biological resources, per se, is recognized, leading to the further acceptance that the benefits from the utilization of these resources, must be shared equitably with the South, who have conserved these resources at considerable opportunity cost. The remaining Articles deal with identification and monitoring of components of biodiversity conservation (in-situ and ex-situ) access to genetic resources and technology, handling of biotechnology, financial resources, financial mechanisms and relationship with existing agreements. Some of the major areas of concern of the Biodiversity Convention are sovereignty of national resources, sharing of benefits along with Intellectual Property Rights, conservation and sustainable use, and rights of indigenous people and local communities.

The main objective of the Convention is to establish a system for regulating the international trade in specimens of species which are or may be at the brink of extinction. With a view to arrest the trend of rapid depletion of wildlife, the Convention promotes in-situ preservation of species by regulating or restricting over-exploitation of endangered species through international commercial trade (the Preamble states the primary purpose of the Convention; international cooperation to protect wild fauna and flora against over-exploitation through international trade ), or even prohibiting such trade. The protection under CITES is depended on en-dangered of species, it does not protect biological diversity per se nor is it concerned with preservation of genetic material. The perspective is obviously restricted as in order that the protectionist regime of the Convention is applicable to a species, it must qualify the criteria of being ‘endangered’ as specified under different lists of the Convention. A brief account of the provisions of the Convention reveals that it promotes conservation of wildlife by regulating or prohibiting international trade. This scope and ambit of the Convention, is so far as its impact on biodiversity conservation is concerned is very limited and protectionist only. Notwithstanding this, it covers a very important aspect of loss of biodiversity, namely, the menace of illegal trade having world-wide network and thus attempts to halt the rapid depletion of wildlife in a significant way. See The Convention on International Trade in Endangered Species of Wild Fauna and Flora.

Under the Convention, each contracting party shall consider its international responsibilities for the conservation, management and wide use of migratory stock of waterfowl, and shall promote the conservation of wetlands and waterfowl by establishing natural resources on wetlands. The International Union for Conservation of Nature and Natural Resources (IUCN) shall perform the functions of the bureau and maintenance of the list of wetland of international importance (the list of wetlands of international importance, under Article 2, “Each contracting party shall designate suitable wetlands within its territory for inclusion in a list of wetlands of international importance”, which is maintained by the bureau established under Article 8. The boundaries to each wetland shall be precisely described and also delimited on a map and they may incorporate riparian and coastal zones adjacent to the wetlands, and islands or bodies of marine water deeper than 6 meters at low tide lying within the wetlands especially where these have
importance as waterfowl habitats). The Ramsar Convention applies to designated areas or sites (the designated area may incorporate riparian and coastal zones adjacent to the wetland, and islands or bodies of marine water and deeper than 6m at low tide within the marine wetlands. Under Article 1(1) wetlands are defined as “areas of marsh, fen, peat land or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water, etc, depth of which at low tide does not exceed 6 meters”. The endangered status of plants or animals found in a given habitat may suffice the application of this Convention for protection and conservation. In fact, the Convention protects the habitat as well as their species. For this purpose, the Convention maintains a list of habitats which are afforded special protection. In addition, the Convention imposes obligations on the contracting parties to preserve areas which are not included in such a list. Wetlands of international importance to waterfowl are to be included in the list ‘in the first instance’, but other areas may also be included on account of their international significance. Thus, protection to wetlands under Ramsar is not confined to wetlands which support waterfowl, but extends to all wetlands of ‘international significance’. See Ramsar Convention.

149 See Ibid
150 Supra n. 145
151 The UNESCO Convention for the Protection of World Cultural and Natural Heritage establishes a ‘system of collective protection of the cultural and natural heritage of outstanding universal value, organized on a permanent basis and in accordance with modern scientific methods’. Each party identifies and delineates it’s on cultural and natural heritage sites, which constitute a world heritage for whose protection it is the duty of the international community to cooperate. Apart from this, the duty of protection, conservation, presentation and transmission to future generations belongs primarily to the individual party. To that end, each party must adopt a general policy to integrate such protection into comprehensive planning programmes to set up appropriate services to foster training, and to submit reports to the general conference of UNESCO on measures taken by them. Further, each party is ‘not to take any deliberate measures which might damage directly or indirectly the cultural and natural heritage’ on the territory of other parties. In Commonwealth of Australia v. State of Tasmania (68 I.L.R. 266 (1983)) the Australian High Court held that provisions of Article 4 and 5 of the Convention imposed an international obligation on Australia to take appropriate measures for the preservation of the world heritage area. The Convention is admitted by the World Heritage Committee, which is an Inter-Governmental Committee for the protection of the cultural and natural heritage of understanding universal value, and comprises twenty-one members elected on the basis of ‘equitable representations of the different regions and cultures of the world’. The Convention also provides for a Secretariat at UNESCO, and a General Assembly of state parties to the Convention. Every state party to this Convention shall submit to the World Heritage Committee and inventory of property forming part of its cultural and natural heritage, for inclusion in the list of such heritage maintained by the committee. From the World Heritage list, the committee establishes a subsidiary ‘List of World Heritage in Danger’, comprising size threatened by ‘serious and specific dangers’ and for the conservation of which ‘major operations’ are necessary which include assistance under the Convention. The causes for dangers include threat of disappearance from accelerate deterioration, development projects, armed conflict, natural disasters, etc. The Convention provides for international assistance to the properties included in the lists for their protection, conservation, preservation or rehabilitation. For this purpose a trust fund known as ‘World Heritage Fund’ has been created under the Convention financed by compulsory and voluntary contributions, other resources. The ‘World Heritage Committee’ shall co-operate with international and national, governmental and non-governmental organizations. The committee may call on such organizations, particularly the International Centre for the Study of the Preservation and Restoration of
Cultural Property (ICOMOS), and the International Union for the Conservation of Nature and Natural Resources (IUCN) as well as on public and private bodies and individuals. The Convention promotes in-situ conservation through these methods. See M. Gadgil, “The Indian Heritage of Conservation Ethic” in B. Allchin, F.R. Allchin and B.K. Thapar (Ed) Conservation of the Indian Heritage New Delhi: Cosmo Publishers (1989)

The objective of the Convention is conservation and effective management of migratory species through the system of ‘List’ approach like the CITES. Article III provides for inclusion of migratory species in Appendix I where there is reliable evidence of the species being endangered. The species which are ‘in danger of extinction throughout all or a significant portion of its range’ are called ‘endangered’. In such a situation, state parties must endeavor to conserve and restore habitats; to prevent or minimize adverse effects of activities which seriously impede or prevent the migration of species; and to prevent, reduce or control factors that are endangering or are likely to further endanger the species. Articles IV provides for inclusion of migratory species having ‘unfavorable conservation statuses in Appendix II (which could also be listed in Appendix I) An ‘unfavorable conservation status’ exists where the migratory species, inter alia, is ‘not maintaining itself on a long-term basis as a viable component of its ecosystems’. This provision is very significant as, even though the Convention is species-specific; it lays emphasis on the viability of species-ecosystem relationship. In case of species acquiring ‘unfavorable conservation status’, the concerned states are required to endeavor to conclude agreements to benefit these species, with a view to restoring such migratory species to a favorable conservation status or to maintain such a status, the agreement should be open to accession to all range states even if they are not parties to the Bonn Convention. Thus, the Convention recognized that the wild animals are an irreplaceable part of the earth’s natural system, and attempts to establish a regulatory frame work for their conservation, particularly because international community must take special care of migratory species of wild animals that live within or pass through national jurisdictional boundaries. The necessity to conserve these migratory species arises from its great ecological importance. Supra n. 9

Ibid

See Agenda 21, UNCED (1992)

Chapter 15 of Section 11 (Conservation and Management of Resources for Development) of Agenda 21 deals with conservation of biological diversity. Under the heading ‘Programme Area’ it has given in detail the basis for action. While affirming that the states have the sovereign right to exploit their own biological resources pursuant to their environmental policies, it has called for urgent and decisive action for conserving and maintaining genes, species and ecosystems, with a view to the sustainable management and use of biological resources.

There are various Central and State legislations covering different aspects of environmental pollution, its protection and ecological balance. Some of the significant enactments are as follows;

(A) Environmental Protection

1. Environment (Protection) Act, 1986

(B) Water Pollution

2. North India Canal and Drainage Act, 1873
3. Indian Ports Act, 1908
4. River Boards Act, 1956
5. Merchant Shipping Act, 1958
6. Water (Prevention and Control of Pollution) Act, 1974
7. Water (Prevention and Control of Pollution) Cess Act, 1977
(C) Air Pollution
8. Indian Boilers’ Act, 1923
10. Factories Act, 1947
11. Industries (Development and Regulation) Act, 1951
(D) Radiation
15. Poisons Act, 1919
16. Factories Act, 1948
17. Insecticides Act, 1968
(E) Forest and Wildlife
18. Indian Forest Act, 1927
20. Wildlife (Protection) Act, 1972
(F) Biological Diversity
(G) Others
22. Indian Fisheries Act, 1897
23. Prevention of Food Adulteration Act, 1954
24. Urban Land (Ceiling and Regulation) Act, 1976
26. Mines Act, 1952
27. Mines and Minerals (Regulation and Development) Act, 1957
28. Indian Penal Code, 1860
29. Criminal Procedure Code, 1973
30. Indian Explosive Act, 1884
31. Indian Easements Act, 1882
33. National Environmental Tribunal Act, 1995
34. National Environment Appellate Tribunal Act, 1995
35. Motor Vehicles Act, 1988
36. Constitution of India, 1950
158 Preamble of the Biological Diversity Act, 2002
159 Section 7 of the Biological Diversity Act, 2002
160 Section 6 of the Biological Diversity Act, 2002
161 Section 18(4) of the Biological Diversity Act, 2002
Third world countries have become dumping grounds for various types of wastes, management of hazardous wastes and toxic substances has emerged as very significant aspect of environmental law. Maintenance of public health and safety is an essential ingredient of legal control. As such, Section 3 of Environmental (Protection) Act, 1986 empowers the Central Government, to take various measures for protecting and improving the quality of the environment and preventing, controlling and abating environmental pollution. The Government is also empowered to lay down procedures and safeguards for the handling of hazardous substances. Accordingly, under the rule-making powers of the Governments various rules dealing with procedure and safeguards for the handling of hazardous substances have been notified. These are as follows;

6. Recycled Plastics (Manufacture and Uses) Rules, 1999
7. Municipal Solid Waste (Management and Handling) Rules, 1999

This Act deals with four categories of forests, namely, reserved forests, village forests, protected forests and non-government (private) forests. The State may declare forest lands or waste lands as reserved forests and may sell the produce from these forests. Any unauthorized felling of trees, quarrying, grazing and hunting in the reserved forests is punishable with fine or imprisonment or both. Reserved forests assigned to a village community are called village forests. The State Governments are empowered to designate protected forests and may prohibit the felling of trees, quarrying and removal of forest produce from these forests. The State Government may also regulate all rights and privileges for use of the protected forest. Thus, the Act represents strong governmental intrusion into private rights of traditional communities and forest dwellers. Since, the entire focus is on state control and commercial uses mandated by a developmental strategy, protection of forest and biodiversity gets a lower priority. Consequently, this has led to depletion of natural resources and decimation of underlying rich wealth of biodiversity. See The Indian Forest Act, 1927

Section 2 of the Forest (Conservation) Act, 1980 contains the most important provision. It requires that notwithstanding anything contained in any other law for the time being in force in a state, the state Government or other authority must obtain approval of the Central Government before it ‘de-reserves’ a reserved forest, uses forest land for non-forest purposes assigns forest land to a private person or corporation of clear forest land for the purpose of reforestation. An Advisory Committee has been constituted under Section 3 of the Act to advise the Central Government on these approvals. A close scrutiny of the provisions of the Act will reveal that its schematic pattern is conservative and lacks in positive orientation to promote conservation through programmic action (Joint Management) by state and people. See The Forest (Conservation) Act, 1980

The Wildlife (Protection) Act, 1972, provides for State Wildlife Advisory Boards, regulation for hunting wild animals and birds, establishment of sanctuaries and national parks, regulation for trade in wild animals, animal products and trophies, and judicially imposed penalties for violating the Act. Hunting endangered species listed in Schedule I of the Act is prohibited throughout India. Hunting other species, like those requiring special protection (Schedule II), big game (Schedule III) and small game (Schedule IV) is regulated through licensing. Only a few species classified as vermin under Schedule V may be hunted without restrictions. The Act is administered by wildlife wardens and their
staff. An amendment to the Act made in 1982, introduced provisions permitting the capture and transportation of wild animals for the scientific management of animal population. But it was realized later that this was not sufficient. The Government, therefore, began the process of enacting a comprehensive law that would include all the aspects of wildlife, including plants. This was because, among the other things, huge quantities of endangered species of plants were being smuggled out of the country. Huge quantities of Costus root, Kuth root, Orchids and other endangered plants have been seized time and again by the wildlife preservation officers and police. Bisheshwar Mishra, “WWF Plea to HC on Plant Protection” The Times of India October 16 (1993) Finally, instead of enacting a separate comprehensive law, the Government amended the Wildlife (Protection) Act in October 1991 by inserting a new Chapter III-A which stipulated that specified plants, given in Schedule VI of the Act, were prohibited from picking, uprooting, possessing, selling etc. The newly inserted Section 17 A provides that no person shall (a) willfully pick, uproot, damage, destroy, acquire or collect any specified plant form any forest land and any area specified by notification by the Central Government, (b) possesses, sell, offer for sale or transfer by way of gift or otherwise or transport any specified plants, whether alive or dead or part or derivative thereof. Provided that nothing in the Section shall prevent a member of a schedule tribe, subjected to the Provisions of Chapter 4 from picking, collecting or possessing in the district he resides any specified plant or part or derivative thereof for his bonafide personal use. See Wildlife (Protection) Act, 1972 and Wildlife (Protection) Amendment Act, 1991


168 See Article 21 of the Constitution of India, Protection of Life and Personal Liberty- No person shall be deprived of his life and personal liberty except according to the procedure established by law.


170 Supra n. 1

171 Nokrek (Meghalaya), Nilgiri (Karnataka, Kerala, Tamil Nadu), Namdapha (Arunachal Pradesh), Nanda Devi (Uttar Pradesh), Sundarbans (West Bengal), Great Nicobar (Andaman and Nicobar Islands), and Gulf of Manner (Tamil Nadu)

172 Project Tiger was launched in 1973. It was based on the philosophy that the tiger, being at the apex of the food pyramid, acts as an indicator of the health of the entire ecosystem. (The tiger eats other carnivores (flesh-eating animals), who eat herbivores who eat plants. So if the lion is healthy, so must all other animals and plants be, down the successive levels of the food pyramid in the ecosystem). The project started with the protection of nine tiger reserves located in different habitat types. It sought to ensure that the ecosystem as well as the tiger population would be looked after. Project Tiger, once launched as one of the most successful conservation projects in the world, is facing threats from several sides. Local communities living around tiger reserves are getting increasingly resentful at their loss of rights over the resources of the reserves. In many cases they are incited enough to willfully set fire, destroy the habitat or even kill wildlife. Also, the demand for tiger bones and skin from other countries is posing a serious threat to the species itself. Some other projects launched in India to save particular species are the Gir Lion Sanctuary Project in Gujarat, Crocodile Breeding Project in Madras, Project Hangul, and conservation of the Himalaya Musk Deer, Manipur Brow-antlered Deer Project and Project Elephant. Conservation projects have also been launched to save several bird species such as the Bustard, Florican, Sarus crane and Siberian Crane. See H.S. Panwar, “Project Tiger” in V.B. Saharia (Ed) Wildlife in India Dehra Dun: Natraj Publications (1982)
Works of Ayurveda lay great emphasis on field studies and contact with people well acquainted with the use of herbs. *Susruta Samhita* mentions that ‘medical herbs and plants should be recognized and identified with the help of cowherds, hermits, huntsmen, forest dwellers and those who cull the fruits and edible roots of the forest’ (S. K. Jain, *A Manual of Ethnobotany* Scientific Publishers, Jodhpur (1995)). In most traditional agricultural societies, women have been responsible for collecting, selecting and storing seeds. Over centuries they have used their deep understanding of the characteristics and value of different crops to sustain and enhance certain traits, and even to develop new varieties. As the family’s primary health-care givers, women also possessed considerable knowledge about medicinal properties of different plants. It is important to realize the significance of this indigenous knowledge of both men and women in the context of biodiversity conservation. See Miriam L. Quinn, “Protection for Indigenous Knowledge: An International Law Analysis” 14 *St. Thomas Law Review* 287 (2001)