UNIT 4:
Biodiversity

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4.1 INTRODUCTION

The great variety of life on earth has provided for man's needs over thousands of years. This diversity of living creatures forms a support system which has been used by each civilization for its growth and development. Those that used this "bounty of nature" carefully and sustainably survived. Those that overused or misused it disintegrated.

Science has attempted to classify and categorize the variability in nature for over a century. This has led to an understanding of its organization into communities of plants and animals. This information has helped in utilizing the earth's biological wealth for the benefit of humanity and has been integral to the process of 'development'. This includes better health care, better crops and the use of these life forms as raw material for industrial growth which has led to a higher standard of living for the developed world. However this has also produced the modern consumerist society, which has had a negative effect on the diversity of biological resources upon which it is based. The diversity of life on earth is so great that if we use it sustainably we can go on developing new products from biodiversity for many generations. This can only happen if we manage biodiversity as a precious resource and prevent the extinction of species.

Definition:
'Biological diversity' or biodiversity is that part of nature which includes the differences in genes among the individuals of a species, the variety and richness of all the plant and animal species at different scales in space, locally, in a region, in the country and the world, and various types of ecosystems, both terrestrial and aquatic, within a defined area.

What is biodiversity?
Biological diversity deals with the degree of nature's variety in the biosphere. This variety can be observed at three levels; the genetic variability within a species, the variety of species within a community, and the organisation of species in an area into distinctive plant and animal communities constitutes ecosystem diversity.

4.1.1 Genetic diversity

Each member of any animal or plant species differs widely from other individuals in its genetic makeup because of the large number of combinations possible in the genes that give every individual specific characteristics. Thus, for example, each human being is very different from all others. This genetic variability is essential for a healthy breeding population of a species. If the number of breeding individuals is reduced, the dissimilarity of genetic makeup is reduced and in-breeding occurs. Eventually this can lead to the extinction of the species. The diversity in wild species forms the '**gene pool**' from which our crops and domestic animals have been developed over thousands of years. Today the variety of nature's bounty is being further harnessed by using wild relatives of crop plants to create new varieties of more productive crops and to breed better domestic animals. Modern biotechnology manipulates genes for developing better types of medicines and a variety of industrial products.

4.1.2 Species diversity

The number of species of plants and animals that are present in a region constitutes its species diversity. This diversity is seen both in natural ecosystems and in agricultural ecosystems. Some areas are more rich in species than others. Natural undisturbed tropical forests have a much greater species richness than plantations developed by the Forest Department for timber

production. A natural forest ecosystem provides a large number of non-wood products that local people depend on such as fruit, fuel wood, fodder, fiber, gum, resin and medicines. Timber plantations do not provide the large variety of goods that are essential for local consumption. In the long-term the economic sustainable returns from non-wood forest products is said to be greater than the returns from felling a forest for its timber. Thus the value of a natural forest, with all its species richness is much greater than a plantation. Modern intensive agricultural ecosystems have a relatively lower diversity of crops than traditional agropastoral farming systems where multiple crops were planted.

At present conservation scientists have been able to identify and categorise about 1.8 million species on earth. However, many new species are being identified, especially in the flowering plants and insects. Areas that are rich in species diversity are called 'hotspots' of diversity. India is among the world's 15 nations that are exceptionally rich in species diversity.

4.1.3 Ecosystem diversity

There are a large variety of different ecosystems on earth, which have their own complement of distinctive inter linked species based on the differences in the habitat. Ecosystem diversity can be described for a specific geographical region, or a political entity such as a country, a State or a taluka. Distinctive ecosystems include landscapes such as forests, grasslands, deserts, mountains, etc., as well as aquatic ecosystems such as rivers, lakes, and the sea. Each region also has man-modified areas such as farmland or grazing pastures.

An ecosystem is referred to as 'natural' when it is relatively undisturbed by human activities, or 'modified' when it is changed to other types of uses, such as farmland or urban areas. Ecosystems are most natural in wilderness areas. If natural ecosystems are overused or misused their productivity eventually decreases and they are then said to be degraded. India is exceptionally rich in its ecosystem diversity.

Evolution and the Genesis of Biodiversity: The origins of life on earth some three and a half billion years ago are obscure. Life was probably initiated as a product of organic reactions in the Earth's primordial seas. Alternative possibilities such as life beginning in a muddy ooze, or of life having been seeded from outer space have also been suggested. Once life took hold on the planet, it began gradually to diversify. Unicellular unspecialized forms gradually evolved into complex multi-cellular plants and animals. Evolution is related to the ability of living organisms to adapt to changes in their environment. Thus the abiotic changes in nature such as climatic and atmospheric upheavals, repeated glaciations, continental drift and the formation of geographical barriers, segregated different communities of plants and animals and gradually lead to the formation of new species over millions of years.

Most species appear to have a life span extending over several million years. Their adaptability to gradual changes in their habitat, and interactions with newly formed species produce groups of inter linked organisms that continue to evolve together. Food chains, prey-predator relationships, parasitism (complete dependence on another species), commensalism (a partnership beneficial to both species), etc. are important examples. Behavioural patterns of the different species comprising a community of species links them to each other through their breeding biology, feeding patterns, migrations, etc. As ancient species became extinct due to geological upheavals, they left behind empty 'niches' in the habitat that stimulated existing species to fill them through the formation of new species. The Earth's ancient history has seen periods of mega extinctions, which have been followed by periods of formation of new species. Though these repeatedly led to a drastic

reduction in the number of species, the diversity of life recuperated each time by gradually increasing the number of species existing on earth. This however took millions of years, as evolution is a very slow process. Thus when man came on the scene some 2 million years ago, the earth was more rich in species than ever before. During the recent past however, extinctions due to the activities of modern man have begun to take place so rapidly that nature has had no time to evolve new species. The earth is loosing species more rapidly than ever before.

The diversity of life at all three organisational levels, genetic, species and ecosystem, is thus being rapidly modified by modern man. This is a great loss to future generations who will follow us.

4.2 BIOGEOGRAPHIC CLASSIFICATION OF INDIA

Our country can be conveniently divided into ten major regions, based on the geography, climate and pattern of vegetation seen and the communities of mammals, birds, reptiles, amphibia, insects and other invertebrates that live in them. Each of these regions contains a variety of ecosystems such as forests, grasslands, lakes, rivers, wetlands, mountains and hills, which have specific plant and animal species.

India's Biogeographic Zones

1. The cold mountainous snow covered Trans Himalayan region of Ladakh.

2. The Himalayan ranges and valleys of Kashmir, Himachal Pradesh, Uttarakhand, Assam and other North Eastern States.

3. The Terai, the lowland where the Himalayan rivers flow into the plains.

4. The Gangetic and Bhramaputra plains.

5. The Thar Desert of Rajasthan.

6. The semi arid grassland region of the Deccan plateau Gujarat, Maharashtra, Andra Pradesh, Karnataka and Tamil Nadu.

7. The Northeast States of India,

8. The Western Ghats in Maharashtra, Karnataka and Kerala.

9. The Andaman and Nicobar Islands.

10. The long western and eastern coastal belt with sandy beaches, forests and mangroves.

4.3 VALUE OF BIODIVERSITY

Environmental services from species and ecosystems are essential at global, regional and local levels. Production of oxygen, reducing carbon dioxide, maintaining the water cycle, protecting soil are important services. The world now acknowledges that the loss of biodiversity contributes to global climatic changes. Forests are the main mechanism for the conversion of carbon dioxide into carbon and oxygen. The loss of forest cover, coupled with the increasing release of carbon dioxide and other gases through industrialization contributes to the '**greenhouse effect'.** Global warming is melting ice caps, resulting in a rise in the sea level which will submerge the low lying areas in the world. It is causing major atmospheric changes, leading to increased temperatures, serious droughts in some areas and unexpected floods in other areas.

Biological diversity is also essential for preserving ecological processes, such as fixing and recycling of nutrients, soil formation, circulation and cleansing of air and water, global life support (plants absorb CO_2, give out O_2), maintain-

ing the water balance within ecosystems, watershed protection, maintaining stream and river flows throughout the year, erosion control and local flood reduction.

Food, clothing, housing, energy, medicines, are all resources that are directly or indirectly linked to the biological variety present in the biosphere. This is most obvious in the tribal communities who gather resources from the forest, or fisherfolk who catch fish in marine or freshwater ecosystems. For others, such as agricultural communities, biodiversity is used to grow their crops to suit the environment. Urban communities generally use the greatest amount of goods and services, which are all indirectly drawn from natural ecosystems.

It has become obvious that the preservation of biological resources is essential for the well-being and the long-term survival of mankind. This diversity of living organisms which is present in the wilderness, as well as in our crops and livestock, plays a major role in human 'development'. The preservation of 'biodiversity' is therefore integral to any strategy that aims at improving the quality of human life.

4.3.1 Consumptive use value

The direct utilisation of timber, food, fuelwood, fodder by local communities.

The biodiversity held in the ecosystem provides forest dwellers with all their daily needs, food, building material, fodder, medicines and a variety of other products. They know the qualities and different uses of wood from different species of trees, and collect a large number of local fruits, roots and plant material that they use as food, construction material or medicines. Fisherfolk are highly dependent on fish and know where and how to catch fish and other edible aquatic animals and plants.

Man and the Web of Life

The Biodiversity of an area influences every aspect of the lives of people who inhabit it. Their living space and their livelihoods depend on the type of ecosystem. Even people living in urban areas are dependent on the ecological services provided by the wilderness in the PAs. We frequently don't see this in everyday life as it is not necessarily overt. It is linked with every service that nature provides us. The quality of water we drink and use, the air we breathe, the soil on which our food grows are all influenced by a wide variety of living organisms both plants and animals and the ecosystem of which each species is linked with in nature.

While it is well known that plant life removes carbon dioxide and releases the oxygen we breathe, it is less obvious that fungi, small soil invertebrates and even microbes are essential for plants to grow.

That a natural forest maintains the water in the river after the monsoon, or that the absence of ants could destroy life on earth, are to be appreciated to understand how we are completely dependent on the living 'web of life' on earth.

The wilderness is an outcome of a long evolutionary process that has created an unimaginably large diversity of living species, their genetic differences and the various ecosystems on earth in which all living creatures live. This includes mankind as well. Think about this and we cannot but want to protect out earth's unique biodiversity. We are highly dependent on these living resources.

4.3.2 Productive use value

Marketable goods.

Value of MFP>Timber (which is part of sustainable use).

The biotechnologist uses biorich areas to 'prospect' and search for potential genetic properties in plants or animals that can be used to develop better varieties of crops that are used in farming and plantation programs or to develop better livestock. To the pharmacist, biological diversity is the raw material from which new drugs can be identified from plant or animal products. To industrialists, biodiversity is a rich store-house from which to develop new products. For the agricultural scientist the biodiversity in the wild relatives of crop plants is the basis for developing better crops.

Genetic diversity enables scientists and farmers to develop better crops and domestic animals through careful breeding. Originally this was done by selecting or pollinating crops artificially to get a more productive or disease resistant strain. Today this is increasingly being done by genetic engineering, selecting genes from one plant and introducing them into another. New crop varieties (cultivars) are being developed using the genetic material found in wild relatives of crop plants through biotechnology.

Even today, species of plants and animals are being constantly discovered in the wild. Thus these wild species are the building blocks for the betterment of human life and their loss is a great economic loss to mankind. Among the known species, only a tiny fraction have been investigated for their value in terms of food, or their medicinal or industrial potential.

Preservation of biodiversity has now become essential for industrial growth and economic development. A variety of industries such as pharmaceuticals are highly dependent on identifying compounds of great economic value from the wide variety of wild species of plants located in undisturbed natural forests. This is called **biological prospecting**.

4.3.3 Social values

While traditional societies which had a small population and required less resources had preserved their biodiversity as a life supporting resource, modern man has rapidly depleted it even to the extent of leading to the irrecoverable loss due to extinction of several species. Thus apart from the local use or sale of products of biodiversity there is the social aspect in which more and more resources are used by affluent societies. The biodiversity has to a great extent been preserved by traditional societies that valued it as a resource and appreciated that its depletion would be a great loss to their society.

The consumptive and productive value of biodiversity is closely linked to social concerns in traditional communities. 'Ecosystem people' value biodiversity as a part of their livelihood as well as through cultural and religious sentiments. A great variety of crops have been cultivated in traditional agricultural systems and this permitted a wide range of produce to be grown and marketed throughout the year and acted as an insurance against the failure of one crop. In recent years farmers have begun to receive economic incentives to grow cash crops for national or international markets, rather than to supply local needs. This has resulted in local food shortages, unemployment (cash crops are usually mechanised), landlessness and increased vulnerability to drought and floods.

Commonly used modern drugs derived from plant sources:

DRUG	PLANT SOURCE	USE
Atropine	Belladonna	Anticholinergic: reduces intestinal pain in diarrhoea.
Bromelain	Pineapple	Controls tissue inflammation due to infection.
Caffeine	Tea, Coffee	Stimulant of the central nervous system.
Camphor	Camphor tree	Rebefacient: increases local blood supply.
Cocaine	Cocoa	Analgesic and local anesthetic: reduces pain and prevents pain during surgery.
Codeine	Opium poppy	Analgesic: reduces pain.
Morphine	Opium poppy	Analgesic: controls pain.
Colchicine	Autumn crocus	Anticancer agent.
Digitoxin	Common foxglove	Cardiac stimulant used in heart diseases.
Diosgenin	Wild yams	Source of female contraceptive: prevents pregnancy.
L-Dopa	Velvet bean	Controls Parkinson's Disease which leads to jerky movements of the hands
Ergotamine	Smut-of-rye or ergot	Control of haemorrhage and migraine headaches.
Glaziovine	ocotea glaziovii	Antidepressant: Elevates mood of depressed patients.
Gossypol	Cotton	Male contraceptive.
Indicine N-oxide	heliotropium indicum	Anticancer agent.
Menthol	Mint	Rubefacient: increases local blood supply and reduces pain on local application.
Monocrotaline	Cotolaria sessiliflora	Anticancer agent.
Papain	Papaya	Dissolves excess protein and mucus, during digestion.
Penicillin	Penicillium fungi	General antibiotic, skills bacteria and controls infection by various micro-organisms.
Quinine	Yellow cinochona	Antimalarial.
Reserpine	Indian snakeroot	Reduces high blood pressure.
Scopolamine	Thorn apple	Sedative.
Taxol	Pacific yew	Anticancer (ovarian).
Vinblastine, vincristine	Rosy periwinkle (Vinca rosea) (Sadaphali)	Anticancer agent: Controls cancer in children.

From: 'The Diversity of Life'; Edward O. Wilson
(Norton Paperback. In association with Havard University Press – 1993)

4.3.4 Ethical and moral values

Ethical values related to biodiversity conservation are based on the importance of protecting all forms of life. All forms of life have the right to exist on earth. Man is only a small part of the Earth's great family of species. Don't plants and animals have an equal right to live and exist on our planet which is like an inhabited spaceship? We do not know if life as we know it exists elsewhere in the universe. Do we have the right to destroy life forms or do we have a duty to protect them?

Apart from the economic importance of conserving biodiversity, there are several cultural, moral and ethical values which are associated with the sanctity of all forms of life. Indian civilization has over several generations preserved nature through local traditions. This has been an important part of the ancient philosophy of many of our cultures. We have in our country a large number of sacred groves or **'deorais'** preserved by tribal people in several States. These sacred groves around ancient sacred sites and temples act as gene banks of wild plants.

4.3.5 Aesthetic value

Knowledge and an appreciation of the presence of biodiversity for its own sake is another reason to preserve it. Quite apart from killing wildlife for food, it is important as a tourist attraction. Biodiversity is a beautiful and wonderful aspect of nature. Sit in a forest and listen to the birds. Watch a spider weave its complex web. Observe a fish feeding. It is magnificent and fascinating.

Symbols from wild species such as the lion of Hinduism, the elephant of Buddhism and deities such as Lord Ganesh, and the vehicles of several deities that are animals, have been venerated for thousands of years. Valmiki begins his epic story with a couplet on the unfortunate killing of a crane by a hunter. The 'Tulsi' has been placed at our doorsteps for centuries.

4.3.6 Option value

Keeping future possibilities open for their use is called option value. It is impossible to predict which of our species or traditional varieties of crops and domestic animals will be of great use in the future. To continue to improve cultivars and domestic livestock, we need to return to wild relatives of crop plants and animals. Thus the preservation of biodiversity must also include traditionally used strains already in existence in crops and domestic animals.

4.4 BIODIVERSITY AT GLOBAL, NATIONAL AND LOCAL LEVELS

There are at present 1.8 million species known and documented by scientists in the world. However, scientists have estimated that the number of species of plants and animals on earth could vary from 1.5 to 20 billion! Thus the majority of species are yet to be discovered.

Most of the world's bio-rich nations are in the South, which are the developing nations. In contrast, the majority of the countries capable of exploiting biodiversity are Northern nations, in the economically developed world. These nations however have low levels of biodiversity. Thus the developed world has come to support the concept that biodiversity must be considered to be a 'global resource'. However, if biodiversity should form a 'common property resource' to be shared by all nations, there is no reason to exclude oil, or uranium, or even intellectual and technological expertise as global assets. India's sovereignty over its biological diversity cannot be compromised without a revolutionary change in world thinking about sharing of all types of natural resources.

Countries with diversities higher than India are located in South America such as Brazil, and South East Asian countries such as Malaysia and Indonesia. The species found in these countries, however, are different from our own. This makes it imperative to preserve our own biodiversity as a major economic resource. While few of the other 'megadiversity nations' have developed the technology to exploit their species for biotechnology and genetic engineering, India is capable of doing so.

Throughout the world, the value of biologically rich natural areas is now being increasingly appreciated as being of unimaginable value. International agreements such as the **World Heritage Convention** attempt to protect and support such areas. India is a signatory to the convention and has included several protected Areas as World Heritage sites. These include Manas on the border between Bhutan and India, Kaziranga in Assam, Bharatpur in U.P., Nandadevi in the Himalayas, and the Sunderbans in the Ganges delta in West Bengal.

India has also signed the **Convention in the Trade of Endangered Species (CITES)** which is intended to reduce the utilization of endangered plants and animals by controlling trade in their products and in the pet trade.

4.5 INDIA AS A MEGA DIVERSITY NATION

Geological events in the landmass of India have provided conditions for high levels of biological diversity. A split in the single giant continent around 70 million years ago, led to the formation of northern and southern continents, with India a part of Gondwanaland - the southern landmass, together with Africa, Australia and the Antarctic. Later tectonic movements shifted India northward across the equator to join the Northern Eurasian continent. As the intervening shallow Tethis Sea closed down, plants and animals that had evolved both in Europe and in the Far East migrated into India before the Himalayas had formed. A final influx came from Africa with Ethiopian species, which, were adapted to the Savannas and semi-arid regions. Thus India's special geographical position between three distinctive centres of biological evolution and radiation of species is responsible for our rich and varied biodiversity.

Among the biologically rich nations, India stands among the top 10 or 15 countries for its great variety of plants and animals, many of which are not found elsewhere. India has 350 different mammals (rated eight highest in the world), 1,200 species of birds (eighth in the world), 453 species of reptiles (fifth in the world) and 45,000 plant species, of which most are angiosperms, (fifteenth in the world). These include especially high species diversity of ferns (1022 species) and orchids (1082 species). India has 50,000 known species of insects, including 13,000 butterflies and moths. It is estimated that the number of unknown species could be several times higher.

It is estimated that 18% of Indian plants are **endemic** to the country and found nowhere else in the world. Among the plant species the flowering plants have a much higher degree of endemism, a third of these are not found elsewhere in the world. Among amphibians found in India, 62% are unique to this country. Among lizards, of the 153 species recorded, 50% are endemic. High endemism has also been recorded for various groups of insects, marine worms, centipedes, mayflies and fresh water sponges.

	India's World Ranking	Number of species in India
Mammals	8th	350
Birds	8th	1200
Reptiles	5th	453
Amphibia	15th	182
Angiosperms	15th-20th	14,500

Apart from the high biodiversity of Indian wild plants and animals there is also a great diversity of cultivated crops and breeds of domestic livestock. This is a result of several thousand years during which civilizations have grown and flourished in the Indian subcontinent. The traditional cultivars included 30,000 to 50,000 varieties of rice and a number of cereals, vegetables and fruit. The highest diversity of cultivars is concentrated in the high rainfall areas of the Western Ghats, Eastern Ghats, Northern Himalayas and the North-Eastern hills.

Gene-banks have collected over 34,000 cereals and 22,000 pulses grown in India. India has 27 indigenous breeds of cattle, 40 breeds of sheep, 22 breeds of goats and 8 breeds of buffaloes.

4.6 HOTSPOTS OF BIODIVERSITY

The earth's biodiversity is distributed in specific ecological regions. There are over a thousand major ecoregions in the world. Of these, 200 are said to be the richest, rarest and most distinctive natural areas. These areas are referred to as the Global 200.

It has been estimated that 50,000 endemic plants which comprise 20% of global plant life, probably occur in only 18 'hot spots' in the world. Countries which have a relatively large proportion of these hot spots of diversity are referred to as 'megadiversity nations'.

The rate at which the extinction of species is occurring throughout our country remains ob-

Global species diversity

Group	No. of Described Species	
Bacteria and blue-green algae	4,760	
Fungi	46,983	
Algae	26,900	
Bryophytes (Mosses and Liverworts)	17,000	(WCMC, 1988)
Gymnosperms (Conifers)	750	(Reven et al., 1986)
Angiosperms (Flowering plants)	250,000	(Reven et al., 1986)
Protozoans	30,800	
Sponges	5,000	
Corals and Jellyfish	9,000	
Roundworms and earthworms	24,000	
Crustaceans	38,000	
Insects	751,000	
other arthropods and minor Invertebrates	132,461	
Molluscs	50,000	
Starfish	6,100	
Fishes (Teleosts)	19,056	
Amphibians	4,184	
Reptiles	6,300	
Birds	9,198	(Clements, 1981)
Mammals	4,170	(Honacki et al., 1982)
Total: 1,435,662 SPECIES		

From 'Conserving the World's Biological Diversity WRI, IUCN, CI, WWF-US, The World Bank.'

scure. It is likely to be extremely high as our wilderness areas are shrinking rapidly. Our globally accepted national **'hot spots'** are in the forests of the **North-East** and the **Western Ghats,** which are included in the world's most biorich areas**.** The **Andaman and Nicobar Islands** are extremely rich in species and many subspecies of different animals and birds have evolved. Among the endemic species i.e. those species found only in India, a large proportion are concentrated in these three areas. The Andaman and Nicobar Islands alone have as many as 2200 species of flowering plants and 120 species of ferns. Out of 135 genera of land mammals in India, 85 (63%) are found in the Northeast. The Northeast States have 1,500 endemic plant species. A major proportion of amphibian and reptile species, especially snakes, are concentrated in the Western Ghats, which is also a habitat for 1,500 endemic plant species.

Coral reefs in Indian waters surround the Andaman and Nicobar Islands, Lakshadweep Islands, the Gulf areas of Gujarat and Tamil Nadu. They are nearly as rich in species as tropical evergreen forests!

4.7 THREATS TO BIODIVERSITY: HABITAT LOSS, POACHING OF WILDLIFE, MAN-WILDLIFE CONFLICTS

Man has begun to overuse or misuse most of these natural ecosystems. Due to this 'unsustainable' resource-use, once productive forests and grasslands have been turned into deserts and wasteland have increased all over the world. Mangroves have been cleared for fuelwood and prawn farming, which has led to a decrease in the habitat essential for breeding of marine fish. Wetlands have been drained to increase agricultural land. These changes have grave economic implications in the longer term.

The current destruction of the remaining large areas of wilderness habitats, especially in the

CASE STUDY

Kailadevi Wildlife Sanctuary – Sawai Madhopur, Rajashtan

While conservation efforts are associated with conflicts between villagers and Forest Officials in most Protected Areas across the country, the Kailadevi Wildlife Sanctuary in Rajasthan has involved local community initiatives for conservation and regeneration. The Sanctuary was initiated in 1983, over 674 sq km forming a part of the 1334 sq km Ranthambore Tiger Reserve. It is located within the Karauli and Sapotra blocks of Sawai Madhopur district.

The primary occupation of the predominant Meena and Gujjar communities is pastoralism and subsistence agriculture.

Pressures on the sanctuary included migrant grazers known as the Rabaris, who came from the Mewar region of Rajasthan with herds of over 150,000 sheep. Other pressures were from exploitation of timber and fuelwood and mining. The threat poised by the migrant grazers spurred the formation of the "Baragaon ki Panchayat" in 1990, which in turn initiated a 'Bhed Bhagao Andolan'.

The Forest Department supported the villagers in the formation of Forest Protection Committees and Van Suraksha Samitis. The benefits of involving local people in protection of their resources were obvious. Illegal felling was checked. The use of forest resources for local use was monitored. The *Forest Protection Committees (FPCs)* were also successful in stopping the mining in the Sanctuary. Mining is now banned in the Sanctuary. The people not only protect their forests but also use their resources judiciously.

super diverse tropical forests and coral reefs, is the most important threat worldwide to biodiversity. Scientists have estimated that human activities are likely to eliminate approximately 10 million species by the year 2050.

There are about 1.8 million species of plants and animals, both large and microscopic, known to science in the world at present. The number of species however is likely to be greater by a factor of at least 10. Plants and insects as well as other forms of life not known to science are continually being identified in the worlds' 'hotspots' of diversity. Unfortunately at the present rate of extinction about 25% of the worlds' species will undergo extinction fairly rapidly. This may occur at the rate of 10 to 20 thousand species per year, a thousand to ten thousand times faster than the expected natural rate! Human actions could well exterminate 25% of the world's species within the next twenty or thirty years. Much of this mega extinction spasm is related to human population growth, industrialization and changes in land-use patterns. A major part of these extinctions will occur in 'biorich' areas such as tropical forests, wetlands, and coral reefs. The loss of wild habitats due to rapid human population growth and short term economic development are major contributors to the rapid global destruction of biodiversity.

Island flora and fauna having high endemism in small isolated areas surrounded by sea have so far been most seriously affected by human activity, which has already led to extinction of many island plants and animals (the dodo is a famous example). Habitat loss also results from man's introduction of species from one area into another, disturbing the balance in existing communities. In the process, the purposely or accidentally introduced organisms (*Eupatorium, Lantana*, Hyacinth, Congress grass or *Parthenium*) have led to the extinction of many local species.

Loss of species occurs due to the destruction of natural ecosystems, either for conversion to agriculture or industry, or by over-extraction of their resources, or through pollution of air, water and soil.

In India, forests and grasslands are continuously being changed to agricultural land. Encroachments have been legalized repeatedly. Similarly natural wetland systems have been drained to establish croplands resulting in loss of aquatic species. Grasslands that were once sustainably used by a relatively smaller number of human beings and their cattle are either changed to other forms of use or degraded by overgrazing.

CASE STUDY:

Kokkare Bellure – Karnataka: Co-existence (Man and Wildlife)

The pelican, which is an endangered species breeds in large numbers at Kokkare Bellur which is one of the ten known breeding sites in India. Kokkare Bellure is a village in Karnataka in Southern India. In December every year, hundreds of spot billed pelicans, painted storks, ibis and other birds migrate to this area to establish breeding colonies on the tall tamarind trees in the center of the village. The local people have protected the birds, believing that they bring good luck with regard to rain and crops. The villagers collect a rich supply of the natural fertilizer that collects below the nests – the *guano*. The droppings of fish-eating birds are rich in nitrates.

The owners of the trees inhabited by the birds dig deep pits under the trees, into which the guano falls. Silt from nearby lakes and ponds is mixed with the guano which is used in their fields and sold as fertilizer. They have now planted trees around their homes to encourage nesting.

Our natural forests are being deforested for timber and replanted using teak, sal or other single species for their timber value. Such plantations do not support the same biological diversity as a multi-storied natural forest, which has a closed canopy and a rich understorey of vegetation.

When excessive firewood is collected from the forest by lopping the branches of trees, the forest canopy is opened up and this alters local biodiversity. Foraging cattle retard the regeneration of the forest as seedlings are constantly trampled.

Increasing human population on the fringes of our Protected Areas degrade forest ecosystems.

This is a major factor to consider in evaluating the quality of the ecosystem. Repeated fires started by local grazers to increase grass growth ultimately reduces regeneration and lowers the diversity of plant species. Without alternate sources of fodder this pressure cannot be decreased.

Another factor that disrupts forest biodiversity is the introduction of exotic weeds which are not a part of the natural vegetation. Common examples in India are lantana bushes, Eupatorium shrubs and 'congress' grass. These have been imported into the country from abroad and have invaded several large tracts of our natural forests. These weeds spread at the expense of the diverse range of indigenous undergrowth species. The impact on the diversity of insect, bird and other wildlife species, though not adequately studied, is quite obvious.

In our country a variety of traditional farming techniques have evolved over several centuries. Cultivation by slash and burn in the Himalayas, and 'rab' by lopping of tree branches to act as a wood-ash fertilizer in the Western Ghats, are two such systems. When human population in these areas was low, these were sustainable methods of agriculture. Unfortunately these areas now have a large number of people who subsist largely on forest agriculture. These methods are now unsustainable and are leading to a loss of forest biodiversity.

Overharvesting of fish, especially by trawling is leading to serious depletion of fish stocks. Turtles are being massacred off the coast of Orissa. The rare whale shark, a highly endangered species, is being killed off the coast of Gujarat.

Poaching: Specific threats to certain animals are related to large economic benefits. Skin and bones from tigers, ivory from elephants, horns from rhinos and the perfume from the must deer are extensively used abroad. Bears are killed for their gall bladders. Corals and shells are also collected for export or sold on the beaches of Chennai and Kanyakumari. A variety of wild plants with real or at times dubious medicinal value are being over harvested. The commonly collected plants include Rauvolfia, Nuxvomica, Datura, etc. Collection of garden plants includes orchids, ferns and moss.

The Rights of Species

We do not see all the varied functions that biodiversity plays in our lives because they are not obvious. We rarely see how they are controlling our environment unless we study nature. Thus we tend to take short-term actions that can have serious impacts on biodiversity leading to even extinction of species by disturbing their habitats. Man has no right to do so. We only share this planet with millions of other species that also have a right to survive on earth. It is morally wrong to allow man's actions to lead to the extinction of species.

4.8 ENDANGERED AND ENDEMIC SPECIES OF INDIA

To appreciate the endemic and endangered species of India it is important to understand the wide variety of plant and animal species that are found in the country.

Of the well-known species, there are several which are endangered by human activity. The endangered species in the country are categorised as Vulnerable, Rare, Indeterminate and Threatened. Other species are found only in India and are thus endemic or restricted to our country. Some of these may have very localized distribution and are considered highly endemic.

Several plant and animal species in the country are now found in only one or a few Protected Areas. Among the important endangered animals are charismatic species such as the tiger, the elephant, the rhino, etc. The less well-known major mammals restricted to a single area include the Indian wild ass, the Hangul or Kashmir stag, the Golden langur, the pygmy hog and a host of others. There are also endangered bird species such as the Siberian crane, the Great Indian Bustard, the Florican and several birds of prey. During the recent past, vultures which were common a decade ago, have suddenly disappeared and are now highly threatened. Equally threatened are several species of reptiles and amphibia. Many invertebrates are also threatened, including a large number of species that inhabit our coral reefs.

Many plant species are now increasingly threatened due to changes in their habitats induced by human activity. Apart from major trees, shrubs and climbers that are extremely habitat specific and thus endangered, there are thousands of small herbs which are greatly threatened by habitat loss. Several orchids are yet another group of plants that are under threat. Many plants are threatened due to overharvesting as ingredients in medicinal products.

To protect endangered species India has created the Wildlife Protection Act. This includes lists of plants and animals categorised according to the threat on their survival.

We know so little about the species diversity of our country. There are several groups of which we know very little. Most of us are only aware of the plight of a few glamorous large mammals, but we need to appreciate the threat to the less known species of plants and animals. We need to find ways to support the conservation of our incredible wildlife for future generations.

4.8.1 Common Plant species

Teak: This tree is from the Southwest parts of peninsular India. It is a common tree in deciduous forests. It yields a much sought after timber used for making excellent furniture. During the early British period it was cut down from many forest tracts to build ships. As the stocks were diminishing, the British selected areas which they called Reserved Forests where teak was planted for the Government's use. Teak is grown extensively by the Forest Department and is a highly priced wood.

The teak tree is identified by its large leaves, which grow to more than 40 or 50cms long and 20cms wide. It has tiny flowers and fruit. In the winter, the trees shed all their leaves. In the growing season, which begins in April and extends through the monsoon, teak forests are bright green and shady. Most natural teak forests have various other species of plants and have a large number of wild animals. Some areas of teak forests that have exceptional populations of wildlife have been included in our National Parks and Wildlife Sanctuaries.

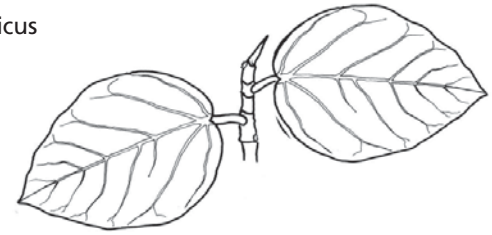
Sal: This is a common species of several types of forests of the Northeastern region of India, extending into Madhya Pradesh and Orissa. It has bright green foliage and its canopy remains green nearly throughout the year. Sal wood is hard and durable. Sal gets a large number of seeds which are used in making cosmetics. The sal forests are rich in wild mammals, birds, reptiles and insect life. Several areas are included in our network of National Parks and Sanctuaries.

Mango: This has become one of our most popular horticultural species with different varieties grown all over the country. The wild mango tree has small tangy fruit and a big seed in comparison to the large pulpy fruit used in horticulture. The mango tree is an evergreen species and gets small flowers that are pollinated by insects. In the forest, fruit dependent animals such as monkeys, squirrels and fruit eating birds relish its ripe fruit.

Mango

Ficus sp.: Peepal, Banyan and many other ficus species form a part of this group of important trees. They are all ecologically of great importance as many different species of insects, birds and mammals live on ficus berries. The flowers are inside the berries. They are pollinated by a specific wasp which lays its eggs inside the berries on which the larvae feed and grow. The ficus trees bear berries throughout the year, thus supplying nutritious food to several animal species when other trees have no fruit. Ficus species are thus known as 'keystone' species in the ecosystem and support a major part of the food web in several ecosystems. Ficus trees such as Peepal and Banyan are considered sacred and are protected in India.

Ficus



Neem: This species is known as *Azadirachta Indica*. It has been traditionally used in indigenous medicine. It has small yellow fruit. The leaves and fruit are bitter to taste. It is used extensively as an environmentally friendly insecticide. It grows extremely well in semi-arid regions and can be planted in afforestation programs where soil is poor and rainfall is low.

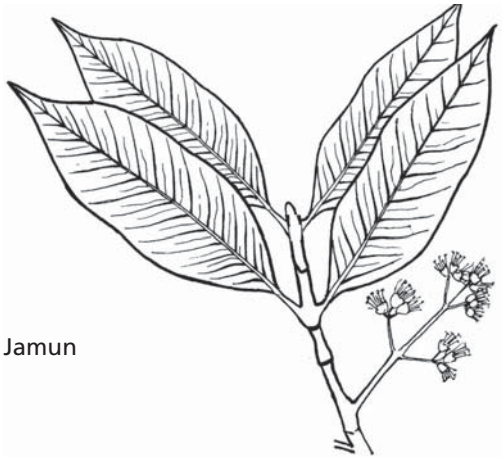
Neem

Tamarind: One of the best known Indian trees, it grows to a large size and is known to live for over 200 years. Its familiar fruit is a curved pod with sour pulp and contains a number of squarish seeds. The pulp in the fresh fruit is either green or red. As it ripens, it turns sticky and brown and separates from the skin. The tree is commonly cultivated as a shade tree and for its edible sour fruit which contains high concentrations of vitamin C. It is used as an additive in food to give a tangy flavour. It is valued for its timber as well as for fuelwood.

Babul: This is a thorny species that is characteristic of semi arid areas of Western India and the Deccan plateau. It grows sparsely in tracts of grassland and around farms. It is used for fodder and fuelwood. It remains green throughout the year even under the driest conditions and is browsed by wild animals and cattle. It has small leaves and bright yellow flowers and small seedpods with multiple seeds. Its main characteristic is its long sharp, straight thorns which prevent excessive browsing of its older branches.

Zizyphus: These are the typical small trees and shrubs that are found in the arid and semi arid areas of India. *Z. mauritiana* and *Z. jujuba* are the most frequent species. It is a favourite of frugivorous birds. The tree fruits extensively and is eaten by a variety of birds and mammals. The popular fruit is commonly collected and sold in local markets.

Jamun: This tree is an evergreen species which has a tasty purple fruit. It is a favourite with not only people but also with many wild birds and mammals. It grows in many parts of India and has several varieties with fruit of different sizes.



Jamun

Tendu is a mid-sized, deciduous tree, common in dry deciduous forests throughout the Subcontinent. There are around 50 Indian species. Its bark exfoliates in large rectangular scales. It branches profusely forming a dense crown. The leaves are elliptical and leathery and its young leaves are extensively used for making 'bidis'. The fruit is brownish yellow and astringent. Tendu leaf collection necessitates burning undergrowth and slashing the branches of the trees to get at the leaves. The resulting disturbance to wildlife is a serious issue in Protected Areas.

Jackfruit: A tree that is planted around many villages and has huge fruit growing from its branches. The fruit has a prickly skin. The fruit when unripe is cooked. Once ripe it is eaten raw after it turns into a sweet, sticky, golden-yellow fruit which has a strong smell.

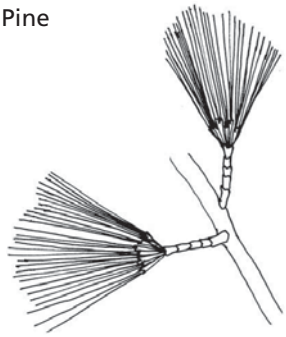
Flame of the Forest (Butea monosperma): This tree grows in many parts of India. It has bright orange flowers when it is leafless, thus it is called 'flame of the forest'. The flowers are full of nectar which attracts monkeys and many nectar dependent birds.

Flame of
the forest

Coral Tree (Erythrina): A common deciduous tree that is leafless in February when it gets bright scarlet flowers that are used for their nectar by many birds such as mynas, crows and sunbirds, that act as its major pollinators. Its long black seed pods contain several shiny brown seeds which germinate well. This tree can also be propagated by cutting and planting its young

Erythrina

Pine



branches. It is a rapid grower and usually begins to flower in four or five years time.

Amla: This deciduous medium sized tree is known for its sour, green-yellow fruit which is rich in vitamin C. It is used as a medicine, in pickles and for dying and tanning. It is frequently referred to as the Indian 'olive', to which it has no similarity either in appearance or taste.

Dipterocarps: This group of trees grows in evergreen forests of the southern part of the Western Ghats and in the Northeast of India, in high rainfall areas. It grows to an enormous height with a wide girth. The seed has a pair of wing like structures which aid in wind dispersal.

Quercus (Oak) is a large tree and is economically an important genus which includes many trees known for their beautiful shape and their changing seasonal colours. There are 30 to 40 Indian species of this genus found in the temperate areas throughout the Himalayas. The fruit is a large, hard, solitary characteristic nut (acorn). Oaks provide the finest hardwoods of great strength and durability and were once used for building ships and bridges. It is a famous wood for high quality furniture. Some of its species are excellent fodder plants.

Pine: There are 5 species of true pines that are found in India in the Himalayan region. The timber of these trees is frequently used in construction, carpentry and the paper industry. Pine resin is used to make turpentine, rosin, tar and pitch. Pine oils are obtained by distillation of leaves and shoots. Pine leaves are thin and needle-like. The male and female spores are produced in woody cones. Dispersal of pollen is aided by each grain having two wings.

Cycas: These plants are uncommon in India and have a palm-like appearance. Cycads along with conifers make up the gymnosperms. They are among the most primitive seed plants, and have remained virtually unchanged through the past 200 million years. There are five species found in India, mostly in high rainfall areas.

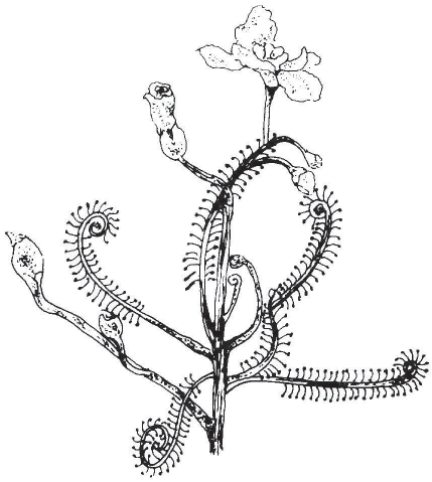
Coconut: This tall stately palm has a more or less straight trunk with circular markings. It mostly grows in coastal plains. The base is surrounded by a mass of fine roots. It produces the familiar coconut, filled with liquid and a soft white edible, initially jelly like material that hardens when the fruit ripens. It is a common ingredient of food in India, especially in the Southern States. It is extensively cultivated along the coastal regions and islands of India. Most parts of the tree yield several useful products such as broomsticks from its leaves and fiber from the husk of dried coconuts.

Orchids: This is the largest group of flowering plants in the world with over 18,000 known species. Of these, 1500 species are found in India, making it one of the largest plant families in the country with a high concentration of a staggering 700 species in the Northeastern States. These plants are terrestrial or epiphytic herbs. Flowers show a range of bright colours

Orchid

and great variations in structure. In some species, one of the petals is distinct from the others and is called a lip or labellum. This colourful petal attracts pollinators. In India a large number of orchid species are found in the Western Ghats, the Northeast, and the Andaman and Nicobar Islands. Orchids are however seen in several ecological conditions except extremes such as very cold or very hot and dry ecosystems.

Drosera: This is a small insectivorous plant, usually 5 or 6cms in height, which has tiny hair which secrete a sticky droplet of fluid on which insects get stuck. The leaf winds around the struggling insect which is then slowly digested. The plant



Drosera

has pretty flowers. It grows in shallow poor quality soil. It is a rare plant and is found in small patches.

Lotus: An aquatic floating plant with a large rhizome, which is rooted in mud. Its leaves are circular flat and covered with a waxy coating which protects it from water. The flower grows on an erect stalk with several petals ranging from pink violet to white. The fruit is a spongy cone with multiple round seeds. It is widely distributed in wetland habitats and shallow parts of lakes and marshy areas. The rhizome, stalks of the leaves and seeds are considered delicacies. The fruit is used for dry decorations. The flower has been a traditional motif in Indian art. The lotus is the National flower of India.

Grasses: Grasses form the second largest group of flowering plants in the world. They are a very important group of plants as they are used for various purposes such as making fiber, paper, thatching material for roofs, oil, gum, medicines and many other useful products. The economically important grasses include sugarcane, bamboo and cereals like rice, wheat, millets, maize, etc. Grasses are important as they provide fodder for domestic animals.

Bamboo: This is a group of large grasslike species that grow as a clump to great heights in many forests of India. It is extremely useful and is used for constructing huts and making several useful household articles in rural areas such as baskets, farm implements, fences, household implements, matting, etc. The young shoots are used as food. It is extensively used in the pulp and paper industry as a raw material.

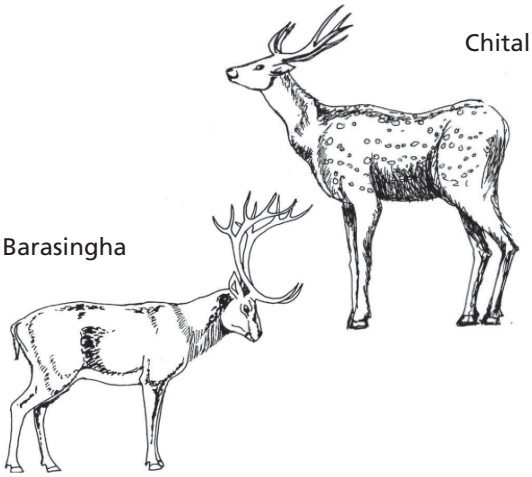
Bamboos flower after more than two decades. The plant then dies. The flowering produces thousands of seeds which results in the slow

regrowth of the bamboo. Bamboo is a favorite food of elephants and other large herbivores of the forest such as gaur and deer.

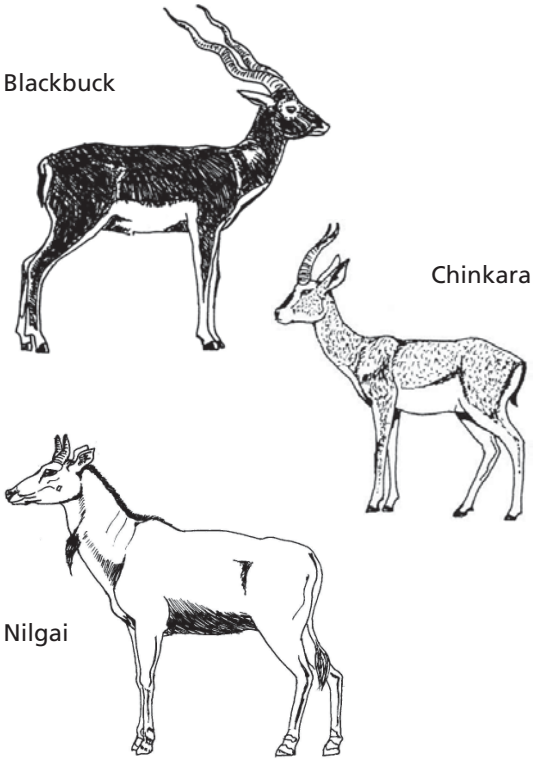
Wild relatives of crop plants: All our present day cultivated varieties of rice, which are grown for food, come from wild varieties of rice, many of which have originated in India, China and Indonesia. Rice forms one of the staple foods of the world. Although wild varieties are not used as food crops, they are important as they contain genes, which can be used to develop disease or pest resistance in crops. Many local varieties of rice have already been lost, as most farmers now grow only high yielding varieties.

4.8.2 Common Animal species

Mammals:
The common deer species found in India include the sambar, chital, barasingha and barking deer. **Sambar** live in small family parties especially in hilly forested areas and feed mainly on shrubs and leaves of low branches. They are dark brown in colour and have large thick antlers, each having 3 branches. **Chital** or spotted deer live in large herds in forest clearings where they graze on the grass. They have a rust brown body with white spots which camouflages them in the forest. Each antler has three branches called tines.

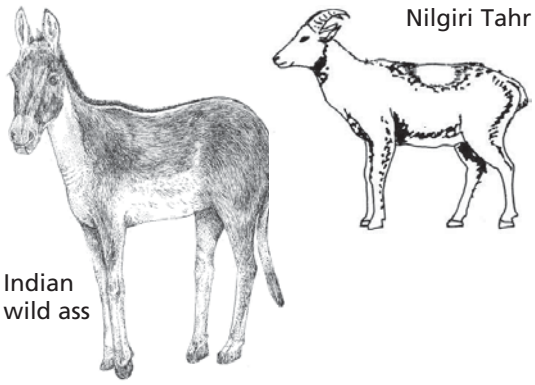


The rare **Hangul** deer is found only in Kashmir. It has a magnificent spread of antlers with 6 branches on each antler. The **Barasingha, or swamp deer**, has wide hoofs that enable this beautiful animal to live in boggy areas of the Terai. Each antler has 6 or more branches. The tiny **barking deer** lives in many forest areas all over India. It has two ridges on its face and a short antler with only 2 branches. Its call sounds like the bark of a dog.



The **blackbuck** is the only true antelope found in India. It lives in large herds. The males are black on top and cream below and have beautiful spiral horns that form a 'V' shape. The **chinkara**, also known as the **Indian gazelle**, is a smaller animal and is pale brown in colour it has beautiful curved horns. The rare **Chausingha**, **or four horned antelope**, is the only animal in the world that has four horns. The **nilgai** is the largest of the dryland herbi-

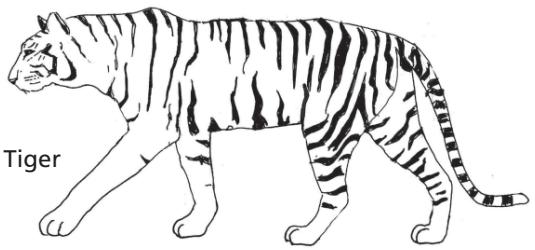
vores. The males are blue-gray. Nilgai have white markings on the legs and head. They have short strong spike-like horns.



A very special rare species is the **Indian wild ass**, endemic to the Little Rann of Kutch. Himalayan pastures support several species of wild goats and sheep, many of them restricted to the region, like the **goral** and the **Himalayan tahr**. A single species, the **Nilgiri tahr** is found in the Nilgiri and Annamalai hills in south India.

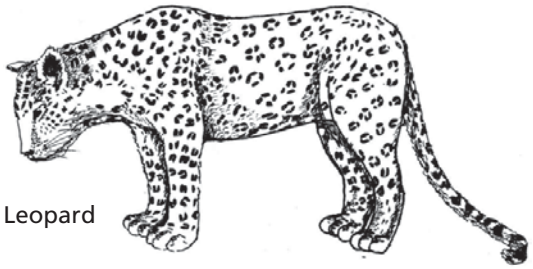
The **rhinocerous** is now restricted to Assam but was once found throughout the Gangetic plains. The **wild buffalo** is now also restricted to the Terai. The **elephant** is distributed in the Northeastern and Southern States. It is threatened by habitat loss and poaching for ivory. **Gaur** is found in patches in several well-wooded parts of India.

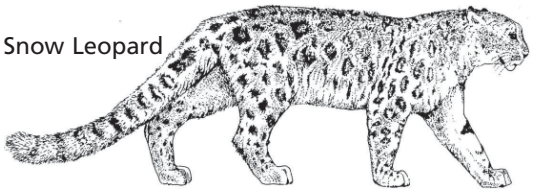
The best known predator of our forests is the **tiger**. Its gold and black stripes hide it perfectly in the forest undergrowth. It preys on herbivores such as sambar or chital or less frequently on domestic animals. The tiger kills only three or four times a month. Its numbers have declined due to poaching for its superb skin, and for the supposed magical value of its teeth, claws and whiskers. In the recent past it has been extensively killed for the supposed medicinal properties of its bones that are used in Chinese medicine.



The **Asiatic lion** is now found only in the Gir forests of Gujarat.

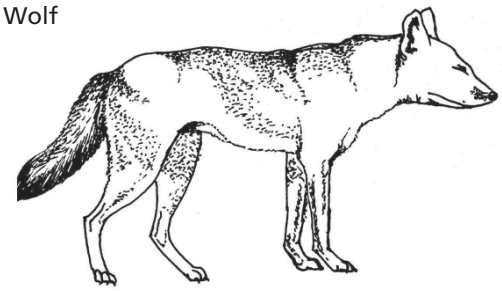
The **leopard** is more adaptable than the tiger and lives both in thick forests and degraded forest areas. Its beautiful ring like markings camouflage it so perfectly that its prey cannot see its stealthy approach. The smaller **jungle cat**, which is a light brown animal and the **leopard cat**, which is a little bigger than a domestic cat, are very rare. The most typical predator of the HImalayas is the **snow leopard**, which is very rare and poached for its beautiful skin which is pale grey with dark grey ring-like markings.

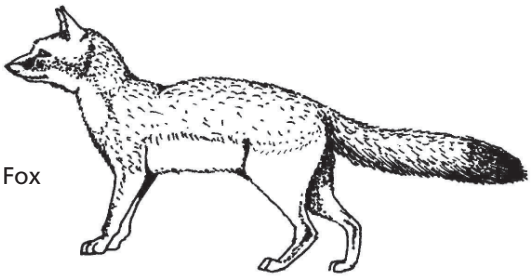




The **wolf, jackal, fox** and the **wild dog or 'dhole'** form a group called canids. Another threatened predator is the **Himalayan wolf**. The wolves are now highly threatened as they have become increasingly dependent on shepherd's flocks. Thus shepherds constantly find ways to kill the wolves.

Wolf





Fox

One of the common monkey species of the forest is the **bonnet macaque**, which has a red face, a very long tail and a whorl of hair on the scalp which looks like a cap. Our other common monkey is the **rhesus macaque**, which is smaller and has a shorter tail than the bonnet. A rare macaque is the **lion-tailed macaque** found only in a few forests of the southern Western Ghats and Annamalai ranges. It is black in colour, has long hair, a grey mane and a tassel at the end of its tail that looks like a lion's tail. The **common langur** has a black face and is known as the Hanuman monkey. The rare **golden langur**, is golden yellow in colour and lives along the banks of the Manas River in Assam. The **capped langur** is an uncommon species of Northeast India. The rare black **nilgiri langur** lives in the southern Western Ghats, Nilgiris and Annamalais.

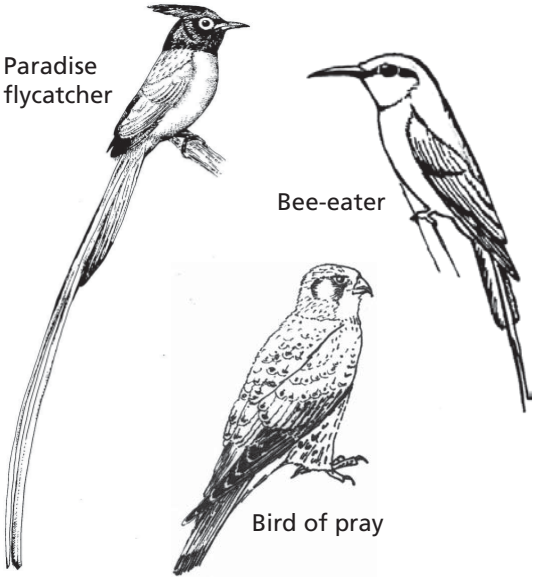
Birds:

There are over 1200 bird species found in India in different habitats. Most of our forest birds are specially adapted to life in certain forest types. Some Himalayan species however can also

Hornbill

be seen in the Western Ghats. There are several species of **Hornbills** that live on fruit. They have heavy curved beaks with a projection on top.

Frugivores such as **parakeets, barbets** and **bulbuls** live on fruit and are often seen eating Ficus fruits such as those of banyan and peepal.



Paradise flycatcher

Bee-eater

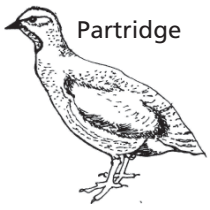
Bird of pray

Insectivorous birds of many species live on forest insects. They include various species of **flycatchers, bee-eaters**, and others. The male paradise flycatcher is a small beautiful white bird with a black head and two long white trailing tail feathers. The female is brown and does not have the long tail feathers. There are several eagles, falcons and kites many of which are now endangered.

Grasslands support many species of birds. The most threatened species is the **Great Indian bustard**, a large, brown stately bird with long legs which struts about through grasslands look-


Great Indian Bustard

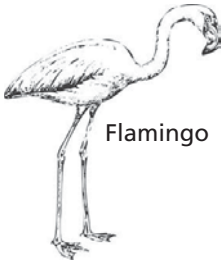
ing for locusts and grasshoppers. Another rare group of threatened birds are the floricans. There are many species of **quails, partridges, larks, munias** and other grain eating birds that are adapted to grasslands.


Partridge

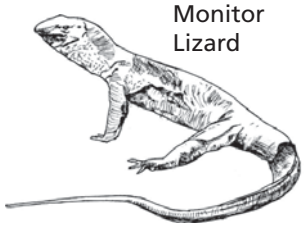

Stilt

There are several species of aquatic birds such as **waders, gulls and terns,** which live along the seashore and go out fishing many kilometers to the sea. Many of these birds have lost their coastal habitats due to pollution. Aquatic birds in freshwater are those with long legs and are known as waders such as **stilts** and **sandpipers**. The other group form birds that swim on water such as several species of **ducks** and **geese**.

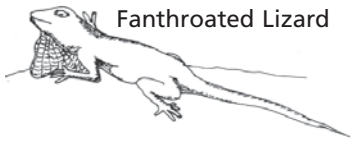
There are many species of spectacular large birds associated with water or marshy areas. These include different species of **storks, cranes, spoonbills, flamingo** and **pelicans**. Many aquatic species are migrants. They breed in Northern Europe or Siberia and come to India in thousands during winter.


Flamingo

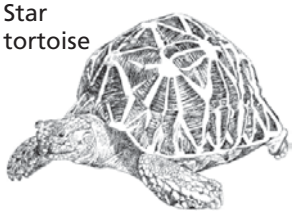
Reptiles:

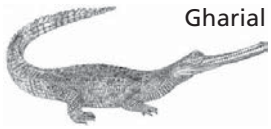

Monitor Lizard

India has a wide variety of lizards, snakes and turtles, with a high level of endemism. The lizards include the


Fanthroated Lizard

common garden lizard, Fan throated lizard, Chamelion, Skink, Common Monitor and **Water Monitor**. Some of these are threatened due to trade in reptile skins. Indian snakes include the **Rock Python, Russell's viper** and the **Vine snake**. We rarely appreciate the fact that only a few species of snakes are poisonous and most snakes are harmless. The **Star tortoise** and **Travancore tortoise** are now rare. The **Olive Ridley** and **Flapshell turtle** are the well-known turtles of India. Many turtles are becoming increasingly rare due to poaching of adults and eggs. The **crocodile** is our largest reptile which is poached for its prized skin. The **gharial** is endemic to India and is highly threatened.


Star tortoise


Gharial

Amphibia:

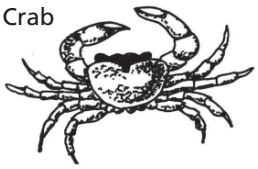
Most of the amphibians found in India are frogs and toads. These include several species like the Indian **Bull frog, Tree frog**, etc. These amphibians are mostly found in the hotspots in the Northeast and the Western Ghats. It is now thought that global warming and increasing lev-

els of UV radiation may be seriously affecting amphibian populations in some areas.

Invertebrates:

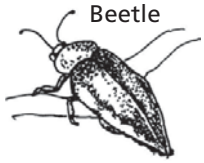

Snail

Invertebrates include a variety of taxa that inhabit both terrestrial and aquatic ecosystems. Microscopic animals like protozoa and **zooplankton** form the basis of the food chain in aquatic habitats. **Coral** is formed by colonies of polyp like animals. **Worms, molluscs (snails), spiders, crabs, jellyfish, octopus** are a few of the better known invertebrates found in India.


Crab

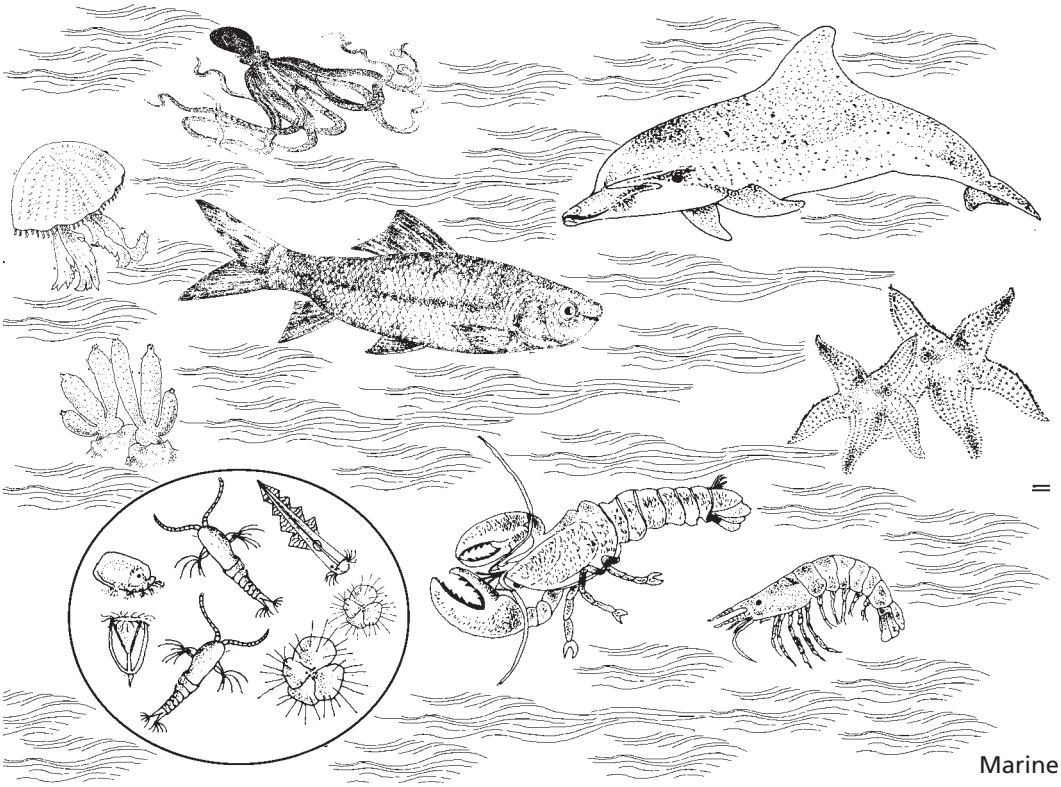
There are more than a million insect species on earth that are known to science. They include **grasshoppers, bugs, beetles, ants, bees, butterflies** and **moth**s. India is rich in its butterfly and moth species.


Spider


Beetle

Marine Life:

Marine ecosystems are most frequently associated with fish and crustacea like **crabs and shrimp**, which we use as food. The other species that are endangered include the marine turtles, which are reptiles, and whales that are mammals. There are a large number of species of freshwater **fish** found in our Indian rivers and lakes that are now threatened by the introduction of fish from abroad as well as due to being


Marine Life

introduced from one river into another. Fish are also now seriously affected by pollution. Marine fisheries are being over harvested in our coastal waters and the fish catch has decreased seriously over the last few years. Mechanized boats with giant, small-meshed nets are a major cause of depleting this resource. There are many endangered fish such as the **Mahseer** which once grew to over a meter in length. Many species of marine animals such as the **whales, sharks** and **dolphins** that live in the Indian Ocean are now threatened by extinction due to fishing in the deep sea.

For further details see:

1) CD ROM on 'The Biodiversity of India', Mapin Publications, Ahmedabad, mapin@icenet.net

2) The Book of Indian Animals, SH Prater, BNHS.

3) The Book of Indian Birds, Salim Ali, BNHS.

4.9 CONSERVATION OF BIODIVERSITY: IN-SITU AND EX-SITU

4.9.1 In-situ conservation

Biodiversity at all its levels, genetic species and as intact ecosystems, can be best preserved in-situ by setting aside an adequate representation of wilderness as '*Protected Areas'.* These should consist of a network of *National Parks and Wildlife Sanctuaries* with each distinctive ecosystem included in the network. Such a network would preserve the total diversity of life of a region.

In the past National Parks and Sanctuaries in India were notified to preserve major wildlife species such as tigers, lions, elephants, and deer. The objective of these areas should be expanded to the preservation of relatively intact natural ecosystems, where biological diversity – from microscopic unicellular plants and animals, to the giant trees and major mammals – can all be preserved.

Project Tiger: Project Tiger was launched by the Government of India with the support of WWF-International in 1973 and was the first such initiative aimed at protecting this key species and all its habitats. Project Tiger was initiated in nine Tiger Reserves in different ecosystems of the country covering an area of 16339 sq km. By 2001 the number of Tiger Reserves increased to 27, covering an area of 37761 sq km. The tiger count climbed from 268 in 1972 in the nine Tiger Reserves, to around 1500 in 1997 in the 23 Tiger Reserves. The Project tiger recognized the fact that tigers cannot be protected in isolation, and that to protect the tiger, its habitat needed to be protected.

Crocodile Conservation: Crocodiles have been threatened as their skin is used for making leather articles. This led to the near extinction of crocodiles in the wild in the 1960s in India.

A Crocodile Breeding and Conservation Program was initiated in 1975 to protect the remaining population of crocodilians in their natural habitat and by creating breeding centers. It is perhaps one of the most successful ex situ conservation breeding projects in the country.

Crocodiles have been extensively bred in over 30 captive breeding centers, zoos and other sites where successful breeding takes place. Thousands of crocodiles of all three species have been bred and restocked in 20 natural water bodies.

Project Elephant: Project Elephant was launched in 1992 to ensure the long-term survival of a viable population of elephants in their natural habitats in north and north-eastern India and south India. It is being implemented in 12 States. In spite of this, our elephant herds are at threat as their habitat is shrinking and their migration routes are disrupted by human activities.

However species cannot be protected individually as they are all inter dependent on each other. Thus the whole ecosystem must be protected. The biologist's view point deals with areas that are relatively species rich, or those where rare, threatened or endangered species are found, or those with 'endemic' species which are not found elsewhere. As rare endemic species are found only in a small area these easily become extinct due to human activity. Such areas must be given an added importance as their biodiversity is a special feature of the region.

Animals such as elephants require different types of habitat to feed in during different seasons. They utilize open grasslands after the rains when the young grass shoots are highly nutritious. As the grasses dry, the elephants move into the forest to feed on foliage from the trees. A Protected Area that is meant to protect elephants must therefore be large enough and include diverse habitat types to support a complete complement of inter linked species.

Wildlife Sanctuaries and National Parks of India: There are 589 Protected Areas in India of which 89 are National Parks and 500 are Wildlife Sanctuaries. They include a variety of ecosystems and habitats. Some have been created in order to protect highly endangered species of wild plants and animals found nowhere else in the world.

The Great Himalayan National Park is the largest sanctuary in this ecosystem and is one of the last homes of the beautiful snow leopard. **Dachigam Sanctuary** is the only place where the rare Hangul or Kashmir stag is found. There are several Sanctuaries in the Terai region, **Kaziranga National Park** is the most famous which has elephant, wild buffalo, gaur, wild boar, swamp deer, and hog deer, in large numbers, as well as tiger and leopard. Its bird life is extremely rich and includes ducks, geese, pelicans and storks. The **Manas Sanctuary**, in addition to the above Terai species, also includes the rare golden langur and the very rare pygmy hog, the smallest wild boar in the world. The florican is found only in a few undisturbed grasslands in the Terai sanctuaries.

In the sal forests of Madhya Pradesh, there are several Protected Areas. **Kanha** offers a wonderful opportunity to observe wild tigers from elephant back. It is the only Protected Area in which a sub species of the Barasingha is found.

Bharatpur is one of the most famous water bird sanctuaries in the world. Thousands of ducks, geese, herons, and other wading birds can be seen here. This is the only home of the very rare Siberian crane which migrates to India every winter. During the last 20 years, the 30 or 40 Siberian cranes have dwindled to only 2 or 3. During 2002-3 no cranes were seen and it is possible that this beautiful bird will never again come to India.

In the Thar desert, the wild life is protected in the **Desert National Park.** Here large numbers of black buck, neelgai and chinkara can be seen. The Great Indian Bustard lives in these arid lands.

Ranthambor was the most well known sanctuary for observing tigers in the wild till about 3 or 4 years ago. Since then many tigers have been killed by poachers.

The **Great and the Little Rann of Kutch** have been made into sanctuaries to protect the very rare wild ass, the flamingo, the star tortoise and the desert fox.

In Gujarat, the **Gir Sanctuary** protects the last population of the majestic Asiatic lion. This thorn and deciduous forest is also the home of large herds of chital, sambhar, and nilgai.

The Sanctuaries of the Western Ghats and associated hill ranges protect some of the most diverse forest types in the country. The few examples of highly threatened species include the Malabar giant squirrel, the flying squirrel and a variety of hill birds, several species of amphibians, reptiles and insects. These regions are also rich in highly endemic plant life. Sanctuaries such as **Bhimashankar, Koyana, Chandoli and Radhanagari** preserve this rich flora in Maharashtra, **Bandipur, Bhadra, Dandeli, Nagarhole,** etc. in Karnataka, and **Eraviculum, Perambiculum, Periyar, Silent Valley**, in Kerala.

In the Nilgiri Hills the rich forest Sanctuaries protect some of the last pockets of the Indian elephant in South India. Examples include **Bandipur, Madhumalai, Wynad** and **Bhadra.** During the last 10 years, a large number of the great tusker elephants of this region have been ruthlessly killed for their ivory. Now very few of these magnificent animals are left in these jungles.

Two important sanctuaries meant for preservation of coastal ecosystems are the **Chilka Lake** and **Point Calimere.** The **Sunderbans** protect the largest mangrove delta in India. The **Marine National Park** in Gujarat protects shallow areas in the sea, islands, coral reefs and extensive mudflats.

Over a hundred Protected Areas have been created in the Andaman and Nicobar Islands to preserve their very special island ecosystems.

CASE STUDY

Orissa – Olive Ridley Turtles

Every year at Gahirmatha and two other sites on the Orissa coast, hundreds of thousands of Olive Ridley turtles congregate on the beach, between December and April, for mass nesting. This was the largest nesting site for the Olive Ridleys in the world. In 1999 by the end of March it was estimated that around 200,000 turtles had nested at the Gahirmatha beach. Marine biologists believe that only one out of every 1000 eggs actually matures into an adult.

There are severe threats to these nesting sites. Shrinking nesting sites, construction of roads and buildings close to these rookeries, and other infrastructure development projects hamper nesting. Trawler fishing is another large threat to the turtles.

After its 'discovery' in 1974, the beach was notified as a Sanctuary (the Bhitarkanaika Sanctuary) and was closed for hunting. Recognising the threats to turtles from fishing by large trawlers, the Orissa Marine Fisheries Regulation Act was passed in 1982. This Act prohibits trawling within 10 km of the coastline throughout the state and makes it mandatory for all trawlers to use Turtle Excluder Devices (TEDs). In 2001, the State Government of Orissa declared that a five month period between January to May should constitute a no-fishing season for a distance of 20 km from the coastline.

Apart form these initiatives, Operation Kachhapa is being coordinated by the Wildlife Protection Society of India, Delhi and Wildlife Society of Orissa with many local NGOs as partners. The Orissa Forest Department, WII, Dehra Dun and the Coast Guard are also involved in the Project.

The need for an Integrated Protected Area System (IPAS): Protected Areas, to be effective, must be established in every biogeographic region. A relatively larger representation must be included of highly fragile ecosystems, areas of high species diversity or high endemism. Protected Areas must also be integrated with each other by establishing corridors between adjacent areas wherever possible so that wildlife can move between them.

In our country, which has a rapidly growing human population, it is not easily feasible to set aside more and more land to create Protected Areas. The need to provide a greater amount of land for agricultural and other needs has become an increasing cause of concern in land and resource management. This forms a major impediment for creating new Protected Areas. Having said this, there is an urgent need to add to our Protected Areas to preserve our very rich biological diversity. Much of the natural wilderness has already undergone extensive changes. The residual areas that have high levels of species richness, endemism or endangered plants and animals must be notified as National Parks and Wildlife Sanctuaries. Other areas can be made into Community Conserved Areas which are managed by local people.

The International Union for Conservation of Nature and Natural Resources states that it is essential to include at least 10% of all ecosystems as Protected Areas if biodiversity is to be conserved in the long-term.

India has only 5% of land in its 589 Protected Areas in 2004. However much of this includes plantations of sal or teak, which were developed for timber in the past and are thus relatively poor in diversity and have a low level of 'naturalness'. There are only a few good grasslands left in our country that are notified as Protected Areas. Some are overgrazed wastelands in areas that were once flourishing grasslands. Most of these areas have a low biological value and need careful management to allow them to revert to a more 'natural' state, with their full complement of plants and animals. Only a few wetlands have been made into Sanctuaries. These require better management.

A major strategy to reduce impacts on the biodiversity of the PAs should be to provide a sustainable source of resources for local people living around them. A Protected Area curtails their traditional grazing practices and access fuelwood sources. These resources must be provided by developing them in buffer areas. Plantations of fuel wood and good grassland management in areas outside Protected Areas can help reduce the pressure on the habitat of wildlife in the Protected Area. Management must ensure that local people derive a direct economic benefit from the presence of the PA. Involving local people in Protected Area management and developing tourist facilities that support the income generation for local people helps in involving their support for the Protected Area.

A carefully designed management plan which incorporates an **'ecodevelopment'** component aimed at providing a source of fuel wood, fodder and alternate income generation for local people, is an important aspect of PA management.

There are several species of plants and animals that survive without protection outside our current network of PAs. As it is not practical to notify more PAs without affecting the lives of people, alternate strategies such as Community Reserves or Community Conserved Areas need to be created. These should be managed by local people to bring about the conservation of biodiversity while using the area's resources in an equitable and sustainable way. A Community Conserved Area must have specific conservation goals that can be achieved without compromising the area's utilitarian potential.

A major drive for conservation of biological diversity can only come from a mass environmental education program on the value of protecting our dwindling biological resources.

4.9.2 Ex-situ conservation

Conservation of a species is best done by protecting its habitat along with all the other species that live in it in nature. This is known as in-situ conservation, which is conserving a species in its own environment by creating National Parks and Wildlife Sanctuaries. However, there are situations in which an endangered species is so close to extinction that unless alternate methods are instituted, the species may be rapidly driven to extinction. This strategy is known as ex-situ conservation, i.e. outside its natural habitat in a carefully controlled situation such as a botanical garden for plants or a zoological park for animals, where there is expertise to multiply the species under artificially managed conditions. These breeding programs for rare plants and animals are however more expensive than managing a Protected Area.

There is also another form of preserving a plant by preserving its germ plasm in a gene bank so that it can be used if needed in future. This is even more expensive.

When an animal is on the brink of extinction, it must be carefully bred so that inbreeding does not lead to the genetic makeup becoming weak. Breeding from the same stock can lead to poorly adapted progeny or even inability to get enough offspring.

Modern breeding programs are done in zoos that provide for all the animal's needs, including enclosures that simulate their wild habitats. There may also be a need to assist breeding artificially. Thus while most zoos are meant to provide visitors with a visual experience of seeing a wild animal close up, and provide the visitors with information about the species, a modern zoo has to go beyond these functions that include breeding of endangered species as a conservation measure.

In India, successful ex situ conservation programs have been done for all our three species of crocodiles. This has been highly successful. Another recent success has been the breeding of the very rare pygmy hog in Gauhati zoo. Delhi zoo has successfully bred the rare Manipur brow antlered deer.

However the most important step of a successful breeding program is the reintroduction of a species into its original wild habitat. This requires rehabilitation of the degraded habitat and removal of the other causes such as poaching, disturbance, or other manmade influences that have been the primary cause of reducing the population of the species.

Conservation of cultivars and livestock breeds: There were an estimated thirty thousand varieties of rice grown in India till about 50 years ago. Now only a few of these are still grown. The new varieties which are now being cultivated everywhere have been developed using germ plasm of these original types of rice. If all the traditional varieties vanish completely it will be difficult to develop new disease resistant varieties of rice in the future. Several varieties have been preserved in gene banks. However, this is both very expensive and risky. Encouraging farmers to continue to grow several traditional varieties is thus an important concern for the future of mankind. At present gene bank collections have over 34 thousand cereals and 22 thousand pulses.

CASE STUDY

Beej Bachao Andolan (Save the Seeds Movement)

This movement began in the Himalayan foothills. The members have collected seeds of diverse crops in Garhwal. The movement has successfully conserved hundreds of local rice varieties, rajma, pulses, millets, vegetables, spices and herbs. Many different varieties are being grown as an outcome of this program in local farmer's fields. This has also been supported by local women's groups who felt these varieties were better than those provided by the green revolution. In contrast, men who were interested in cash returns in a short time found it difficult to appreciate the benefits of growing indigenous varieties.

In the past, domestic animals were selected and bred for their ability to adapt to local conditions. Traditional agropastoralists in India have selectively bred livestock for 2 to 3 thousand years. India has 27 breeds of cattle, 40 breeds of sheep, 22 breeds of goats, and 8 breeds of buffaloes. These traditional breeds must be maintained for their genetic variability.