

Unit

4 Biodiversity and its Conservation

If we divide the whole earth's mass into 10 billion parts, it is only in one part where life exists and the astounding variety of living organisms numbering somewhere around 50 million species are all restricted to just about a kilometer-thick layer of soil, water and air. Isn't it wonderful to see that so much diversity has been created by nature on this earth from so little physical matter!

Biodiversity refers to the variety and variability among all groups of living organisms and the ecosystem complexes in which they occur. From the driest deserts to the dense tropical rainforests and from the high snow-clad mountain peaks to the deepest of ocean trenches, life occurs in a marvellous spectrum of forms, size, colour and shape, each with unique ecological inter-relationships. Just imagine how monotonous and dull the world would have been had there been only a few species of living organisms that could be counted on fingertips!

In the Convention of Biological diversity (1992) biodiversity has been defined as the variability among living organisms from all sources including *inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part.

Levels of Biodiversity

Units of biodiversity may range from the genetic level within a species to the biota in a specific region and may extend up to the great diversity found in different biomes.

■ GENETIC DIVERSITY

It is the basic source of biodiversity. The genes found in organisms can form enormous number of combinations each of which gives rise to some variability. Genes are the basic units of hereditary information transmitted from one generation to other. When the genes within the same species show different versions due to new combinations, it is called genetic variability. For example, all rice varieties belong to the

species *Oryza sativa*, but there are thousands of wild and cultivated varieties of rice which show variations at the genetic level and differ in their color, size, shape, aroma and nutrient content of the grain. This is the genetic diversity of rice.

■ SPECIES DIVERSITY

This is the variability found within the population of a species or between different species of a community. It represents broadly the species richness and their abundance in a community. There are two popular indices of measuring species diversity known as *Shannon-Wiener index* and *Simpson index*.

What is the number of species on this biosphere? The estimates of actual number vary widely due to incomplete and indirect data. The current estimates given by Wilson in 1992 put the total number of living species in a range of 10 million to 50 million. Till now only about 1.5 million living and 300,000 fossil species have been actually described and given scientific names. It is quite likely that a large fraction of these species may become extinct even before they are discovered and enlisted.

■ ECOSYSTEM DIVERSITY

This is the diversity of ecological complexity showing variations in ecological niches, trophic structure, food-webs, nutrient cycling etc. The ecosystems also show variations with respect to physical parameters like moisture, temperature, altitude, precipitation etc. Thus, there occurs tremendous diversity within the ecosystems, along these gradients. We may consider diversity in forest ecosystem, which is supposed to have mainly a dominance of trees. But, while considering a tropical rainforest, a tropical deciduous forest, a temperate deciduous forest and a boreal forest, the variations observed are just too many and they are mainly due to variations in the above mentioned physical factors. The ecosystem diversity is of great value that must be kept intact. This diversity has developed over millions of years of evolution. If we destroy this diversity, it would disrupt the ecological balance. We cannot even replace the diversity of one ecosystem by that of another. Coniferous trees of boreal forests cannot take up the function of the trees of tropical deciduous forest lands and vice versa, because ecosystem diversity has evolved with respect to the prevailing environmental conditions with well-regulated ecological balance.

■ BIOGEOGRAPHICAL CLASSIFICATION OF INDIA

India has different types of climate and topography in different parts of the country and these variations have induced enormous variability in flora and fauna. India has a rich heritage of biological diversity and occupies the tenth position among the plant rich nations of the world.

It is very important to study the distribution, evolution, dispersal and environmental relationship of plants and animals in time and space. **Biogeography** comprising of phytogeography and zoogeography deals with these aspects of plants and animals. In order to gain insight about the distribution and environmental interactions of flora and fauna of our country, it has been classified into ten biogeographic zones (Table 4.1). Each of these zones has its own characteristic climate, soil, topography and biodiversity.

Table 4.1. India's major biogeographic habitats

Sr. No.	Biogeographic Zone	Biotic Province	Total area (Sq. Km.)
1.	Trans-Himalayan	Upper Regions	186200
2.	Himalayan	North-West Himalayas West Himalayas Central Himalayas East Himalayas	6900 720000 123000 83000
3.	Desert	Kutch Thar Ladakh	45000 180000 NA
4.	Semi-Arid	Central India Gujarat-Rajwara	107600 400400
5.	Western Ghats	Malabar Coast Western Ghat Mountains	59700 99300
6.	Deccan Peninsula	Deccan Plateau South Central Plateau Eastern Plateau Chhota Nagpur Central Highlands	378000 341000 198000 217000 287000
7.	Gangetic Plain	Upper Gangetic Plain Lower Gangetic Plain	206400 153000

8.	North-East India	Brahmaputra Valley North-Eastern Hills	65200 106200
9.	Islands	Andaman Islands Nicobar Islands Lakshadweep Islands	6397 1930 180
10.	Coasts	West Coast East Coast	6500 6500

Source: "Conserving our Biological Wealth", WWF for Nature-India and Zoological Survey of India.

■ VALUE OF BIODIVERSITY

The value of biodiversity in terms of its commercial utility, ecological services, social and aesthetic value is enormous. We get benefits from other organisms in innumerable ways. Sometimes we realize and appreciate the value of the organism only after it is lost from this earth. Very small, insignificant, useless looking organism may play a crucial role in the ecological balance of the ecosystem or may be a potential source of some invaluable drug for dreaded diseases like cancer or AIDS. The multiple uses of biodiversity or biodiversity value has been classified by McNeely *et al* in 1990 as follows:

(i) **Consumptive use value:** These are direct use values where the biodiversity product can be harvested and consumed directly e.g. fuel, food, drugs, fibre etc.

Food: A large number of wild plants are consumed by human beings as food. About 80,000 edible plant species have been reported from wild. About 90% of present day food crops have been domesticated from wild tropical plants. Even now our agricultural scientists make use of the existing wild species of plants that are closely related to our crop plants for developing new hardy strains. Wild relatives usually possess better tolerance and hardiness. A large number of wild animals are also our sources of food.

Drugs and medicines: About 75% of the world's population depends upon plants or plant extracts for medicines. The wonder drug *Penicillin* used as an antibiotic is derived from a fungus called *Penicillium*. Likewise, we get *Tetracyclin* from a bacterium. Quinine, the cure for malaria is obtained from the bark of *Cinchona* tree, while *Digitalin* is obtained from foxglove (*Digitalis*) which is an effective cure for heart ailments. Recently *vinblastin* and *vincristine*, two anticancer drugs, have been obtained from Periwinkle (*Catharanthus*) plant, which

possesses anticancer alkaloids. A large number of marine animals are supposed to possess anti-cancer properties which are yet to be explored systematically.

Fuel: Our forests have been used since ages for fuel wood. The fossil fuels coal, petroleum and natural gas are also products of fossilized biodiversity. Firewood collected by individuals are not normally marketed, but are directly consumed by tribals and local villagers, hence falls under consumptive value.

(ii) **Productive use values:** These are the commercially usable values where the product is marketed and sold. It may include lumber or wild gene resources that can be traded for use by scientists for introducing desirable traits in the crops and domesticated animals. These may include the animal products like tusks of elephants, musk from musk deer, silk from silk-worm, wool from sheep, fir of many animals, lac from lac insects etc, all of which are traded in the market. Many industries are dependent upon the productive use values of biodiversity e.g.- the paper and pulp industry, Plywood industry, Railway sleeper industry, Silk industry, textile industry, ivory-works, leather industry, pearl industry etc.

Despite international ban on trade in products from endangered species, smuggling of fur, hide, horns, tusks, live specimen etc. worth millions of dollars are being sold every year. Developing countries in Asia, Africa and Latin America are the richest biodiversity centers and wild life products are smuggled and marketed in large quantities to some rich western countries and also to China and Hong Kong where export of cat skins and snake skins fetches a booming business.

(iii) **Social Value:** These are the values associated with the social life, customs, religion and psycho-spiritual aspects of the people. Many of the plants are considered holy and sacred in our country like Tulsi (holy basil), Peepal, Mango, Lotus, Bael etc. The leaves, fruits or flowers of these plants are used in worship or the plant itself is worshipped. The tribal people are very closely linked with the wild life in the forests. Their social life, songs, dances and customs are closely woven around the wildlife. Many animals like Cow, Snake, Bull, Peacock, Owl etc. also have significant place in our psycho-spiritual arena and thus hold special social importance. Thus biodiversity has distinct social value, attached with different societies.

(iv) **Ethical value:** It is also sometimes known as **existence value**. It involves ethical issues like “*all life must be preserved*”. It is based on the concept of “*Live and Let Live*”. If we want our human race to survive, then we must protect all biodiversity, because biodiversity is valuable.

The ethical value means that we may or may not use a species, but knowing the very fact that this species exists in nature gives us pleasure. We all feel sorry when we learn that “passenger pigeon” or “dodo” is no more on this earth. We are not deriving anything direct from Kangaroo, Zebra or Giraffe, but we all strongly feel that these species should exist in nature. This means, there is an ethical value or existence value attached to each species.

(v) **Aesthetic value:** Great aesthetic value is attached to biodiversity. No one of us would like to visit vast stretches of barren lands with no signs of visible life. People from far and wide spend a lot of time and money to visit wilderness areas where they can enjoy the aesthetic value of biodiversity and this type of tourism is now known as *eco-tourism*. The “*Willingness to pay*” concept on such eco-tourism gives us even a monetary estimate for aesthetic value of biodiversity. Ecotourism is estimated to generate about 12 billion dollars of revenue annually, that roughly gives the aesthetic value of biodiversity.

(vi) **Option values:** These values include the potentials of biodiversity that are presently unknown and need to be explored. There is a possibility that we may have some potential cure for AIDS or cancer existing within the depths of a marine ecosystem, or a tropical rain-forest.

Thus option value is the value of knowing that there are biological resources existing on this biosphere that may one day prove to be an effective option for something important in the future. Thus, the option value of biodiversity suggests that any species may prove to be a miracle species someday. The biodiversity is like precious gifts of nature presented to us. We should not commit the folly of losing these gifts even before unwrapping them.

The option value also includes the values, in terms of the option to visit areas where a variety of flora and fauna, or specifically some endemic, rare or endangered species exist.

(vii) **Ecosystem service value:** Recently, a non-consumptive use value related to self maintenance of the ecosystem and various important ecosystem services has been recognized. It refers to the services provided by ecosystems like prevention of soil erosion, prevention of floods, maintenance of soil fertility, cycling of nutrients, fixation of nitrogen, cycling of water, their role as carbon sinks, pollutant absorption and reduction of the threat of global warming etc.

Different categories of biodiversity value clearly indicate that ecosystem, species and genetic diversity all have enormous potential and a decline in biodiversity will lead to huge economic, ecological and socio-cultural losses.

Biodiversity value of some selected organisms in monetary terms

- A male lion living upto an age of 7 years can generate upto \$ 515,000 due to its aesthetic value as paid by tourists, whereas if killed for the lion skin a market price upto \$ 1,000 can be fetched.
- In its lifetime a Kenyan elephant can earn worth \$ 1 million as tourist revenue.
- The mountain gorillas in Rwanda are fetching \$ 4 million annually through eco-tourism.
- Whale watching on Hervey Bay on Queensland's coast earns \$12 million annually.
- Tourism to Great Barrier Reef in Australia earns \$ 2 billion each year.
- A typical tree provides \$ 196,2150 worth of ecological services as oxygen, clean air, fertile soil, erosion control, water recycling, wildlife habitat, toxic gas moderation etc. Whereas its worth is only about \$ 590 if sold in the market as timber.

■ GLOBAL BIODIVERSITY

Following the 1992 “Earth Summit” at Rio de Janeiro, it became evident that there is a growing need to know and scientifically name, the huge number of species which are still unknown on this earth. Roughly 1.5 million species are known till date which is perhaps 15% or may be just 2% of the actual number. Tropical deforestation alone is reducing the biodiversity by half a percent every year. Mapping the biodiversity has therefore, been rightly recognized as an emergency task in order to plan its conservation and practical utilization in a judicious manner.

Terrestrial biodiversity of the earth is best described as *biomes*, which are the largest ecological units present in different geographic areas and are named after the dominant vegetation e.g. the tropical rainforests, tall grass prairies, savannas, desert, tundra etc.

The tropical rainforests are inhabited by teeming millions of species of plants, birds, amphibians, insects as well as mammals. They are the earth's largest storehouse of biodiversity. Many of these species have developed over the time in highly specialized niches and that makes them more vulnerable to extinction when their natural home or niche is destroyed. About 50 to 80% of global biodiversity lies in these rainforests. More than one-fourth of the world's prescription drugs are extracted from plants growing in tropical forests. Out of the 3000 plants identified by National Cancer Research Institute as sources of cancer

fighting chemicals, 70% come from tropical rain forests. Very recently, extract from one of the creeping vines in the rainforests at Cameroon has proved effective in the inhibition of replication of AIDS virus. It is interesting to note that the common Neem tree, so popular in tropical India, known for its medicinal properties has now come into lime light even in the western temperate countries.

There is an estimated 1,25,000 flowering plant species in tropical forests. However, till now we know only 1-3% of these species. Needless to say, we must try in every way to protect our tropical rainforests. The Silent Valley in Kerala is the only place in India where tropical rain forests occur. You may recall the case of Silent Valley Hydroelectric Project, which was abandoned mainly because it had put to risk our only tropical rain forest biodiversity.

Temperate forests have much less biodiversity, but there is much better documentation of the species. Globally, we have roughly 1,70,000 flowering plants, 30,000 vertebrates and about 2,50,000 other groups of species that have been described. There is a stupendous task of describing the remaining species which may range anywhere from 8 million to 100 million.

Table 4.2 shows the estimated number of some known living species in different taxonomic groups:

**Table 4.2 Living species estimates
(World Resource Institute, 1999)**

Taxonomic group	Number
Bacteria & Cyanobacteria	5,000
Protozoans (Single celled animals)	31,000
Algae	27,000
Fungi (Molds, Mushrooms)	45,000
Higher Plants	2,50,000
Sponges	5,000
Jelly fish, Corals etc.	10,000
Flatworms, roundworms, earthworms	36,000
Snails, Clams, Slugs etc	70,000
Insects	7,50,000
Mites, Ticks, Croaks, shrimps	1,20,000
Fish and Sharks	22,000
Amphibians	4,000
Reptiles	5,000
Birds	9,000
Mammals	4,000
Total	1,400,000

It is interesting to know that marine diversity is even much higher than terrestrial biodiversity and ironically, they are still less known and described. Estuaries, coastal waters and oceans are biologically diverse and the diversity is just dazzling. Sea is the cradle of every known animal phylum. Out of the 35 existing phyla of multicellular animals, 34 are marine and 16 of these are exclusively marine.

■ BIOLOGICAL DIVERSITY AT NATIONAL LEVEL (Indian Biodiversity):

Every country is characterized by its own biodiversity depending mainly on its climate. India has a rich biological diversity of flora and fauna. Overall six percent of the global species are found in India. It is estimated that **India ranks 10th among the plant rich countries of the world, 11th in terms of number of endemic species of higher vertebrates and 6th among the centers of diversity and origin of agricultural crops.**

The total number of living species identified in our country is 150,000. Out of a total of 25 biodiversity hot-spots in the world, India possesses two, one in the north-east region and one in the western ghats. Indian is also one of the 12 mega-biodiversity countries in the world, which will be discussed later.

■ REGIONAL OR LOCAL BIODIVERSITY

Biodiversity at regional level is better understood by categorizing species richness into four types, based upon their spatial distribution as discussed below

(i) **Point richness** refers to the number of species that can be found at a single point in a given space.

(ii) **Alpha (α -) richness** refers to the number of species found in a small homogeneous area

(iii) **Beta (β -) richness** refers to the rate of change in species composition across different habitats.

(iv) **Gamma (γ -) richness** refers to the rate of change across large landscape gradients.

α -richness is strongly correlated with physical environmental variables. For example, there are 100 species of tunicates in arctic waters, 400 species in temperate waters and 600 in tropical seas. Thus, temperature seems to be the most important factor affecting α -richness of tunicates.

β -richness means that the cumulative number of species increases as more heterogeneous habitats are taken into consideration. For example, the ant species found in local regions of north pole is merely 10. As we keep on moving towards the equator and thus add more and more habitats, the number of species of ants reaches as high as 2000 on the equatorial region.

■ INDIA AS A MEGA-DIVERSITY NATION

India is one of the 12 megadiversity countries in the world. The Ministry of Environment and Forests, Govt. of India (2000) records 47,000 species of plants and 81,000 species of animals which is about 7% and 6.5% respectively of global flora and fauna.

Table 4.3. Distribution of species in some major groups of flora and fauna in India

Group-wise species Distribution			
Plants	Number	Animals	Number
Bacteria	850	Lower groups	9979
Fungi	23,000	Mollusca	5042
Algae	2500	Arthropoda	57,525
Bryophytes	2564	Pisces (Fishes)	2546
		Amphibia	
Pteridophytes	1022	Reptiles	428
Gymnosperms	64	Birds	1228
Angiosperms	15,000	Mammals	204
			372

Endemism: Species which are restricted only to a particular area are known as endemic. India shows a good number of endemic species. About 62% of amphibians and 50% of lizards are endemic to India. Western ghats are the site of maximum endemism.

Center of origin: A large number of species are known to have originated in India. Nearly 5000 species of flowering plants had their origin in India. From agro-diversity point of view also our country is quite rich. India has been the center of origin of 166 species of crop plants and 320 species of wild relatives of cultivated crops, thereby providing a broad spectrum of diversity of traits for our crop plants.

Marine diversity: Along 7500 km long coastline of our country in the mangroves, estuaries, coral reefs, back waters etc. there exists a

rich biodiversity. More than 340 species of corals of the world are found here. The marine diversity is rich in mollusks, crustaceans (crabs etc.), polychaetes and corals. Several species of Mangrove plants and seagrasses (Marine algae) are also found in our country.

A large proportion of the Indian Biodiversity is still unexplored. There are about 93 major wet lands, coral reefs and mangroves which need to be studied in detail. Indian forests cover 64.01 million hectares having a rich biodiversity of plants in the Trans-Himalayan, north-west, west, central and eastern Himalayan forests, western ghats, coasts, deserts, Gangetic plains, deccan plateau and the Andaman, Nicobar and Lakshadweep islands. Due to very diverse climatic conditions there is a complete rainbow spectrum of biodiversity in our country.

■ HOT SPOTS OF BIODIVERSITY

Areas which exhibit high species richness as well as high species endemism are termed as hot spots of biodiversity. The term was introduced by Myers (1988). There are 25 such hot spots of biodiversity on a global level out of which two are present in India, namely the Eastern Himalayas and Western Ghats (Table 4.4).

These hotspots covering less than 2% of the world's land area are found to have about 50% of the terrestrial biodiversity. According to Myers *et al.* (2000) an area is designated as a hotspot when it contains at least 0.5% of the plant species as endemics.

About 40% of terrestrial plants and 25% of vertebrate species are endemic and found in these hotspots. After the tropical rain forests, the second highest number of endemic plant species are found in the Mediterranean (Mittermeier). Broadly, these hot spots are in Western Amazon, Madagascar, North and East Borneo, North Eastern Australia, West Africa and Brazilian Atlantic forests. These are the areas of high diversity, endemism and are also threatened by human activities. More than 1 billion people (about 1/6th of the world's population) most of whom are desperately poor people, live in these areas. Any measures of protecting these hotspots need to be planned keeping in view the human settlements and tribal issues.

Earlier 12 hot spots were identified on a global level. Later Myers *et al* (2000) recognized 25 hot spots as shown in Table 4.3. Two of these hotspots lie in India extending into neighbouring countries namely, Indo-Burma region (covering Eastern Himalayas) and Western Ghats - Sri Lanka region. The Indian hot spots are not only rich in floral wealth and endemic species of plants but also reptiles, amphibians, swallow tailed butterflies and some mammals.

Table 4.4. Global hotspots of biodiversity

Hotspots	Plant Species	Endemic Plants	% of Global Plants	Vertebrate Species	Endemic Vertebrates	% of Global Vertebrates
1. Tropical Andes	45000	20000	6.7	3389	1567	5.7
2. Mesoamerican forests	24000	5000	1.7	2859	1159	4.2
3. Caribbean	12000	7000	2.3	1518	779	2.9
4. Brazil's Atlantic Forest	20000	8000	2.7	1361	567	2.1
5. Choc/Darien of Panama	9000	2250	0.8	1625	418	1.5
6. Western Ecuador	10000	4400	1.5	1268	117	0.4
7. Central Chile	3429	1605	0.5	335	61	0.2
8. California Floristic Province	4426	2125	0.7	584	71	0.3
9. Madagascar	12000	9704	3.2	987	771	2.8
10. Eastern Arc and Coastal Forest of Tanzania/Kenya	4000	1500	0.5	1019	121	0.4
11. Western African Forests	9000	2250	0.8	1320	270	1.0

Hotspots	Plant Species	Endemic Plants	% of Global Plants	Vertebrate Species	Endemic Vertebrates	% of Global Vertebrates
12. Cape Floristic Province	8200	5682	1.9	562	53	0.2
13. Succulent Karoo	4849	1940	0.6	472	45	0.2
14. Mediterranean Basin	25000	13000	4.3	770	235	0.9
15. Caucasus	6300	1600	0.5	632	59	0.2
16. Sundaland	25000	15000	5.0	1800	701	2.6
17. Wallacea	10000	1500	0.5	1142	529	1.9
18. Philippines	7620	5832	1.9	1093	518	1.9
19. Indo-Burma/Eastern Himalayas	13500	7000	2.3	2185	528	1.9
20. South-Central China	12000	3500	1.2	1141	178	0.7
21. Western-Ghats/Sri Lanka	4780	2180	0.7	1073	355	1.3
22. South-western Australia	5469	4331	1.4	456	100	0.4
23. New Caledonia	3332	2551	0.9	190	84	0.3
24. New Zealand	2300	1865	0.6	217	136	0.5
25. Polynesia/Micronesia	6557	3334	1.1	342	223	0.8
Total	—	133,149	44.4	—	9645	35.3

Source: Myers *et al.*, 2000.

(a) **Eastern Himalayas:** They display an ultra-varied topography that fosters species diversity and endemism. There are numerous deep and semi-isolated valleys in Sikkim which are extremely rich in endemic plant species. In an area of 7298 Km² of Sikkim about 4250 plant species are found of which 60% are endemic.

The forest cover of Eastern Himalayas has dwindled to about 1/3rd of its original cover. Certain species like *Sapria himalayana*, a parasitic angiosperm was sighted only twice in this region in the last 70 years.

Recent studies have shown that North East India along with its contiguous regions of Burma and Chinese provinces of Yunnan and Schezwan is an active center of organic evolution and is considered to be the cradle of flowering plants. Out of the world's recorded flora 30% are endemic to India of which 35,000 are in the Himalayas.

(b) **Western Ghats:** It extends along a 17,000 Km² strip of forests in Maharashtra, Karnataka, Tamil Nadu and Kerala and has 40% of the total endemic plant species. 62% amphibians and 50% lizards are endemic to Western Ghats.

Forest tracts upto 500 m elevation covering 20% of the forest expanse are evergreen while those in 500-1500 m range are semi-evergreen. The major centers of diversity are *Agastyamalai Hills* and *Silent Valley—the New Amambalam Reserve Basin*. It is reported that only 6.8% of the original forests are existing today while the rest has been deforested or degraded, which raises a serious cause of alarm, because it means we have already lost a huge proportion of the biodiversity.

Although the hotspots are characterized by endemism, interestingly, a few species are common to both the hotspots in India. Some common plants include *Ternstroemia japonica*, *Rhododendron* and *Hypericum*, while the common fauna includes laughing thrush, Fairy blue bird, lizard hawk etc. indicating their common origin long back in the geological times.

■ THREATS TO BIODIVERSITY

Extinction or elimination of a species is a natural process of evolution. In the geologic period the earth has experienced mass extinctions. During evolution, species have died out and have been replaced by others. However, the rate of loss of species in geologic past has been a slow process, keeping in view the vast span of time going back to 444 million years. The process of extinction has become particularly fast in the recent years of human civilization. In this century, the human impact

has been so severe that thousands of species and varieties are becoming extinct annually. *One of the estimates by the noted ecologist, E.O. Wilson puts the figure of extinction at 10,000 species per year or 27 per day!* This startling figure raises an alarm regarding the serious threat to biodiversity. Over the last 150 years the rate of extinction has escalated more dramatically. If the present trend continues we would lose 1/3rd to 2/3rd of our current biodiversity by the middle of twenty first century.

Let us consider some of the major causes and issues related to threats to biodiversity.

■ LOSS OF HABITAT

Destruction and loss of natural habitat is the single largest cause of biodiversity loss. Billions of hectares of forests and grasslands have been cleared over the past 10,000 years for conversion into agriculture lands, pastures, settlement areas or development projects. These natural forests and grasslands were the natural homes of thousands of species which perished due to loss of their natural habitat. Severe damage has been caused to wetlands thinking them to be useless ecosystems. The unique rich biodiversity of the wetlands, estuaries and mangroves are under the most serious threat today. The wetlands are destroyed due to draining, filling and pollution thereby causing huge biodiversity loss.

Sometimes the loss of habitat is in instalments so that the habitat is divided into small and scattered patches, a phenomenon known as **habitat fragmentation**. There are many wild life species such as bears and large cats that require large territories to subsist. They get badly threatened as they breed only in the interiors of the forests. Due to habitat fragmentation many song birds are vanishing.

There has been a rapid disappearance of tropical forests in our country also, at a rate of about 0.6% per year. With the current rate of loss of forest habitat, it is estimated that 20-25% of the global flora would be lost within a few years. Marine biodiversity is also under serious threat due to large scale destruction of the fragile breeding and feeding grounds of our oceanic fish and other species, as a result of human intervention.

■ POACHING

Illegal trade of wildlife products by killing prohibited endangered animals i.e. poaching is another threat to wildlife. Despite international ban on trade in products from endangered species, smuggling of wildlife items like furs, hides, horns, tusks, live specimens and herbal products

worth millions of dollars per year continues. The developing nations in Asia, Latin America and Africa are the richest source of biodiversity and have enormous wealth of wildlife. The rich countries in Europe and North America and some affluent countries in Asia like Japan, Taiwan and Hong Kong are the major importers of the wild life products or wild life itself.

The trading of such wild life products is highly profit making for the poachers who just hunt these prohibited wild life and smuggle it to other countries mediated through a mafia. *The cost of elephant tusks can go upto \$ 100 per kg; the leopard fur coat is sold at \$ 100,000 in Japan while bird catchers can fetch upto \$ 10,000 for a rare hyacinth macaw, a beautiful coloured bird, from Brazil.* The worse part of the story is that for every live animal that actually gets into the market, about 50 additional animals are caught and killed.

If you are fond of rare plants, fish or birds, please make sure that you are not going for the endangered species or the wild-caught species. Doing so will help in checking further decline of these species. Also do not purchase furcoat, purse or bag, or items made of crocodile skin or python skin. You will certainly help in preserving biodiversity by doing so.

■ MAN-WILDLIFE CONFLICTS

We have discussed about the need to preserve and protect our wildlife. However, sometimes we come across conflicting situations when wildlife starts causing immense damage and danger to man and under such conditions it becomes very difficult for the forest department to pacify the affected villagers and gain local support for wild-life conservation.

Instances of man animal conflicts keep on coming to lime light from several states in our country. In Sambalpur, Orissa 195 humans were killed in the last 5 years by elephants. In retaliation the villagers killed 98 elephants and badly injured 30 elephants. Several instances of killing of elephants in the border regions of Kote-Chamarajanagar belt in Mysore have been reported recently. The man-elephant conflict in this region has arisen because of the massive damage done by the elephants to the farmer's cotton and sugarcane crops. The agonized villagers electrocute the elephants and sometimes hide explosives in the sugarcane fields, which explode as the elephants intrude into their fields. In fact, more killings are done by locals than by poachers. Recently, in early 2004, a man-eating tiger was reported to kill 16 Nepalese people and one 4-year old child inside the Royal Chitwan

National Park, 240 Km South-west of Kathmandu. The Park renowned for its wildlife conservation effort has became a zone of terror for the locals. At times, such conflicting situations have been reported from the border regions of Corbett, Dudhwa, Palamau and Ranthambore National Parks in our country as well. Very recently in June, 2004 two men were killed by leopards in Powai, Mumbai. A total of 14 persons were killed during 19 attacks since January by the leopards from the Sanjay Gandhi National Park, Mumbai which has created a panic among the local residents.

Causes of Man-animal conflicts: The root causes of these conflicts are discussed below:

(i) Dwindling habitats of tigers, elephants, rhinos and bears due to shrinking forest cover compels them to move outside the forest and attack the field or sometimes even humans. Human encroachment into the forest areas raises a conflict between man and the wildlife, perhaps because it is an issue of survival of both.

(ii) Usually the ill, weak and injured animals have a tendency to attack man. Also, the female tigress attacks the human if she feels that her newborn cubs are in danger. But the biggest problem is that if human-flesh is tasted once then the tiger does not eat any other animal. At the same time, it is very difficult to trace and cull the man-eating tiger and in the process many innocent tigers are also killed.

(iii) Earlier, forest departments used to cultivate paddy, sugarcane etc. within the sanctuaries when the favourite staple food of elephants i.e. bamboo leaves were not available. Now due to lack of such practices the animals move out of the forest in search of food. It may be noted that, One adult elephant needs 2 quintals of green fodder and 150 kg of clean water daily and if it is not available, the animal strays out.

(iv) Very often the villagers put electric wiring around their ripe crop fields. The elephants get injured, suffer in pain and turn violent.

(v) Earlier there used to be wild-life corridors through which the wild animals used to migrate seasonally in groups to other areas. Due to development of human settlements in these corridors, the path of wildlife has been disrupted and the animals attack the settlements.

(vi) The cash compensation paid by the government in lieu of the damage caused to the farmers crop is not enough. In Mysore, a farmer gets a compensation of Rs. 400/- per quintal of expected yield while the market price is Rs. 2400/- per quintal. The agonized farmer therefore gets revengeful and kills the wild animals.

Remedial Measures to Curb the Conflict

(i) Tiger Conservation Project (TCP) has made provisions for making available vehicles, tranquillizer guns, binoculars and radio sets etc. to tactfully deal with any imminent danger.

(ii) Adequate crop compensation and cattle compensation scheme must be started, along with substantial cash compensation for loss of human life.

(iii) Solar powered fencing should be provided along with electric current proof trenches to prevent the animals from straying into fields.

(iv) Cropping pattern should be changed near the forest borders and adequate fodder, fruit and water should be made available for the elephants within forest zones.

(v) Wild life corridors should be provided for mass migration of big animals during unfavorable periods. About 300 km² area is required for elephant corridors for their seasonal migration.

(vi) In Simlipal Sanctuary, Orissa there is a ritual of wild animal hunting during the months of April-May for which forest is burnt to flush out the animals. Due to massive hunting by people, there is a decline in prey of tigers and they start coming out of the forest in search of prey. Now there is WWF-TCP initiative to curb this ritual of "Akhand Shikar" in Orissa.

■ ENDANGERED SPECIES OF INDIA

The International Union for Conservation of Nature and Natural Resources (IUCN) publishes the Red Data Book which includes the list of endangered species of plants and animals. The red data symbolizes the warning signal for those species which are endangered and if not protected are likely to become extinct in near future.

In India, nearly 450 plant species have been identified in the categories of endangered, threatened or rare. Existence of about 150 mammals and 150 species of birds is estimated to be threatened while an unknown number of species of insects are endangered. It may not be of direct relevance here to give a complete list of endangered flora and fauna of our country. However, a few species of endangered reptiles, birds, mammals and plants are given below:

(a) Reptiles : Gharial, green sea turtle, tortoise, python

(b) Birds : Great Indian bustard, Peacock, Pelican, Great Indian Hornbill, Siberian White Crane

- (c) Carnivorous : Indian wolf, red fox, Sloth bear, red panda, Mammals tiger, leopard, striped hyena, Indian lion, golden cat, desert cat, dugong
- (d) Primates : Hoolock gibbon, lion-tailed macaque, Nilgiri langur, Capped monkey, golden monkey
- (e) Plants : A large number of species of orchids, Rhododendrons, medicinal plants like *Rauvolfia serpentina*, the sandal wood tree *Santalum*, *Cycas beddonei* etc.

The Zoological Survey of India reported that Cheetah, Pink headed duck and mountain quail have already become extinct from India.

- A species is said to be *extinct* when it is not seen in the wild for 50 years at a stretch e.g. Dodo, passenger pigeon.
- A species is said to be *endangered* when its number has been reduced to a critical level or whose habitats, have been drastically reduced and if such a species is not protected and conserved, it is in immediate danger of extinction.
- A species is said to be in *vulnerable* category if its population is facing continuous decline due to overexploitation or habitat destruction. Such a species is still abundant, but under a serious threat of becoming endangered if causal factors are not checked.
- Species which are not endangered or vulnerable at present, but are at a risk are categorized as *rare* species. These taxa are usually localized within restricted areas i.e. they are usually endemic. Sometimes they are thinly scattered over a more extensive area.

Some important endangered and extinct species are shown in Plate IV.

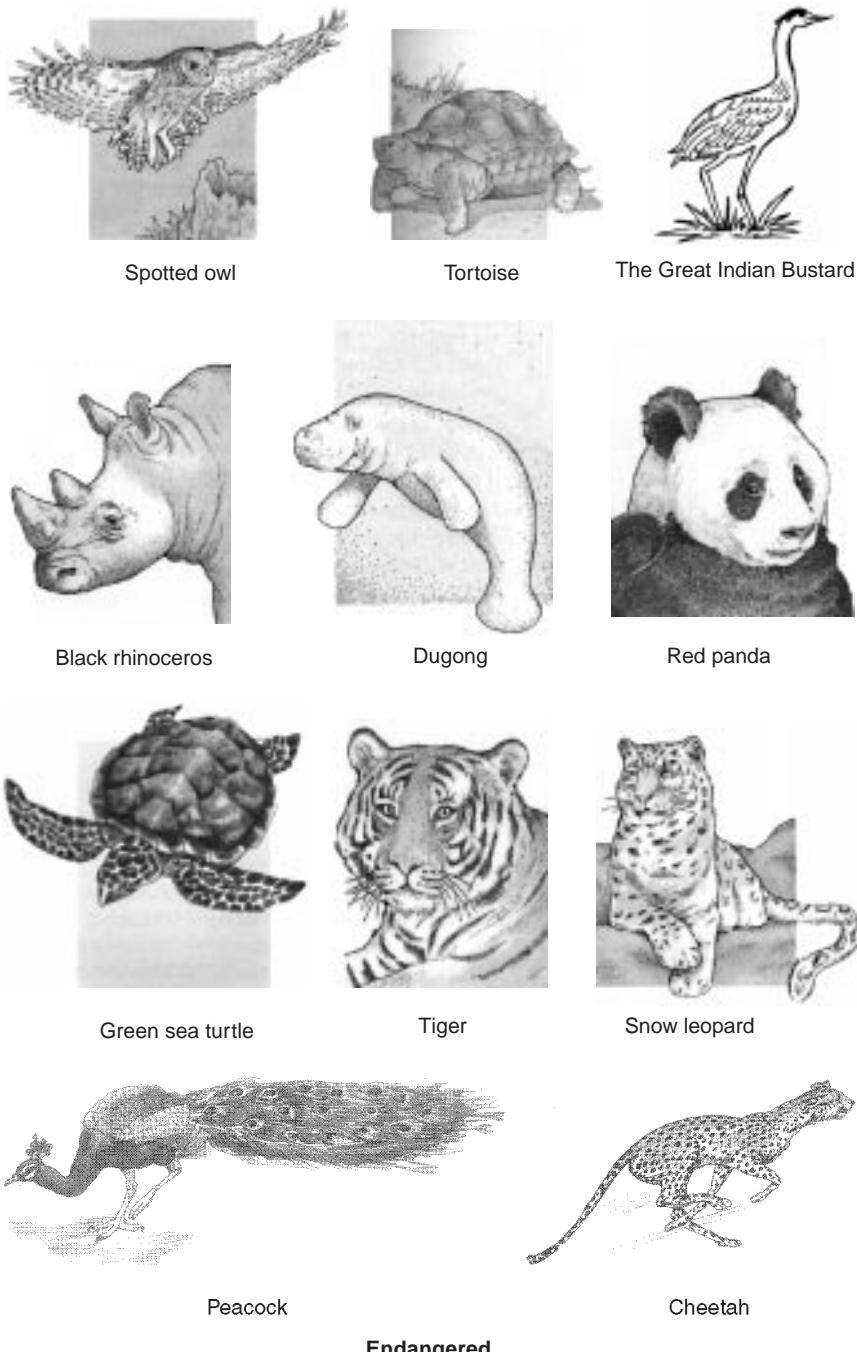


Passenger pigeon



Dodo

Extinct



Endangered

Plate IV. Some important extinct and endangered Indian species of animals.

■ ENDEMIC SPECIES OF INDIA

India has two biodiversity hot spots and thus possesses a large number of endemic species. Out of about 47,000 species of plants in our country 7000 are endemic. Thus, Indian subcontinent has about 62% endemic flora, restricted mainly to Himalayas, Khasi Hills and Western Ghats. Some of the important endemic flora include orchids and species like *Sapria himalayana*, *Uvaria lurida*, *Nepenthes khasiana*, *Pedicularis perroter* etc. Some endemic plant species are shown in Plate V.

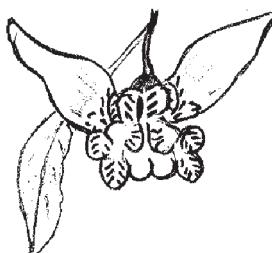
A large number out of a total of 81,000 species of animals in our country is endemic. The western ghats are particularly rich in amphibians (frogs, toads etc.) and reptiles (lizards, crocodiles etc.). About 62% amphibians and 50% lizards are endemic to Western Ghats. Different species of monitor lizards (*Varanus*), reticulated python and Indian Salamander and Viviparous toad *Nectophryne* are some important endemic species of our country.



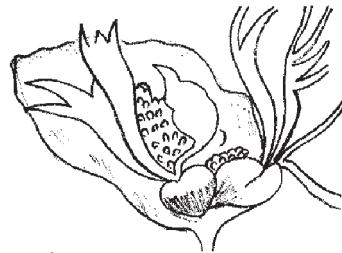
Toothbrush orchid
endemic to Sikkim



Nepenthes khasiana
(Pitcher plant)
Endangered and endemic



An endangered
endemic orchid of
Eastern Himalayas



Platycerium, rare and
endemic to Manipur

Plate V. Some endemic and endangered plants.

■ CONSERVATION OF BIODIVERSITY

The enormous value of biodiversity due to their genetic, commercial, medical, aesthetic, ecological and optional importance emphasizes the need to conserve biodiversity. Gradually we are coming to realize that wildlife is not just 'a game to be hunted', rather it is a 'gift of nature' to be nurtured and enjoyed. A number of measures are now being taken the world over to conserve biodiversity including plants and wildlife.

There are two approaches of biodiversity conservation:

(a) *In situ* conservation (within habitat): This is achieved by protection of wild flora and fauna in nature itself. e.g. Biosphere Reserves, National Parks, Sanctuaries, Reserve Forests etc.

(b) *Ex situ* conservation (outside habitats) This is done by establishment of gene banks, seed banks, zoos, botanical gardens, culture collections etc.

***In Situ* Conservation**

At present we have 7 major Biosphere reserves, 80 National Parks, 420 wild-life sanctuaries and 120 Botanical gardens in our country covering 4% of the geographic area.

The ***Biosphere Reserves*** conserve some representative ecosystems as a whole for long-term *in situ* conservation. In India we have Nanda Devi (U.P.), Nokrek (Meghalaya), Manas (Assam), Sunderbans (West Bengal), Gulf of Mannar (Tamil Nadu), Nilgiri (Karnataka, Kerala, Tamil Nadu), Great Nicobars and Similipal (Orrisa) biosphere Reserves. Within the Biosphere reserves we may have one or more National Parks. For example, Nilgiri Biosphere Reserve has two National Parks *viz.* Bandipur and Nagarhole National Park.

A **National Park** is an area dedicated for the conservation of wildlife along with its environment. It is also meant for enjoyment through tourism but without impairing the environment. Grazing of domestic animals, all private rights and forestry activities are prohibited within a National Park. Each National Park usually aims at conservation specifically of some particular species of wildlife along with others. Some major National Parks of our country are enlisted in the Table 4.5 below:

Table 4.5. Some important National parks in India

Name of National Park	State	Important Wildlife
Kaziranga	Assam	One horned Rhino
Gir National Park	Gujarat	Indian Lion
Dachigam	J & K	Hangul
Bandipur	Karnataka	Elephant
Periyar	Kerala	Elephant, Tiger
Kanha	M.P.	Tiger
Corbett	U.P.	Tiger
Dudwa	U.P.	Tiger
Ranthambore	Rajasthan	Tiger
Sariska	Rajasthan	Tiger

Wildlife sanctuaries are also protected areas where killing, hunting, shooting or capturing of wildlife is prohibited except under the control of highest authority. However, private ownership rights are permissible and forestry operations are also permitted to an extent that they do not affect the wildlife adversely.

Some major wildlife sanctuaries of our country are shown in Table 4.6.

Table 4.6. Some Important Wildlife Sanctuaries of India

Name of Sanctuary	State	Major Wild Life
Ghana Bird Sanctuary	Rajasthan	300 species of birds (including migratory)
Hazaribagh Sanctuary	Bihar	Tiger, Leopard
Sultanpur Bird Sanctuary	Haryana	Migratory birds
Nal Sarovar Bird Sanctuary	Gujarat	Water birds
Abohar Wildlife Sanctuary	Punjab	Black buck
Mudamalai Wildlife Sanctuary	Tamil Nadu	Tiger, elephant, Leopard
Vedanthangal Bird Sanctuary	Tamil Nadu	Water birds
Jaldapara Wild Life Sanctuary	W. Bengal	Rhinoceros, elephant, Tiger
Wild Ass Sanctuary	Gujarat	Wild ass, wolf, nilgai, chinkara

For plants, there is one gene sanctuary for Citrus (Lemon family) and one for pitcher plant (an insect eating plant) in Northeast India. For the protection and conservation of certain animals, there have been specific projects in our country e.g. Project Tiger, Gir Lion Project, Crocodile Breeding Project, Project Elephant, Snow Leopard Project etc.

Ex situ Conservation: This type of conservation is mainly done for conservation of crop varieties, the wild relatives of crops and all the local varieties with the main objective of conserving the total genetic variability of the crop species for future crop improvement or afforestation programmes. In India, we have the following important **gene bank/seed bank** facilities:

(i) **National Bureau of Plant Genetic Resources (NBPGR)** is located in New Delhi. Here agricultural and horticultural crops and their wild relatives are preserved by *cryo-preservation* of seeds, pollen etc. by using liquid nitrogen at a temperature as low as -196°C. Varieties of rice, pearl millet, Brassica, turnip, radish, tomato, onion, carrot, chilli, tobacco, poppy etc. have been preserved successfully in liquid nitrogen for several years without losing seed viability.

(ii) **National Bureau of Animal Genetic Resources (NBAGR)** located at Karnal, Haryana. It preserves the semen of domesticated bovine animals.

(iii) **National Facility for Plant Tissue Culture Repository (NFPTCR)** for the development of a facility of conservation of varieties of crop plants/trees by tissue culture. This facility has been created within the NBPGR.

The G-15 countries have also resolved to set up a network of gene banks to facilitate the conservation of various varieties of aromatic and medicinal plants for which India is the networking co-ordinator country.

QUESTIONS

1. Define biodiversity. Explain genetic diversity, species diversity and ecosystem diversity.
2. What do you mean by consumptive use value, productive use value, social value, ethical value and option value of biodiversity?
3. What is meant by alpha, beta and gamma richness? Discuss, giving examples.
4. Comment upon Indian biodiversity with special reference as a megadiversity nation.