UNIT 8

BIODIVERSITY : THREATS AND CONSERVATION

Structure

8.1 INTRODUCTION

Since 3.5 billion years ago when life began, about 500 million kinds of plants, animals and microorganisms have made earth their home. UN Convention on Biological Diversity says there are some 13 million species still living on earth of which 1.7 million species have been identified and described. We, however, do not have an exact number because there are many areas of the earth that are biologically unexplored, such as the tropical rain forests where majority of the living organisms live but are yet to be identified.

A few species naturally become extinct over time and it is believed that during certain periods of geological time, great numbers of species have been lost relatively quickly – on the scale of thousands of years. Scientists have documented five periods of mass extinctions since the emergence of life on this planet. It is thought that each of these episodes, during which a large fraction of all species were lost, was caused by a catastrophic natural event on earth. Growing human population, leading to over exploitation of biotic resources and habitat destruction, is responsible for today's exceptionally high extinction rates. Many scientists consider this as the sixth extinction episode.

Biotic diversity -the richness of life on earth -is like a common property or resource belonging to the whole human race. Therefore biodiversity conservation is a major concern worldwide. Conservationists are involved in global efforts to protect biodiversity. We should conserve the rich biodiversity of the earth for the posterity so that in future people can enjoy the richness of earth.

In this unit the two mechanisms for protection of biological diversity have been given special emphasis. Conservation of natural communities and populations in the wild is known as *in situ* or on site conservation. Nature reserves are also very important site of flora and fauna as they are conserved there in pristine state. The other strategy, where species are maintained in artificial conditions under human supervision, is known as *ex situ* or off-site conservation. Examples of *ex situ* conservation are the botanical gardens and zoological parks.

Expected Learning Outcomes

After completing the study of this unit you should be able to:

- list various causes of biodiversity losses and discuss its major impact on whole world;
- explain the need and concept of biodiversity conservation;
- enumerate the needs for *in-situ* conservation of species and the various measures and mechanisms;
- appreciate the need for *ex-situ* conservation of species and the various mechanisms that are involved in this process of conservation; and
- appreciate the importance of nature reserve in biodiversity conservation.

8.2 CAUSES OF BIODIVERSITY LOSS

The main causes of biodiversity loss include land-use changes, changing levels of atmospheric carbon dioxide, changing climate, biological invasion and nitrogen deposition (air pollution). The causes of biodiversity loss are many and varied, and often interrelated. You will study about these factors in detail in the following subsections.

8.2.1 Habitat Loss

Habitat refers to the area where species seek food, get shelter and reproduce. The greatest threat to wild plant and animal species is due to destruction or alteration of their habitat. If an animal's habitat is destroyed or disrupted, it must adapt to the new changes, move elsewhere or die. When it is forced out of its territory, and if it finds a suitable habitat there is a possibility that the habitat is already in use. Consequently, it must compete with the local population of the same species as well as other animals. The other option is that it must migrate into a marginal habitat where it may succumb to predation, starvation or disease. Some organisms such as pigeon, house sparrows, rodents (like rat and mice) and deer flourish in the modified habitats provided by human activities but many others do not.

Some habitats are more vulnerable to species extinction, these are called fragile habitats. **Coral reefs, oceanic islands and mountain tops are important fragile habitats.**

Box. 8.1: Case study 1: Fragile habitats

Coral Reefs

Coral reefs have been found to be particularly fragile as they are susceptible to a rise in water temperature, sea levels and the introduction of pollutants and sediments that change its water quality. Coral reef development is greatest in warm, shallow sun-drenched areas and it needs clean and clear water. Productivity is decreased, or even eliminated, in areas subject to dirty sediment-laden water. Coral growth is naturally very slow.

In 1992, about 10% of the earth's existing coral reefs were found to be irreparably damaged, while 30% were expected to suffer damage within the next 20 years. It is also expected that there may be a further 30% loss within the next 20-40 years if remedial action is not implemented. It is estimated that Tsunami, 2004 had caused considerable damage to the coral reefs of coastal areas of India, Sri Lanka and Thailand.

Oceanic Islands

Existing data shows that 75% of the recorded animal extinctions since 1600 have been on islands rather than in continental areas .Terrestrial species in isolated oceanic islands are more vulnerable to being wiped out than continental species. The reasons for species extinction on oceanic island are restricted ranges, threat from alien species and characteristics of island species.

Habitat Islands

Species in ecological islands or "habitat islands" (areas of habitat separated from other such areas by inhospitable environments that act as effective barriers to dispersal) are at greater risk of extinction. For instance, freshwater lakes – bodies of water surrounded by land – like real islands, suffer high rates of extinction due to habitat modification or the introduction of exotic invasive species. Among continental extinctions, at least 66% of species loss has been in aquatic habitats.

Biodiversity loss in lakes is further increased by the fact that isolated inland water bodies can also have a high species endemism, resulting in global extinctions when these species are lost.

Habitat destruction is recognised today as the most significant threat to global biodiversity and bears responsibility for much of the species loss worldwide. This includes:

- felling of forests for land use (e.g. clear felling for development, agriculture), large scale logging and small scale patchwork agriculture. Shifting cultivation alone is believed to be responsible for 70% of deforestation in Africa, 50% of deforestation in Asia, and 35% of forest loss in the America.

- destruction of mangrove sites for aquaculture
- mining and destruction of corals
- conversion of wetlands for land uses
- over-extraction of timber and fuel wood
- human-induced burning of habitats (e.g. forest firing for shifting cultivation and firing grasslands to improve fodder for cattle)
- damming of rivers
- siltation and sedimentation of freshwater bodies
- pollution also disturbs the natural habitat considerably. Industrial wastes cause severe impact, particularly on the aquatic habitats. For example, during the 1950s and 1960s, insecticides particularly chlorinated hydrocarbons (such as DDT), reduced the population levels of several birds such as the bald eagle and brown pelican.

In many countries there are very few pristine areas left that have not been modified in some way by humans. When habitats are not completely destroyed, they are fragmented into smaller patches, creating islands of habitats in a sea of development. Fragmentation exposes species to more light, wind and temperature effects than are natural, thus affecting the species survival as food and water sources are lost and few mates remain. In fragmented landscapes many species soon become isolated from others of their own kind resulting in inbreeding, loss of genetic diversity and local extinction.

More than three quarters of the species that are in danger of extinction today are due to the destruction of their forest habitats. A large number of these species are from the tropics, where human population growth has been most explosive and habitats have been destroyed most rapidly. Tropical rain forests cover a mere 7 per cent of the earth's surface, yet they house about three quarters of the total species. Today these forests are being destroyed at an alarming rate.

8.3 HUMAN–WILD LIFE CONFLICT

People use some plant and animal species at a greater rate than the species can replace themselves. Nine of the world's major ocean fisheries are declining because of too much fishing as well as water pollution and habitat destruction, e.g. southern bluefin tuna, the Atlantic halibut and the Pacific and Atlantic salmon. Current logging rates threaten to eliminate mahogany and many other tree species that take many years to grow and mature.

The $10 billion-a-year global market in wildlife – for pets, folk medicines, gourmet foods, decorative objects and other uses – threatens elephants and rhinos, sea horses and colourful corals, tropical plants and birds, and bears, pandas and tigers.

8.3.1 Selective Destruction of Species

The selective destruction of one species of an existing fauna can produce equally unfortunate results. The perfect demonstration of unexpected consequences of such selective destruction can be explained to you by the example of Passenger pigeon (Fig. 8.1). The Passenger pigeon (*Ectopistes migratorius*) was probably most abundant bird on earth as recently as the middle of the nineteenth century. Their flocks darkened the sky during migration, and one such flock alone was 400 km long and had no less than two billion birds. So huge was their numbers that the branches of trees would break under the weight of the perching birds. It took hours for the flocks to pass through a place. There used to be as many as 90 nests per tree throughout a stretch of forest of about 5 km width and 67 km length. In 1871, an estimated 136 million passenger pigeons nested in a 2,200 sq. km area of central Wisconsin, USA. An immense tonnage of droppings fertilised the forests where passenger pigeons roosted. Today there is not even a single passenger pigeon on the earth. You must be wondering why this extinction occurred. This happened because millions of passenger pigeons were killed for food every year.

Fig.8.1: Passenger pigeon a lesson learnt but too late.

8.3.2 Domestication of Selective Species

Humans have taken care of the living beings which are useful to them through extensive breeding programmes, to derive maximum benefit of their products. During the process, the species have lost certain useful characteristics so much so that these forms cannot survive on their own in nature. A very good example is corn, which is pampered so much by human that if it is left on its own, it cannot survive.

Today human has large herds of domestic animals. These animals can also play a significant part in the reduction of animal populations by overgrazing the land, thus destroying the vegetation on which both they and the wild animals depend. The native wildlife of a particular area is capable of utilising the native plant life much more efficiently than introduced domestic cattle, and is thus much less likely to convert fertile areas into deserts.

The other important parameter is that the domestic cattle are carriers of several diseases which they can transmit to wild animals. For example, the steady rehabilitation of the Great Indian Rhinoceros was seriously hampered by the rinderpest disease which they contracted from the local domestic cattle.

Several years ago, a hillside in Mexico was being ploughed when a few alert scientists discovered a previously unknown species of wild corn – *Zea diploperennis* that only grew on that hill and was found nowhere else. These corn plants are perennial whereas the domestic varieties of corn are annuals. Moreover, the wild corn is resistant to many diseases that infest domestic varieties. The species was thus saved and it is now being used to breed and improve new domestic varieties.

8.3.3 Use of Pesticides

Pesticides harm insect pollinators, including managed honeybee populations, which can in turn reduce crop yields. Runoff seeping into rivers, lakes and coastal environments can produce negative impacts on entire aquatic ecosystems.

Several pesticides banned in the United States are still exported to developing countries such as DDT, DDE and PCBs. These substances mimic or interface with normal hormones in living organisms. Reproductive

abnormalities have been found in alligators, terns, salmon and gulls exposed to high levels of chemicals from pesticides and animal hormones in their environment.

8.3.4 Global Climate Change

Substantial evidence demonstrates that people are contributing to measurable changes in the global climate, threatening life. By burning fossil fuels such as oil, natural gas and coal and by burning trees, we have dramatically increased the amount of CO_2 in the atmosphere. While scientists do not know the exact effects of increased CO_2, they predict that it will lead to higher overall global temperatures, increasing sea levels, and changes in climate patterns.

The changed atmospheric conditions that result from global warming could create greater numbers of intense storms and prolonged droughts. On the other hand, the expected speed of climate changes coupled with direct loss of natural habitat may prevent some species from adapting quickly enough. They are likely to become extinct, locally or more broadly, and their roles in natural systems will be lost forever.

SAQ 1

a) What are the demerits of domestication of selective animals? How can it destroy biodiversity?

b) The perfect example of selective destruction is
   i) Great Indian Rhinoceros
   ii) Alligators
   iii) Passenger pigeon
   iv) Sea gulls

c) The main reasons for animal species extinction at the current high rates are
   i) Habitat destruction
   ii) Hunting
   iii) Over harvesting from the wild
   iv) Domestication of selective species of animals

d) Habitat modification may occur due to
   i) Fragmentation of original habitat
   ii) Pollution
   iii) Changes in species composition due to humans
   iv) All of the above

8.4 POACHING OF WILD LIFE

The hunting and export of excessive numbers of certain animal species is another important factor leading to dangerous reductions in numbers. There are three main types of hunting:

i) **Commercial hunting** – in which the animals are killed for profit from sale of their furs, bones or other parts;

ii) **Subsistence hunting** – the killing of animals to provide food for survival; and

iii) **Sport hunting** – the killing of animals for recreation. Although subsistence hunting was once a major cause of extinction of some species, it has now declined sharply in most areas. Sport hunting is now closely regulated in most countries; species are endangered only when protective regulation does not exist or are not enforced.

On a worldwide basis, commercial hunting threatens a number of large animal species. The jaguar, tiger, snow leopard, and cheetah are hunted for their skins, elephants for their ivory tusks (accounting for the slaughter of about 90,000 elephants a year) and rhinoceros for their horns. Single rhino horn – which is a mass of compact hair – is worth as much as $24,000 in the black market. It is used to make handles for ornamental knives in North Yemen, and ground into a powder and used in parts of Asia for medicinal purposes, especially reducing fever. It is also thought to be an aphrodisiac or sexual stimulant even though it consists of a substance (keratin) that can be obtained by eating hair trimmings and finger nails. Although 60 countries have agreed not to import or export rhino horns, illegal trafficking goes on because of its high market value.

Another highly publicised commercial hunt is that of the whale. The whaling industry has generally concentrated its efforts on the large, profitable baleen whales, which were slaughtered for their blubber and baleen, the bony sieves they filter sea water with. From the blubber, high grade oil was made for lamps and for lubricating machines. The baleen or "whalebone" was used to make corset stays, combs and similar products. The history of whaling is one of over-exploitation followed by abandonment.

Carolina parakeet-their brightly coloured feathers caused their downfall. These feathers were prized for decorating women's hats and made the birds popular as pets. Their extinction came in 1914.

The heath hen was used as food. In the early 1900s people realised that the bird was becoming scarce and a bird sanctuary was set up. The flock soon grew, but a fire swept across the sanctuary, and only a few males survived. The last bird died in 1932.

The Labrador duck became extinct before anyone realised it was gone. Most of the birds were killed for their feathers, which were used to stuff pillows.

Among all the countries, India has the greatest number of mammalian species on the threatened species (endangered, rare etc.) list, and in the Red Data Book, ranks first of the world.

8.5 BIOLOGICAL INVASION

Purposely or accidentally, people often bring non-native species into new areas where the species have few or no natural predators to keep their populations in check. These invasive species – also called **alien**, **introduced** or **exotic species** – are considered the most important cause of native biodiversity loss. Invasive or alien species are those species which when introduced into new areas cause **biological invasions**. They range from microbes to mammals. Invasive species also cause economic and environmental havoc. Invasive species can also alter fire cycles, nutrient cycling and the hydrology and energy budgets in native ecosystems. The problem of invasive species will rise severely through climate change.

Some examples of invasive species are given below which you can see and experience yourself how these destroy the local flora.

- Water hyacinth, a water plant with a showy purple flower, is a native of the Brazil and is now seen as the most important nuisance aquatic plant

The blue whale, the largest animal that has ever lived, once numbered around 2,00,000 but by the mid 1950s it has been reduced to about 10,000. Many scientists believe that the blue whale population, although now protected, may not recover

worldwide. It affects water flow, electricity generation, transport, water quality and indigenous biodiversity. In India it was introduced in 1886 in Bengal as an ornamental, pond plant. Since then it has spread throughout India as an obnoxious aquatic weed covering large area. Fish and rice crops worth millions of rupees are damaged each year at the hands of this weed.

- *Parthenium hysterophorus,* also known as congress weed was introduced in India with food grains imported from USA. It reproduces freely from seeds and has spread in neglected areas throughout the country. Its pollen also causes skin allergies.
- Golden apple snail is one of the most devastating invasive alien species. It was imported from Latin America to South East Asia in the 1980s.
- *Prosopis juliflora* (Mesquite) in the semi-arid parts of India has displaced other flora of the area. It has become as invasive seriously threatening the biodiversity.

SAQ 2

a) Invasive species which causes skin allergies

i) water hyacinth

ii) congress weed

iii) mesquite

iv) sweet pea

b) Discuss with example how is poaching responsible for extinction of big animals

c) Discuss the harmful effects of invasive species with example

8.6 NEED FOR CONSERVING BIODIVERSITY

Why is biodiversity so important? Why should we care about it? What is the, value- biodiversity? May be the lay people don't understand the various roles it plays in our life, but certainly they know the importance of biodiversity.

There are many factors that underlie the need to conserve biodiversity, such as,

"The more biodiversity we destroy and the more irrevocably we change the biosphere, the more we limit our choices for the future."

- present and potential uses of the components of biological diversity - especially as we have no way of knowing or predicting what will be of use in the future.
- biodiversity is essential to maintain the earth's life support systems that enable the biosphere to support human life.
- It is ethically important to maintain all of the earth's biological diversity, including all the other extant (currently existing) life forms.

Biological diversity has to be conserved at all levels - comprising genes, species and ecosystems. The greater the number of individuals of a species

and the number of different populations of the species conserved, the greater will be the biological diversity conserved. Maintaining a high genetic diversity ensures that individual species are more adapted to their environment and changing conditions, and are thus less vulnerable to extinction. Wide ecosystem diversity will ensure that more species have living conditions vital for their survival; while a wide species diversity will ensure that ecosystems are more stable in the long term.

8.7 CONSERVATION OF BIODIVERSITY

Conservation needs different strategies, they can be species based or habitat based or ecosystem based. Some species are given importance at national level while some need treatment at international levels. Most of the conservation is done at *in situ* and *ex situ* conditions. In this unit we will discuss what these conditions mean, what is the difference between them and what are the methods and techniques used. We have also described some important projects such as project tiger and how this project had helped in increasing tiger populations. Some techniques such as seed bank and tissue culture are also proving very helpful in conservation of plants which fulfill several of our needs.

In-situ conservation means "on-site conservation". It is the process of protecting an endangered plant or animal species in its natural habitat, either by protecting or cleaning up the habitat itself, or by defending the species from predators. The benefit to *in-situ* conservation is that it maintains recovering populations in the surroundings where they have developed their distinctive properties.

Wildlife conservation is mostly based on *in-situ* conservation. This involves the protection of wildlife habitats. Also, sufficiently large reserves are maintained to enable the target species to exist in large numbers. The population size must be sufficient to enable the necessary genetic diversity to survive within the population.

***Ex-situ* conservation** means, literally "off-site conservation". It is the process of protecting population of an endangered species of plant or animal by removing it from an unsafe or threatened habitat and placing it, or part of it, under the care of humans. While *ex-situ* conservation is comprised of some of the oldest and best known conservation methods known to human, it also involves newer, sometimes controversial laboratory methods.

Ex-situ conservation, while helpful in human's efforts to sustain and protect our environment, is rarely enough to save a species from extinction. It is to be used as a last resort or as a supplement to *in-situ* conservation because it cannot recreate the habitat as a whole: the entire genetic variation of a species, its symbiotic counterparts, or those elements which, over time, might help a species adapt to its changing surroundings. Further more, *ex-situ* conservation techniques are often costly. Plants and animals living in *ex-situ* breeding grounds have no natural defense to the diseases and pests new to the species.

8.7.1 *In-situ* Conservation

This approach deals with maintaining species in their natural habitats, which is believed to be the best way to maintain the earth's biological diversity. It also allows natural evolutionary processes to continue and for species to keep on adapting to their surroundings. However, this needs good management practices and controlled land use to ensure the successes of conservation objectives. Thus **Protected Areas** play a very important role in *in-situ* conservation of species, particularly threatened species, by ensuring conservation of their habitat.

When a location is selected, the design of the preserved area plays an important role and is characterised by three important characteristics: size, shape and connectivity. If the size of the preserved area is big it increases the number of species contained in preserved area. The rounder shape minimizes edge effects because the perimeter (edge) is smaller relative to the area inside than with other shapes. Connectivity between potential fragments allows members of the same species to immigrate and interbreed. The connections are also called corridors. Buffer zones are another important preserve characteristic (Fig.8.2)

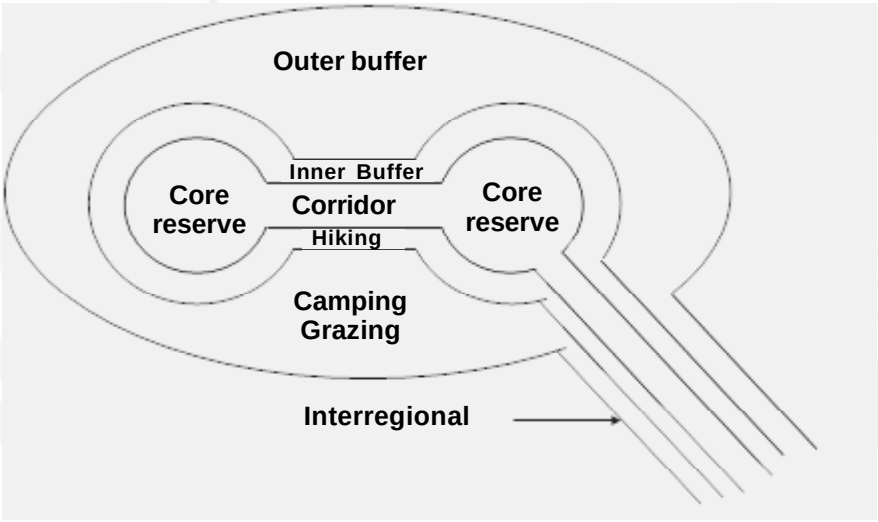

Fig.8.2: Structure of preserved areas

A buffer zone is moderately utilised land that provides a transition into the unmodified natural habitat in the core preserve where no human disturbance is allowed.

Buffer zones are very important for both psychological and practical reasons and from this zone inhabitants of the area can derive some benefits from the preserve. By permitting moderate recreational forestry, farming and other activities, buffer zone provides jobs, and income with no ill effects on species in the core preserve. Other types of areas that are important for *in-situ* conservation of species are:

- **National parks and sanctuaries**

  Most national parks are areas of land that have great natural beauty, which are set aside and protected for the conservation of habitat of many

plants and animals. In national parks peoples are allowed to enjoy the scenery and wildlife, but visitor management is often required to reduce conflicts between recreation and conservation.

National parks are largely natural and unchanged by human activities, but many of them already had existing human impacts before they were designated for protection and human activities have often been allowed to continue. People have no rights in a National Park.

The first wildlife sanctuary was the Vedanthangal Bird Sanctuary near Madras, set up in 1878, which merely formalised the traditional protection afforded by villagers for pelicans, herons and other birds breeding at Vedanthangal. Another such sanctuary was set up at Ranganathittu near Mysore, in 1942. As in 2018, India has 103 National Parks, 536 Wildlife Sanctuaries and 18 Biosphere Reserves.

Box. 8.2: Tigers Reserves

Project tiger was launched on 1 April, 1973 as centrally sponsored scheme of Government of India to maintain viable population of the tiger and its natural habitat. The main objective of the scheme is to ensure a viable population of tiger in India for scientific, economic, aesthetic, cultural and ecological values and to preserve areas of biological importance as natural heritage for the benefit, education and enjoyment of the people. Main objectives under the scheme include wildlife management and protection. Initially, the Project started with nine tiger reserves, covering an area of 16,339 sq.km with a population of 268 tigers. At present there are 27 tiger reserves covering an area of 37, 761 sq.km. with a population of 2967 tigers. This amounts of almost 1.14% of the total geographical area of the country. The selection of reserves was guided by representation of ecotypical wilderness areas across the biogeographic range of tiger distribution in the country. Project Tiger is undisputedly a custodian of major gene pool in the country. It is also a repository of some of the most valuable ecosystem and habitats for wildlife.

Fig. 8.3: Indian Tiger.

The Tiger Reserves are constituted on a 'core-buffer strategy'. The core area is kept free of biotic disturbances and forestry operations, collection of minor forest produce, grazing and human disturbances are not allowed within. However, the buffer zone is managed as a 'multiple use area' with twin objectives of providing habitat supplement to the spillover population of wild animals from the core conservation unit, and to

"A Tiger is a large-hearted gentleman (Fig.8.3) with boundless courage and that when he is exterminated – as exterminated he will be unless public opinion rallies to his support – India will be the poorer by having lost the finest of her fauna" **-Jim Corbett**

provide site specific ecodevelopmental inputs to surrounding villages for relieving the impact on the core. No relocation is visualized in the buffer area, and forestry operations, Non-Timber Forest Produce (NTFP) collection and other rights and concessions to the indigenous communities are permitted in a regulated manner to complement the initiatives in the core unit. The effective protection and intensive conservation measures inside the reserves have brought about considerable indescribable achievements. The project has been instrumental in mustering local support for conservation programme in general.

Captive Breeding Programmes

Captive breeding does play an important role in elephant conservation. Some of the most successful captive breeding programmes are those where elephants are kept under semi-natural conditions like in forest camps. In the forest camps in southern India, elephants have been seen to regularly breed in captivity and it has also been observed that the elephant population has sustained itself without the addition of any elephant from the wild.

In most forest camps, bulls and cows of all ages are kept together and are allowed to mingle with each other. They are also left in the forests at night, so that they can feed. Sometimes, the cows have been known to mate with wild bulls.

Crocodile Conservation

In situ conservation of selected species of birds and reptiles has been fortified through captive breeding programmes. The Government of India started a Crocodile Breeding and Management Project in 1976 to save the three endangered crocodilian species, the fresh water crocodile, salt water crocodile and the *gharial*. Thousands of crocodiles of these three species have been reared at 16 centres and several of these have been released into the wild. Eleven sanctuaries have been declared specially for crocodile protection including the National Chambal Sanctuary in Madhya Pradesh. The endangered white-winged wood duck was also bred in captivity and released into Protected Areas of the Northeast, in an Indo-British collaborative programme.

SAQ 3

a) Total number of Biosphere Reserves in India are

   i) 12

   ii) 14

   iii) 16

   iv) 18

b) Describe the importance of buffer zone in protected areas.

8.7.2 *Ex-situ* Conservation

Ex-situ conservation is comprised of some of the oldest and best known conservation methods known to human, it also involves newer, sometimes controversial laboratory methods.

Ex situ conservation has certain limitations for conservation of animals. These include adaptation problems, loss of genetic variability due to inbreeding, and concentration in small place, surplus animals, and continuity in funds. Research on captive population can provide insight into the basic biology of the species and suggest new conservation strategies.

However, much more needs to be done to protect global resource (flora and fauna) needed for healthy and productive animals and plants that are used for food, material, economic and aesthetic needs of the society.

- **Botanical Gardens**

  Together, the world's 1500 botanic gardens (Fig. 8.4), arboreta, and national plant collections maintain the largest array of plant diversity outside of nature, and they have major, if often overlooked, potential as resource centers for conservation, education, and development. If the infrastructure and technical facilities of most of these institutions can be strengthened, they can conserve *ex situ* stocks of most of the world's endangered plant species. Already, individuals of an estimated 12,000 to 15,000 threatened species are being cultivated in botanic gardens and arboreta

Fig. 8.4: The Great Banyan Tree in Indian Botanical Garden, Kolkata.

- **Zoological Parks**

  The basic philosophy behind the creation of zoological parks in modern times is to create an understanding of the environment and ecological balance of life, meaning strengthening the bond between people and the living earth. These zoological parks are no mere picnic spots. They are now centres for *ex-situ* wild life conservation and environmental education.

  The history of modern zoos has started some 200 years ago with the creation of the first public zoo. Since then every part of world has

Collectively the zoos of the network are visited annually by at least 600,000,000 people (approximately 10% of the current world population).

developed their own zoological parks with great diversity such as aquaria, bird-parks, private zoos and safari parks. The World Zoo Conservation Strategy concludes that the evolution of zoo should continue to help the conservation of wildlife. There are several species of wildlife which would have been extinct today except for efforts by zoos and animal reserves.

Ex-Situ conservation of wild animals in zoo

Some important techniques used in *ex-situ* conservation are dealt here.

i) **Captive breeding**

Captive breeding is one of the important strategies used by both government and non-government organizations. Captive-breeding programmes of endangered and threatened species have become familiar programmes that strive to preserve biodiversity and species-survival plans such as cheetah.

ii) **Embryo Storage and transfer technology**

Techniques for embryo transfer and artificial insemination, which have been developed for laboratory animals and farm animals, are potentially very useful for improving the reproductive potential of captive populations of endangered species. These kinds of techniques have been worked out mainly for mammals.

iii) **Artificial insemination**

Artificial insemination is another technology that may be useful. Sperm can be frozen and used later, or transferred to another breeding facility to increase genetic diversity. Sometimes, the sperm can be added to the eggs in a dish and fertilization will occur. In other cases (for example, horses) the sperm has to be injected into the egg. A few years ago, the black-footed ferret was down to six individuals, but artificial insemination has now been used to produce 16 kittens. Elephants and cheetahs have conceived, and a cheetah cub has been born following artificial insemination. Elephants have not bred naturally in captivity, so this method may be useful simply to make captive breeding possible.

In New Zealand scientists are hoping to use trans-species cloning to bring back the recently extinct Huia bird.

iv) **Somatic cell cloning**

Somatic cell cloning holds some promise for propagating from one or a few survivors of an almost extinct species. This was first done with domestic sheep at the Roslin Institute in Edinburgh (from University of Virginia) but has since been done with other mammals. It has already been used to rescue a rare breed of cattle that had been reduced to a single old female (“Lady”) and some frozen sperm. Granulosa cells (somatic cells in the ovary) from Lady were fused with enucleated eggs (lacking DNA) from a different breed, and the resulting eggs were implanted into an Angus cow (a common breed). The first calf born from these cells is genetically identical to Lady, as expected, although her markings were slightly different.

v) **Fostering**

Many egg-laying animals (i.e. birds and reptiles) are capable of producing many more eggs than they can rear. This raises the possibility of collecting the extra eggs and hatching and rearing the animals in captivity with a foster parent, then using them to supplement wild populations. It has worked extremely well with some birds, particularly the peregrine falcon, which is now doing so well that the fostering programme is being phased out. Rearing of whooping cranes has also been successful, and the species recovered from a population of 21 birds in 1941 to over 300 in 1996.

vi) **Translocations**

Sometimes conservation of faunal species involves or necessitates translocation of animals. This means the movement of individuals from its natural habitat, or from captivity, to another habitat. Translocations are carried out in connection with introductions or reintroductions, and should be handled with extreme caution.

vii) **Introduction**

This involves the translocation of a species (from its natural habitat or from captivity) into an area outside its historical distribution. Such species would then become an "exotic" to the area. This should be handled with extreme care and needs. Extensive study of the habitat and the behaviour and social organization of the species to be introduced has to be done, to ensure that the species has a good chance of adapting to the habitat.

viii) **Reintroduction**

This involves the translocation of a species (from its natural habitat or from captivity) into an area within its historical distribution, either to boost existing populations, or to establish new populations when the original population had died out. This too should be handled with extreme care and needs extensive study of the habitat and the behaviour and social organization of the species to be reintroduced.

In at least seven cases (Pere David's deer, Arabian Oryx, American bison, Red wolf, Guam kingfisher, Guam rail, and the California condor) the species were extinct in the wild at the time of reintroduction.

Seed Bank

The preservation of plant germplasm in seedbanks, (or genebanks), is one of the techniques of *ex-situ* conservation of plant species.Seeds have a natural dormancy feature, which allows for their suspended preservation for long periods of time with little damage, provided the conditions are favourable. Banking dormant seeds enables to keep genetically representative samples of rare and endangered plant species as a kind of "genetic insurance".

Seeds Storing

Storing germplasm in seedbanks is both inexpensive and space efficient. It allows preservation of large populations with little genetic erosion. Seedbanks also offer good sources of plant material for biological research, and avoid disturbance or damage of natural populations.

Tissue Culture

Plant tissue culture is an essential component of plant biotechnology. The possibility to regenerate whole plant from protoplasts, single cells, tissues and organs, *in vitro*, has opened out entirely new approaches to plant improvement, and has considerably enhanced the efficiency of the conventional methods of plant breeding and plant propagation.

SAQ 4

a) Which of the following provides genetic insurance

   i) tissue culture

   ii) somatic cell cloning

   iii) introduction

   iv) seed bank

b) Artifical insemination can be beneficial in

   i) Dogs

   ii) Cats

   iii) Elephants

   iv) Snakes

8.8 NATURE RESERVES

The nature reserves are the important area for the conservation of biodiversity. The growing destruction of biodiversity reemphasises the valuable contribution of nature reserves. These areas are resourceful and useful means to deal with biodiversity losses and help in buffering society from climatic effects and maintains the critical ecosystem services to the society.

Biosphere Reserves

Bisphere reserves are internationally recognised areas established to promote and demonstrate a balanced relationship between humans and the biosphere (Fig. 8.5). They highlight the value of nature conservation within a particular natural region and reconcile the conservation of biological diversity with sustainable use. Consequently they are ideally suited to meet today's conservation needs when human populations are increasing and the practicality of leaving aside large areas to protect pristine natural wild lands is decreasing, despite the fact that more people than ever before are dependent on wild species and natural ecosystems for their well-being.

The programme of Biosphere Reserve was initiated under the Man and Biosphere (MAB) programme by UNESCO in 1971. Biosphere Reserves programme is intended to conserve representative ecosystems as opposed to only species or habitat conservation. It provides *in-situ* conservation under natural conditions, long-term conservation of plants, animals and micro organisms. The purpose of the formation of the Biosphere Reserve is to conserve *in-situ* all forms of life, along with its support system, in its totality, so

Fig. 8.5: Sundarban Biosphere Reserve.

that it could serve as a referral system for monitoring and evaluating changes in natural ecosystems. The first biosphere reserve of the world was established in 1979, since then the network of biosphere reserves has increased to 425 in 95 countries in the world (MAB - 2003). Presently, there are 18 designated biosphere reserves in India. India's first Biosphere Reserve was the Nilgiri Biosphere Reserve.

Wetlands

India's wetlands (Fig.8.6) are distributed in different geographical regions ranging from the cold arid zone of Ladakh to the wet humid climate of Imphal; the warm arid zone of Rajasthan to tropical monsoonal Central India, and the wet humid zone of the Southern peninsula.

Fig. 8.6: Wetlands.

In the world over, a wetland is considered important if it:

- is particularly a good representative example of a natural or near natural wetland, characteristic of the appropriate biogeographic region;
- plays a substantial hydrological, biological, or ecological role in the natural functioning of a major river basin or coastal system;
- is a specific type of wetland, rare or unusual; or
- supports an appreciable assemblage of rare, vulnerable or endangered species or subspecies of plants or animals.

Importantly, wetlands are habitats for a wide variety of plant and animal life. Most important of these is the waterfowl. Since wetlands are shallow water

areas, they provide an ideal habitat for water birds. Examples of such kinds of wetlands can be found all over the world.

Apart from harbouring birds, wetlands are also a nursery ground for several species of fish and shell fish and a wide variety of aquatic organisms. Chilka in Odisha, for example, has dolphins that move around in the area where the lake meets the sea. Coastal wetlands especially being an ecotone between the sea and freshwater, and/or freshwater and terrestrial habitats have high species diversity.

Ecologically, too, wetlands perform important functions. They regulate the water regime, act as natural filters and, display a marvelous nutrient dynamics. As an ecosystem, wetlands are useful for nutrient recovery and cycling, releasing excess nitrogen, deactivating phosphates, removing toxins, chemicals and heavy metals through absorption by plants and also in the treatment of waste water.

Bulwark a defensive wall, especially of earth

Furthermore, coastal wetlands with their unique mangroves (Fig. 8.7) are a natural bulwark against erosion by sea. The possible threat of rise in sea level is universally dreaded. One immediate preventive of this possible threat, as has been suggested by experts, would be the plan of a network of mangroves. In fact, mangrove wetlands of India and Bangladesh act as buffers against the devastating storms of the Bay of Bengal. Wetlands, thus, help in mitigating floods, recharging aquifers and reducing surface run-off and the consequent erosion.

Some of the most important Indian wetlands are: Kolleru (Andhra Pradesh), Wullar (Jammu and Kashmir), Chilka (Odisha), Loktak (Manipur), Bhoj (Madhya Pradesh), Sambar (Rajasthan), Pichola (Rajasthan), Ashtamudi (Kerala), Sasthamkotta (Kerala), Harike (Punjab), Kanjli (Punjab), Ujni (Maharashtra), Sukhna (Chandigarh), Renuka (Himachal Pradesh), Kabar (Bihar), Nalsarovar (Gujrat) and Dal (Jammu and Kashmir).

Fig. 8.7: Mangroves acting as bulwark for environment.

In the context of the environment, too, wetlands play a very important role. They protect and improve the quality of water and keep the local weather moderate. Using wetlands for water quality improvement has been tried in cold climates. Wetlands in urban periphery are natural receptacles for waste water and can harness effectively the nutrients available in the waste through fisheries and agriculture.

Box 8.3: Natural Wetlands of India

Most of the natural wetlands of India are connected with the river systems of the North and South. On the other hand, the various multi-purpose projects launched to harness river systems have provided a number of wetlands, e.g., Harike Barrage at the confluence of the Beas and Sutlej in Punjab, Bhakra Nangal Dam in Punjab and the Kosi Barrage on the Bihar-Nepal border. Besides these, we also have a network of lakes – natural as well as manmade, for example, Kabar lake, Chilka lake, Pichola Complex and Sukhna lake etc. In addition of these, there are 6,740 square kilometres of mangroves. The major concentrations of mangroves in the country are the Sunderbans and the Andaman and Nicobar Islands, which hold 80% of the mangroves in India. Rests of them are in Odisha, Andhra Pradesh, Tamil Nadu, Karnataka, Maharashtra, Gujrat, and Goa.

The two wetlands from India which found place in first International Convention on Wetlands held at Ramsar in Iran in February 1971were Chilka and Bharatpur. Currently there are 26 Ramsar sites in India, covering most of the important wetlands.

In a remarkable sense, wetlands have become central points for bird observations, the lead example being set by Bharatpur Sanctuary. It is, therefore, proposed at various forums to develop other wetlands as tourist attraction centres.

8.9 SUMMARY

- Biodiversity is threatened by the sum of all human activities. It is useful to group threats into the categories of habitat destruction, invasion by non-native species, over-hunting, pollution and climate charge.
- Habitat loss presents the single greatest threat to world biodiversity, and the magnitude of this threat can be approximated from species-area curves and rates of habitat loss. The spread of non-native species threatens many local species with extinction, and pushes the world's biota towards a more homogeneous and widely distributed sub-set of survivors.
- Climate change threatens to force species and ecosystems to migrate toward higher latitudes, with no guarantee of suitable habitat or access routes.
- Many species have gone extinct, some naturally and others because of human activities i.e. deforestation, desertification and destruction of wetlands and coral reefs.
- Habitats that are vulnerable to greater species extinction are referred to as fragile habitats. Coral reefs, oceanic islands, mountain tops and habitat islands are considered as fragile habitats.
- Major impacts of biodiversity loss are steady increase in atmospheric CO_2 level, adverse effects on local climate and water flow, reduction of genetic diversity, extinction of species and loss of livelihoods.

- *In-situ* conservation meaning on-site conservation and *Ex-situ* conservation meaning off-site conservation are two important ways of conservation of species. Wildlife conservation is mostly based on *in-situ* conservation. *Ex-situ* conservation is man's efforts to sustain and protect the environment and *ex-situ* conservation is used when species extinction is imminent.
- *In-situ* conservation of species is generally operated in places like, National Parks and Wildlife Sanctuaries, Wetlands, Biosphere Reserves. Tiger Reserves and Elephant Reserves.
- *Ex-situ* conservation sites are Botanical Gardens and Zoologica Parks.
- Seed banks and tissue culture are important methods for plant conservation.
- Nature reserves are hubs of biodiversity and they should be left as such so ecosystem can function properly.

8.10 TERMINAL QUESTIONS

1. Why is biodiversity important for human beings? Make a list of advantages from biodiversity .
2. Describe how is global climate change harming biodiversity on the earth.
3. Why is biodiversity important? Discuss some of its values, and indicate the ones you favour the most.
4. Describe each of the five major threats to biodiversity. Give an example of a species affected by each of these threats.
5. Differentiate between *in-situ* and *ex-situ* conservation. What is the ultimate goal of captive breeding? Why is it best used only as a last resort?
6. Visit a local zoo or botanical garden. What activities are conducted there to promote biological conservation? List them.
7. What are the advantages of tissue culture ?
8. Write a note on Biosphere Reserves.

8.11 ANSWERS

Self-Assessment Questions

1. a) please refer to sub-section 8.3.2
   b) (iii);
   c) (iv);
   d) (iv)
2. a) (ii);
   b) please refer to section 8.4
   c) please refer to section 8.5

3. a) (iv);
   b) See sub-section 8.7.1
4. a) (iv);
   b) (iii)

Terminal Questions

1. Refer to sub-section 8.6
2. Refer to sub-section 8.3.4.
3. Refer to introduction of the unit and section 8.6.
4. Refer to section 8.2 causes of biodiversity loss.
5. Refer to section 8.7 conservation of biodiversity.
6. This is open ended question, visit a local zoo or botanical garden make a list of various activities that are taking place there for biological conservation.
7. Refer to sub-section 8.7.2.
8. Refer to section 8.8 Nature reserves.

8.12 FURTHER READING

1. WCMC (1992) Global Biodiversity. Status of the earth's Living Resources. Chapman & Hall.
2. National Biodiversity Action Plan and Strategy of India, (Draft of 2002).
3. IUCN (1999) *Resource Material on Biodiversity for General Certificate of Education*.
4. Glowka, L. et. al., (1994) A Guide to the Convention on Biological Diversity. IUCN. Gland and Cambridge.

Internet Sites

http://www.unep.ch/conventions/geclist.htm

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http://www.cites.org/eng/disc/what.shtml

Acknowledgement for Figures

1. Fig. 8.3 Indian Tiger

   https://www.indiatoday.in/education-today/gk-current-affairs/story/international-tiger-day-india-1298968-2018-07-28

2. Fig. 8.4 The Great Banyan Tree (photograph by Biswarup Ganguly)https://www.atlasobscura.com/articles/curious-fact-of-the-week-great-banyan-tree

3. Fig. 8.5 sundarban reserves

   http://www.moef.nic.in/report/0203/