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ECOLOGY & ENVIRONMENT

CIVIL SERVICES EXAMINATION 2025

Published by

MADE EASY PUBLICATIONS

MADE EASY Publications Pvt. Ltd.
Corporate Office: 44-A/4, Kalu Sarai
(Near Hauz Khas Metro Station), New Delhi-110016
Contact: 011-45124660, 8860378007
E-mail: infomep@madeeasy.in
Visit us at: www.madeeasypublications.org

Ecology and Environment

First Edition: 2017
Second Edition: 2018
Third Edition: 2019
Revised & Updated: 2020
Fourth Edition: 2021
Fifth Edition: 2022
Sixth Edition: 2023

Seventh Edition: Nov. 2023

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Biodiversity

CHAPTER

3

BIODIVERSITY

3.1 Introduction

Biodiversity is the variety of all living things: the different plants, animals and microorganisms, the genetic information they contain and the ecosystems they form. The biodiversity we see today is the fruit of billions of years of evolution shaped by natural processes and, increasingly, by the influence of humans. It forms the web of life, of which we are an integral part and upon which we so fully depend.

Thousands of new species are discovered each year, but it will still take hundreds of years to find the rest.

3.2 Levels of Biodiversity

Three levels of biodiversity are generally accepted: genetic, species, and ecosystem. These levels are all interrelated yet distinct enough that they can be studied as three separate components.

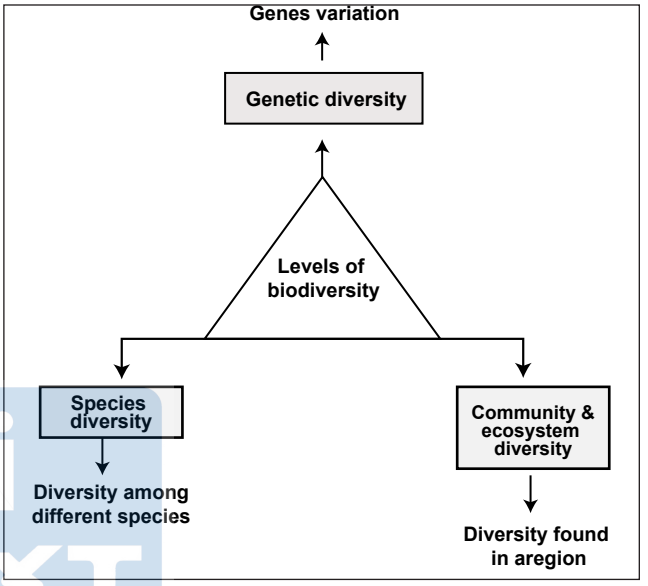
Genetic Diversity

Genes are the basic unit of all life on Earth. Genetic diversity is the variety of genes within a species. Genetic diversity can be measured at many different levels, including population, species, community, and biome. E.g. Due to habitat fragmentation genetic diversity of Indian tigers have been reduced.

IMPORTANCE OF GENETIC DIVERSITY

Genetic diversity is important as it represents the **raw material for evolution and adaptation.** More genetic diversity in a species or population means a greater ability for some of the individuals in it to adapt to changes in the environment. Less diversity leads to uniformity, which is a problem in the long term, as it is unlikely that any individual in the population would be able to adapt to changing conditions.

For **Example:** Modern agricultural practices use monocultures, which are large cultures of genetically identical plants. Though it is advantageous for growing and harvesting crops, it can be a problem when a disease or parasite attacks the field, as every plant in the field will be susceptible. Also, Monocultures are unable to adapt well with changing conditions.



Level of Biodiversity

Species Diversity

Species diversity is the variety of species within a habitat or a region. Some habitats, such as rainforests and coral reefs, have high species diversity. For Example, colder regions support less species diversity than the warmer regions. Also, good climate with good physical geography supports better species diversity. *Simposn's diversity index* is often used to quantify the biodiversity of a habitat. According to this index, zero represents infinite diversity, whereas one represents only one species dominating the landscape and no diversity.

Invertebrates - animals without backbones - make up about 99% of all animal species, and most of these are insects. Invertebrates include crabs, snails, worms, corals and seastars, as well as insects, such as beetles and flies. Insects fill many vital roles in ecosystems as pollinators, recyclers of nutrients, scavengers and food for others.

There are two levels of species diversity:

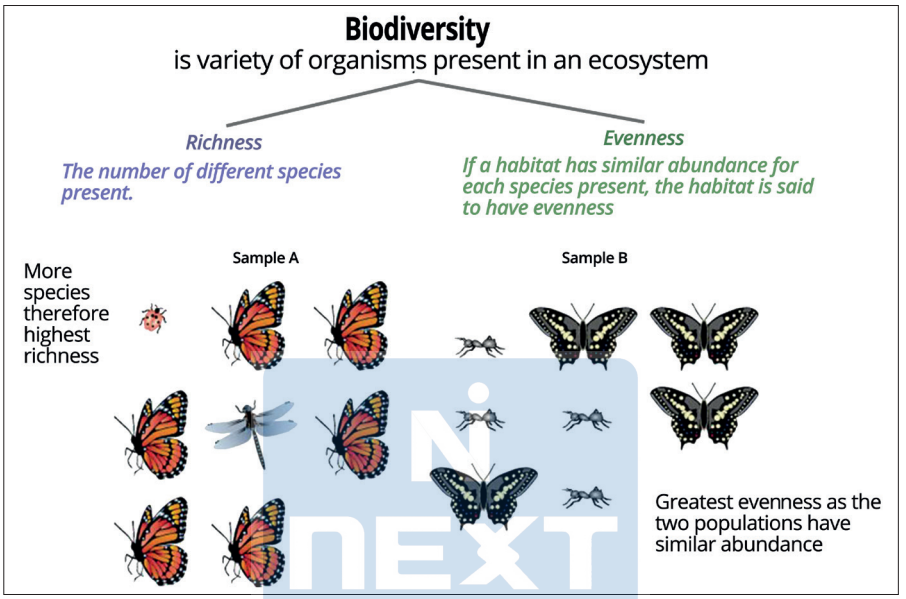
- **Regional Diversity** of whole nations or parts of continents within which many different communities exist
- **Local Diversity** in a given nation where different communities exist at different latitudes.

Ecosystem Diversity

Ecosystem diversity is the variety of ecosystems at a given place. It incorporates both habitat and community diversity. This is the least-understood level of the three described diversities due to the complexity of the interactions. Inherent in ecosystem diversity are thus both biotic (living) and abiotic (non-living) components, which makes it different from both genetic and species diversity. As the environment changes, the species best adapt to itself according to the environment thus the diversity of the species in an ecosystem is influenced by the ecosystem itself.

3.3 Measurement of Biodiversity

Biodiversity is defined and measured as an attribute that has two components — richness and evenness.



Richness

Richness is expressed as the number of species and is usually called species richness. Here individuals are genetically or functionally related.

Evenness

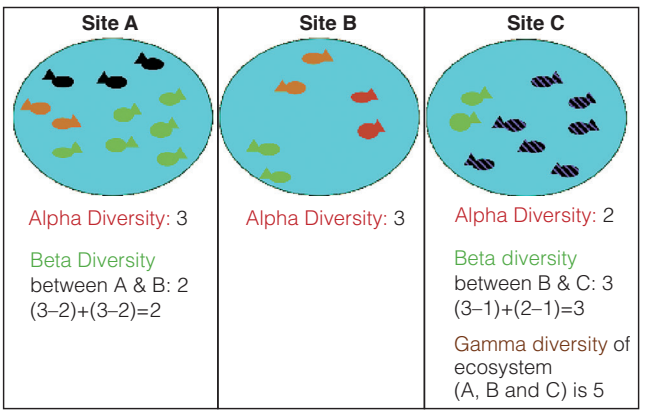
Evenness is proportions of species or functional groups present on a site. The more equal species are in proportion to each other, the greater the evenness of the site. A site with low evenness indicates that a few species dominate the site.

Species diversity is a measurement of species richness and species evenness. It is a measurement of species richness combined with evenness, meaning it takes into account not only how many species are present but also how evenly distributed the numbers of each species are.

For example, if two communities both have five species, species richness would be five for both communities. If the first community had 100 individuals and 80 of them were all one species, this would not be a community with a very even distribution. If the second community had 100 individuals, with 20 individuals belonging to each of the five species, this community would be more evenly distributed. Because it was more evenly distributed, community two would have a greater species diversity.

R H Whittaker classified the spatial component of biodiversity into alpha, beta, and gamma diversity. These are defined below:

- **Alpha Diversity:** Alpha diversity refers to the diversity within a particular area or ecosystem, and is usually expressed by the number of species (i.e., species richness) in that ecosystem.
- **Beta Diversity:** It refers to the change in species diversity between two ecosystems. E.g. Measuring species diversity between the grassland and terrain ecosystem.



- **Gamma Diversity:** Gamma diversity is a measure of the overall diversity for the different ecosystems within a region. Gamma diversity can also be defined as "geographic-scale species diversity.

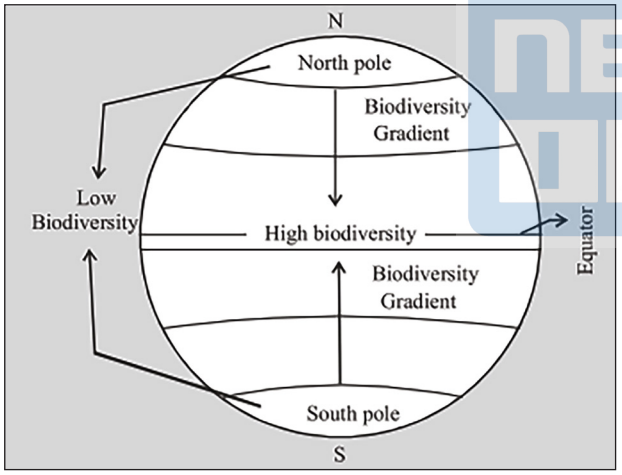
3.4 Patterns of Biodiversity

As ecologists studied biodiversity in the environment, they observed a regular pattern in which diversity was distributed over the entire area of the planet. Ecologists discovered two broad kinds of diversity patterns, namely Latitudinal diversity gradient and Species-Area Relationship.

Latitudinal Diversity Gradient

According to the Latitudinal Diversity Gradient (LDG), the species diversity follows a regular pattern as we move from the equator to the polar regions. The plant and animal diversity observed to be maximum at the equator and it decreases as we move towards the poles. This increase in species richness is called Latitudinal Diversity Gradient.

India, located at the tropical regions, shows high species richness. However, the great Amazon rainforests show maximum biological diversity in terms of the number of species residing in that region.

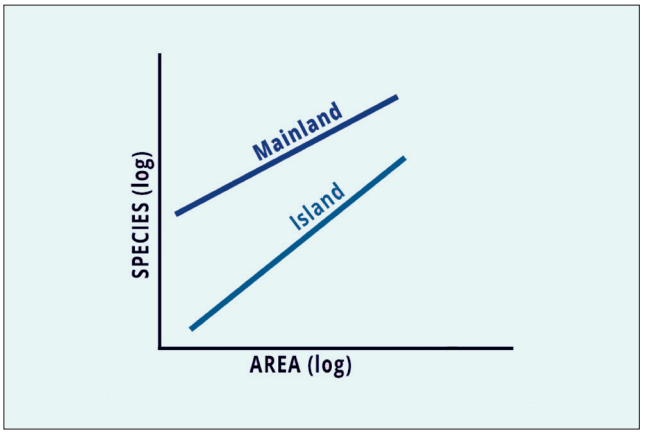


Species-Area Relationship

The species-area relationship is one of the oldest known and most documented patterns in ecology. It describes the general pattern of increase in species richness with increasing area of observation The relationship between island area and number of species is well known i.e. larger islands contain more species than smaller islands.

Note: "Islands" can be used to refer not only to pieces of land surrounded by water, but to habitat islands as well (lakes, forest fragments, etc.)

The basic idea of the model is that the number of species on an island is determined by the immigration of new species and the extinction of species already present; when these two rates balance one another, the species number is at equilibrium. In general, it has been found that the relationship between island area and number of species present is fairly constant for islands in a given geographic region. For conservation planning, knowledge of this relationship is of utmost importance.



3.5 Biodiversity Hotspots

Biodiversity Hotspot as an idea was first developed by *Norman Myers* in 1988. It is a biogeographic region that is both a significant reservoir of biodiversity and is threatened with destruction. Conservation International adopted Myers' hotspots as its institutional blueprint in 1989, and in 1999, the organization undertook an extensive global review which introduced quantitative thresholds for the designation of biodiversity hotspots.

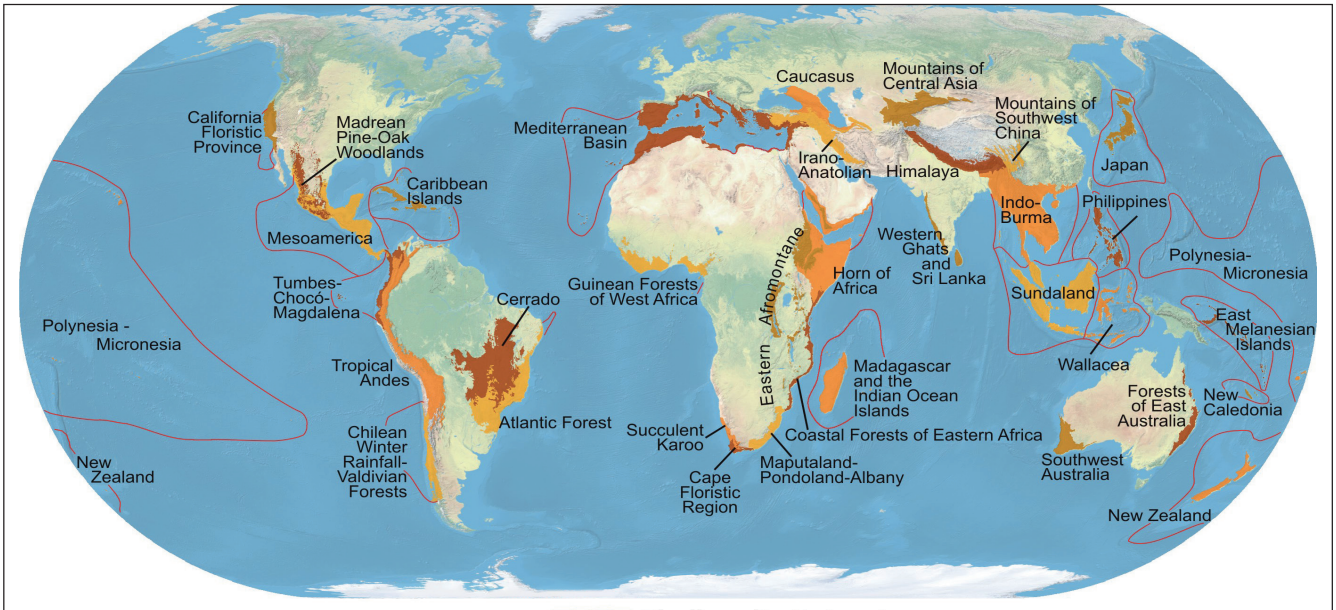
Currently, 36 biodiversity hotspots have been identified, most of which occur in tropical forests. They represent just 2.3% of Earth's land surface, but between them they contain around 50% of the world's endemic plant species and 43% of all terrestrial vertebrates.

Criteria for Measuring Biodiversity Hotspots

To qualify as a biodiversity hotspot, a region must meet two strict criteria:

- It must have at least **1,500 vascular plants as endemics (> 0.5% of the world's total)** — i.e. it must have a high percentage of plant life found nowhere else on the planet. A hotspot, in other words, is irreplaceable.
- It must have **30% or less of its original natural vegetation** (it has to have lost 70% of its original native habitat). In other words, it must be threatened.

Out of the 36 globally identified biodiversity hotspots, India harbours four hotspots, i.e., **Himalaya, Western Ghats and Sri Lanka, Indo-Burma and Sundaland.**



Conservation International (conservation.org) defines 35 biodiversity hotspots — extraordinary places that harbor vast numbers of plant and animal species found nowhere else. All are heavily threatened by habitat loss and degradation, making their conservation crucial to protecting nature for the benefit of all life on Earth.

Criteria for Biodiversity Hotspot

ATTRIBUTES OF INDIAN BIODIVERSITY HOTSPOTS					
S. No.	Attributes	Hotspots			
		Himalaya	Indo-Burma	W. Ghats & Sri Lanka	Sundaland
1.	Hotspot original extent (km^2)	741,706	2,373,057	189,611	1501,063
2.	Hotspot vegetation remaining (km^2)	185,427	118,653	43,611	10,0571
3.	Endemic plant species	3160	7,000	3,049	15,000
4.	Endemic threatened birds	8	18	10	43
5.	Endemic threatened mammals	4	25	14	60
6.	Endemic threatened amphibians	4	35	87	59
7.	Extinct species*	0	1	20	4
8.	Human population density (people/km^2)	123	134	261	153
9.	Area protected (km^2)	112.578	235,758	26,130	179,723
10.	Area protected (km^2) in categories I-IV**	77,739	132,283	21,259	77,408

*Recorded extinction since 1500., **Categories I-IV afford higher levels of protection.

3.6 Sources of Biodiversity

Mutation

Mutations increase genetic diversity by altering the genetic material (mostly DNA) of organisms. Although this gives rise to differences in organisms, it is an extremely slow process compared to the other ways in which local diversity increases.

Speciation

The creation of a new species is known as speciation. It occurs when groups in a species become reproductively isolated and diverge. Species are typically defined as being unable to successfully breed with other species (the so-called Biological Species Concept), although there are other ways of defining species. Speciation can occur through several different means, including geographical isolation, competition, and polyploidy.

These are described as:

- **Geographical Isolation:** Geographical isolation, such as new mountain chains etc can divide a population into two separate populations. The two isolated populations continue to evolve separately from one another. Eventually they can diverge to a great enough degree that they are no longer able to interbreed and are considered to be different species.
- **Competition:** If a new resource, such as a new food source, becomes available to a population, some part of the population may become specialized in obtaining that resource. In time, there is a chance that the population will become totally different from the original population.
- **Polyploidy:** Polyploidy is a condition in which the cells of an organism have more than one pair of chromosomes. Speciation through polyploidy happens far more often in plants than in animals, as animals are much more sensitive to large changes in their genetic structure. This method of speciation is almost instantaneous, happening in a single generation.

Immigration

Immigration increases diversity as new individuals and perhaps even new species enter an area, increasing its diversity. The rate at which immigration happens depends on the size of the area in question, how many species are there already, and how close the area in question is to the source of immigration.

Succession

Succession is the process through which an area gains species as successive communities of organisms replace one another until an end-point is reached.

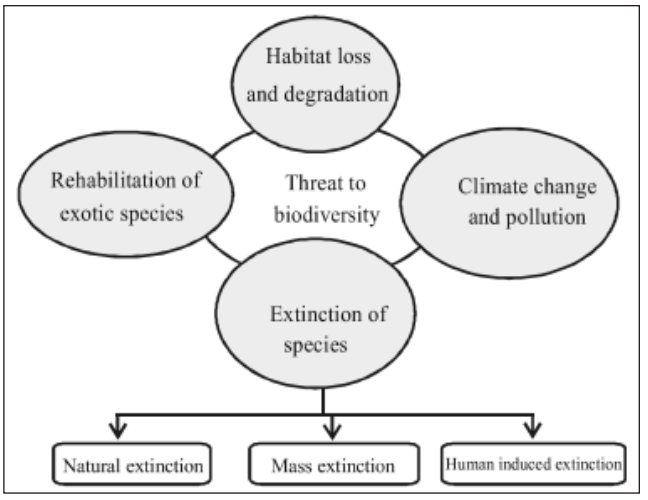
3.7 Loss of Biodiversity

Biodiversity does go through changes through time i.e. numbers of species present on earth changes over time and the composition of species changes as well. For example, there are no dinosaurs left on the planet today, but we know that at one point in the past they thrived. That is an example of change in biodiversity.

Unfortunately, human activity is causing plants and animals to go extinct at rapid rates, and causing the ranges of other species to be drastically reduced. By some estimates, the rate of extinction is now many times greater than the natural rate because of anthropogenic activities and the associated climate changes. Due to these biodiversity losses, the present time is often called "The Sixth Mass Extinction" with reference to biodiversity loss.

Causes of Biodiversity Loss

There are various causes of loss of Biodiversity and most of them emanates from the action of human beings. Some of them are:



Important factors responsible for the loss of biodiversity

- **Habitat Destruction:** Habitat Destruction happens whenever humans change a landscape and modify the ecosystem that resides there. Habitat loss is caused by deforestation, mining, industrial expansion, overpopulation, pollution and global warming. For example: Destruction of Elephant corridors in Chotanagpur region due to the extensive mining.
- **Invasive Species Introductions:** Invasive species competes for food with the native species and also alters the structure of the habitat, threatening natives species. For example: Lantana camara, Water hyacinth proliferation in the water bodies of Assam.
- **Climate Change:** Changes in climate have altered life on Earth. Ecosystems have come and gone and species routinely go extinct. But rapid, manmade climate change speeds up the process, without affording ecosystems and species the time to adapt. Consequently, many species are not able to cope, causing them to die out. For example: Ocean acidification results in coral bleaching.
- **Overexploitation of Resources:** Activities like over hunting, overfishing and over-harvesting contribute greatly to the loss of biodiversity, killing off numerous species over the past several hundred years. Poaching and other forms of hunting for profit increase the risk of extinction, the extinction of an apex predator or, a predator at the top of a food chain can result in catastrophic consequences for ecosystems.
- **Pollution:** Pollution is a major threat to biodiversity. Industrial, agricultural and waste-based pollutants

can have catastrophic effects on many species. Apart from habitat destruction, pollution poses long-term cumulative impacts on the species health, contributing to their eventual death. For instance, marine and freshwater life forms are most affected by pollution. For example: Thermal power plant – discharging the high temperature coolant water into the marine region causing thermal pollution in marine ecosystem.

Consequences of Biodiversity Loss

Biodiversity loss has a negative impact on our societies. It negatively affects or contributes to the health of individuals, the climate, natural resources, pollution, poverty and the extinction of species.

According to the IUCN red list 784 species have got extinct in past five hundred years.

- **Economic Cost:** In terms of ecosystem services – functions like pollination, irrigation, soil reclamation and other things that would have to be paid for if nature couldn't take care of it on its own – the value of global biodiversity has been estimated in the trillions of dollars.
- **Reduced Food Security:** Biodiversity is essential for food security and nutrition. With the erosion of biodiversity, humankind loses the potential to adapt ecosystems to new challenges such as population growth and climate change. Achieving food security for all is intrinsically linked to the maintenance of biodiversity.
- **Increased Contact with Disease:** The loss of biodiversity has two significant impacts on human health and the spread of disease.
- **Loss of Livelihoods:** From fishermen to farmers, biodiversity not to mention healthy ecosystems – is essential for maintaining livelihoods. When ocean ecosystems collapse, for example, entire communities built on the bounty they provide fold as well. Whether the cause is pollution, overfishing, ocean acidification, or a combination of these and more, humans are tied to the downfall of the ecosystems that surround them.

3.8 Biodiversity Conservation

Conservation of Biodiversity is the protection, preservation, management, or restoration of wildlife and their natural habitats such as forests and water. Through the conservation of biodiversity, survival of many species and habitats which are threatened due to human activities can be ensured.

Need to Conserve Biodiversity

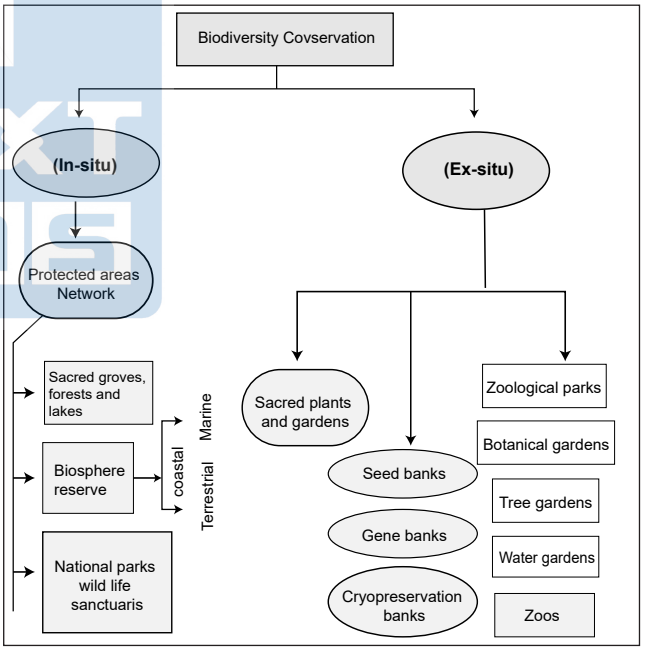
Biodiversity is of great importance in order to maintain stable ecosystems.

The destruction of ecosystems can have a catastrophic effect both on local and global levels. E.g.: Rainforests, contribute both to the process of soil formation and help to regulate the climate through photosynthesis – by producing oxygen and absorbing carbon dioxide. Wetlands act as sponge-like reservoirs in dry weather and help to filter and purify water. Coral reefs and mangrove swamps protect the land that they surround by reducing the effects of erosion and also acts as first line of defence during disaster like Tsunamis, Storm surge etc.

Conservation Methods of Biodiversity

In Situ-Conservation

In-situ conservation can either be targeted at populations of selected species (species-centered) or whole (ecosystem-based). It involves the conservation strategies to be followed in the habitat of the concern species. ecosystems



Methods of Biodiversity conservation

Some of the Protected Areas designed for In-Situ conservation are:

National Parks

They are the areas that are set by the Government to conserve the natural environment under **Wild Life Protection Act, 1972**. A national park has more restrictions as compared to a wildlife sanctuary. Their boundaries are fixed and defined. The main objective of a national park is to protect the natural environment of the area and biodiversity conservation. **National parks**

can be declared both by the Central Government and State Governments. No alteration of the boundaries of a national park shall be made except on a resolution passed by the State Legislature. **They cannot be downgraded to the status of a 'sanctuary'**.

No human activities are allowed inside National Parks. Grazing of livestock and private tenurial rights are not permitted here. Species mentioned in the Schedules of the Wildlife Act are not allowed to be hunted or captured. No person shall destroy, remove, or exploit any wildlife from a national park or destroy or damage the habitat of any wild animal or deprive any wild animal of its habitat within a national park.

Wildlife Sanctuaries

They are declared by state Government under **Wild Life Protection Act, 1972.** A wildlife sanctuary is an area of nature owned by the Government or a private agency for the protection of particular species of flora or fauna during a part of the year or in its entirety. *Human activities like harvesting of timber, collecting minor forest products and private ownership rights are allowed as long as they do not interfere with the well-being of animals*. Boundaries of sanctuaries are not well defined and controlled biotic interference is permitted. For example: Keoladeo National Park before attaining the status of a National Park was called as Bharatpur Bird sanctuary.

Often, National Park is considered synonymous to Wildlife Sanctuary, as it is also declared reserved for the protection and development of wild life. However, they are different. The main difference between the two is that in a sanctuary, some other activities may be allowed, whereas in a National park no other activities are allowed. For example, the people may possess rights for timber extraction in a wildlife sanctuary, but this right is not provided under the premises of a national park.

Conservation Reserves

Conservation Reserves are introduced **under the Wildlife (Protection) Amendment Act of 2002 – the amendment to the Wildlife Protection Act of 1972**. It is an area owned by the state Government adjacent to the national parks and sanctuaries for protecting the landscape, seascape, and habitat of fauna and flora. It is managed through a conservation reserve management committee.

The **State Government** may, after having consultations with the local communities, declare any area owned by the Government as a conservation reserve. *Tiruppadaimarathur Conservation Reserve* in Tirunelveli, Tamil Nadu is the *first conservation reserve* established in the country in 2005. It is an effort of the village community to protect the birds nesting in their village and acted for declaration of conservation reserve.

Community Reserves

Community Reserves are introduced **under the Wildlife (Protection) Amendment Act of 2002, the amendment to the Wildlife Protection Act of 1972.** The state Government may notify any community land or private land as a community reserve, provided that the members of that community or individuals concerned are agreeable to offer such areas for protecting the fauna and flora, as well as their traditions, cultures and practices.

The declaration of such an area is aimed at improving the socio-economic conditions of the people living in such areas as well as conserving wildlife. The reserve is managed through a community reserve management committee. The state Government may, where the community or individual has volunteered to conserve wildlife and its habitat, declare the area by notification as community reserve.

No change in land use pattern shall be made within the community reserve, except in accordance with a resolution passed by the management committee and approval of the same by the state Government.

Biosphere Reserves

Biosphere reserves are areas of terrestrial, marine and coastal ecosystems which promote the conservation of biodiversity with its sustainable use. Biosphere Reserve are integral components of the internationally recognized framework of UNESCO's Man and Biosphere (MAB) programme initiated in 1971 and they are nominated by national Governments. There are over 500 biosphere reserves in over 100 countries around the world.

Criteria

The core area should be typical of a bio-geographical unit and large enough to sustain viable populations representing all trophic levels in the ecosystem.

A site that must contain an effectively protected and minimally disturbed core area of value of nature conservation.

Areas potential for preservation of traditional tribal or rural modes of living for harmonious use of environment.

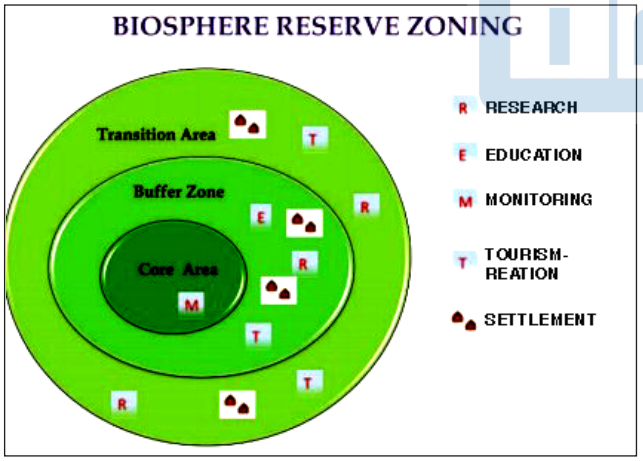
The management authority to ensure the involvement/ cooperation of local communities to bring variety of knowledge and experiences to link biodiversity conservation and socio-economic development while managing and containing the conflicts.

Structure of Biosphere Reserve

- **Core Zone:** Core zone must contain suitable habitat for numerous plant and animal species, including higher order predators and may contain centres of endemism. **Core area is a legally protected** area

where human intervention is strictly prohibited. It also represent important genetic reservoirs having exceptional scientific interest. **A core zone being mostly protected under the Wildlife (Protection) Act, 1972.**

- **Buffer Zone:** The buffer zone surrounds the core zone. The uses and activities are managed in this area in the ways that help in protection of core zone in its natural condition. These uses and activities include restoration, demonstration sites for enhancing value addition to the resources, limited recreation, tourism, fishing, grazing, etc; which are permitted to reduce its effect on core zone. **Research and educational activities are to be encouraged**. Human activities for research and educational purposes within Biosphere Reserve, are likely to continue if these do not adversely affect the ecological diversity and conservation objectives.
- **Transition Zone:** It is the outermost part of a biosphere reserve. This is usually not delimited one and is a **zone of cooperation** where conservation knowledge and management skills are applied and uses are managed in harmony with the purpose of the biosphere reserve. This includes settlements, crop lands, managed forests and area for intensive recreation and other economic uses characteristics of the region.



There are 18 notified Biosphere reserves in India. Out of them, **12 Biosphere Reserves are in the UNESCO's MAB World Network**. These Biosphere Reserves and their respective years of including in MAB network are as follows: *Nilgiri (2000), Gulf of Mannar (2001), Sunderban (2001), Nanda Devi (2004), Nokrek (2009), Pachmarhi (2009), Similipal (2009), Achanakmar-Amarkantak Biosphere Reserve (2012), Great Nicobar Biosphere Reserve (2013), Agasthyamala Biosphere Reserve (2016), Khangchendzonga Biosphere Reserve, Sikkim (2018) and Panna Biosphere Reserve Madhya Pradesh, (2020).*

NATIONAL PARK/SANCTUARIES AND BIOSPHERE RESERVES: A COMPARISON

National Park/Sanctuaries	Biosphere Reserves
National Parks, Wildlife Sanctuaries, Conservation Reserves, Community Reserves and Tiger Reserves are established as per provisions of Wildlife Protection Act, 1972	There is no law as such under which Biosphere Reserves are established.
No grazing or private tenurial rights land rights are allowed in National Parks. Limited economic activity (sand and stone mining) is permitted in biosphere reserves	Biosphere reserves serve as 'living laboratories' for testing out and demonstrating integrated management of land, water and biodiversity.
Wildlife sanctuaries and national parks are set up for the protection of mammals normally	Biosphere reserves envisage protection of plant species, Invertebrates and biotic community as a whole

Sacred Groves

Sacred groves comprise of patches of forests or natural vegetation – from a few trees to forests of several acres – that are usually dedicated to local folk deities (Example – Ayyanar and Amman) or tree spirits (Vanadevatais). These spaces are protected by local communities because of their religious beliefs and traditional rituals that run through several generations.

The degree of sanctity of the sacred forests varies from one grove to another. For example, the Garo and the Khasi tribes of northeastern India completely prohibit any human interference in the sacred groves. The Gonds of central India prohibit the cutting of a tree but allow fallen parts to be used. Although there has been no comprehensive study on the sacred groves of the entire country, experts estimate the total number of sacred groves in India could be in the range of 100,000 – 150,000. These are categorized into:

- *Traditional Sacred Groves* (It is the place where the village deity resides, who is represented by an elementary symbol).
- *Temple Groves* (created around a temple and conserved, and groves around the burial or cremation grounds).

Significance of Sacred Groves

The sacred groves are important repositories of floral and faunal diversity. They also act as a rich gene pool including rare, threatened and endangered species. The groves are often associated with ponds, streams or springs, which help meet the water requirements of the local people. The

vegetative cover also helps in the recharging the aquifers. The vegetation cover of the sacred groves improves the soil stability of the area and also prevents soil erosion. They have medicinal use as it is a repository for plants with Ayurvedic properties.

In modern times, they have become biodiversity hotspots due to progressive habitat destruction in neighbouring areas. Sacred groves in urban landscapes act as 'lungs' to the city as well. Threats to Sacred groves includes Urbanization and encroachment, Over-exploitation of resources like overgrazing and excessive firewood collection, Religious practices; clearing them for construction of shrines and temples, Invasion by invasive species.

Ex-Situ Conservation Methods

Ex-situ conservation is the preservation of components of biological diversity outside their natural habitats. This involves conservation of genetic resources, as well as wild and cultivated or species, and draws on a diverse body of techniques and facilities.

Reintroduction of an animal or plant is a type of Ex-Situ conservation method e.g. Gangetic gharial has been reinduceed in the rivers of Madhya Pradesh, Uttar Pradesh and Rajasthan, where they were extinct earlier.

Botanical Gardens

Botanic gardens are institutions holding documented collections of living plants for the purposes of scientific research, conservation, display and education. They are one of the most popular methods for ex-situ conservation. The Conservation is being realized by means of seeds, cuttings, and tissue or cell cultures and should secure genetically representative permanent collections for conservation, (re-) introduction, research, and education.

Zoological Parks

It is a facility in which animals are housed within enclosures, displayed to the public, and in which they may also breed. The breeding of endangered species is coordinated by cooperative breeding programmes containing international studbooks and coordinators, who evaluate the roles of individual animals and institutions from a global or regional perspective, and there are regional programmes all over the world for the conservation of endangered species.

Seed Banks/Gene Banks

A seed bank stores seeds under specific conditions to preserve genetic diversity; hence it is a type of gene bank. Seed banking has considerable advantages over other methods of ex situ conservation such as ease of storage, economy of space, relatively low labour demands and consequently, the capacity to maintain large samples at an economically viable cost. There are many reasons to store seeds. One reason is to have the genes that plant breeders need to increase yield, disease resistance, drought tolerance, nutritional quality, taste, etc. of plants used in agriculture (i.e., crops or domesticated species). Another reason is to forestall the loss of genetic diversity in rare or imperiled plant species in an effort to conserve biodiversity ex-situ.

Cryopreservation

Cryopreservation or cryoconservation is a process where organelles, cells, tissues, extracellular matrix, organs or any other biological constructs susceptible to damage caused by unregulated chemical kinetics are preserved by cooling to very low temperatures (typically -80 °C using solid carbon dioxide or -196 °C using liquid nitrogen). At low enough temperatures, any enzymatic or chemical activity which might cause damage to the biological material in question is effectively stopped. Cryopreservation is a useful method for long-term storage of germplasm, especially for plant species that are difficult to conserve as seeds due to low desiccation tolerance.

For aquatic species, cryopreservation has limited application because female gametes and fertilized eggs usually cannot be frozen. For livestock, the term "cryoconservation" is often used to refer to cryopreservation of germplasm for the purpose of genetic conservation, whereas cryopreservation refers to the actual freezing technology and its general application. This distinction is more relevant for livestock than for other sectors because cryopreservation is more widely applied for uses other than conservation.

Cryopreservation can be used for

- Conservation of plant germplasm
  - Vegetative propagated species (root and tubers, ornamental, fruit trees)
  - Recalcitrant seed species (Howea, coconut, coffee)
- Conservation of tissue with specific characteristics
  - Medicinal and alcohol producing cell lines
  - Genetically transformed tissues
  - Transformation/ Mutagenesis competent tissues (ECSs)
- Eradication of viruses (Banana, Plum)
- Conservation of plant pathogens (fungi, nematodes)

Constraints in Biodiversity Conservation

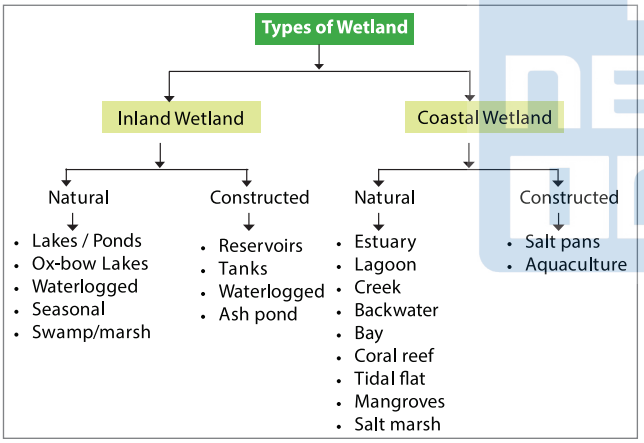
- Rising Human Population which inevitably results in human-animal Conflict by fragmentation and destruction of habitats.
- Socio-Economic inequality, which results in unsustainable harvesting of biological resources by the wealthy sections of society violating the basic access rights of the poor.

- Lack of capital & technology with the poor and developing countries, which are often the hotspots of biodiversity.
- Difficulty in determining economic value of biodiversity, which often results in it getting less importance in high-level policy making.

3.9 Wetlands

Wetlands are areas where water is the primary factor controlling the environment and the associated plant and animal life. They occur where the water table is at or near the surface of the land, or where the land is covered by water. Once treated as transitional habitats or seral stages in succession from open water to land, the wetlands are now considered to be distinct ecosystems with specific ecological characteristics, functions and values.

Ramsar Convention on Wetlands define wetlands as: "areas of marsh, fen, peat-land or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters".



Importance of Wetlands

Wetlands are a critical part of our natural environment and are vital for human survival. They are among the world's most productive environments; cradles of biological diversity that provide the water and productivity upon which countless species of plants and animals depend for survival. Wetlands are indispensable for the countless benefits or "ecosystem services" that they provide humanity, ranging from freshwater supply, food and building materials, and biodiversity, to flood control, groundwater recharge, and climate change mitigation.

They protect our shores from wave action, reduce the impacts of floods, absorb pollutants, improve water quality and mitigate the effects of natural disasters like cyclones and tidal waves. They provide habitat for animals and plants and many contain a wide diversity of life, supporting plants and animals that are found nowhere else. They are the vital link between land and water. Wetland systems, directly and indirectly, support lakhs of people, providing goods and services to them.

Their capacity during heavy rainfall to retain excess floodwater that would otherwise cause flooding results in maintaining a constant flow regime downstream, preserving water quality and increasing biological productivity for both aquatic life as well as human communities of the region. Inundated wetlands are very effective in storing rainwater and are the primary source for recharging groundwater aquifers.

Many wading birds and waterfowl like egrets, herons and cranes nest in wetlands. Wetlands also provide food and shelter for mammals. They act as natural filters and help remove a wide range of pollutants from water, including harmful viruses from sewage and heavy metals from industries. Wetlands retain nutrients by storing eutrophic parameters like nitrogen and phosphorus and accumulating them in the sub-soil, thereby decreasing the potential for eutrophication.

Threats to Wetlands

The Wildlife Institute of India's survey reveals that 70-80% of individual freshwater marshes and lakes in the Gangetic flood plains have been lost in the last five decades. At present, only 50 percent of India's wetlands remain. They are disappearing at a rate of 2% to 3% every year. Some of the responsible factors are:

- **Urbanization:** Wetlands near urban centers are under increasing developmental pressure for residential, industrial and commercial facilities. Urban wetlands are essential for preserving public water supplies. E.g. Bellandur Lake, Bengaluru.
- **Anthropogenic Activities:** Due to unplanned urban and agricultural development, industries, road construction, impoundment, resource extraction and dredge disposal, wetlands have been drained and transformed, causing substantial economic and ecological losses in the long term. E.g. Great Lakes of USA.
- **Agricultural Activities:** Following the Green Revolution of the 1970s, vast stretches of wetlands have been converted to paddy fields. Construction of a large number of reservoirs, canals and dams to provide for irrigation significantly altered the hydrology of the associated wetlands. E.g. Shahpura Lake of Bhopal.
- **Hydrologic Activities:** Construction of canals and diversion of streams and rivers to transport water to lower arid regions for irrigation has altered the drainage pattern and significantly degraded the wetlands of the region.

Functions of Wetlands

- **Water Purification:** They help in improving water quality through removing or retaining inorganic nutrients or by processing organic wastes and reducing suspended nutrients.
- **Role in the Hydrologic Cycle:** Wetlands receive, store and release water in various ways and thus play a very important role in the hydrologic cycle.
- **Processing of Carbon and Other Nutrients:** Wetlands are very important for the process of the biogeochemical cycle which involves the physical, chemical, and biological transformation of various nutrients within biota, soils, water, and air. They provide the conditions needed for the removal of nitrogen and phosphorus from surface water.
- **Stabilization of Shorelines:** As they are generally located at the margins of lakes, bays, rivers, and oceans, they protect the shorelines and stream banks against erosion. The plants and trees in the wetlands hold the soil with their roots, absorb the energy of waves and break up the flow of streams or currents.
- **Atmospheric Maintenance:** They store carbon within their living and preserved plant biomass instead of releasing it into the atmosphere as carbon dioxide and thus help in moderating the global climate.
- **Deal with Environmental Problems:** Wetlands help in reducing environmental problems such as algal blooms, dead zones, and fish kills that are generally related to nutrient overloading.
- **Maintaining Water Supply:** Wetlands help in maintaining streamflow during dry periods and replenishing groundwater thus maintaining the water supply.
- **Habitat for Various Organisms:** Wetlands act as habitats for fish, wildlife, and plants. Many species of plants and animals depend on wetlands for their survival. Wetlands act as primary habits and seasonal habits for many animal species.
- **Prevention from Flood:** As they have a low topographic position, they store and slowly release surface water, rain, snowmelt, groundwater, and floodwaters. Wetland vegetation also obstructs the movement of floodwater and distributes them more slowly over floodplains. Wetlands also prevent waterlogging of agricultural lands.
- **Economic Benefits:** Wetlands support many plant species that have medicinal value. They are a source of timber in many areas. Similarly, many plants like blueberries, mints, and wild rice are produced in wetlands. Many countries have their fishing and shellfishing industries dependent on wetlands. Wetlands are also home to many animals having commercial value.
- **Source of Livelihood for Local People:** Wetlands also serve the needs of local people living in that area. Many people depend on wetlands for various things that have commercial value and it thus helps in satisfying their daily needs.
- **Provide Opportunities for Recreation, Education, Research, and Aesthetic Activities:** Wetlands act as grounds for research and recreation. Many people who love birdwatching or wildlife photography visit these habitats to have a view of various species.

Conservation of Wetlands

The Convention on Wetlands of international importance especially as Waterfowl Habitat (the Ramsar Convention) was signed in Ramsar, Iran, on 2 February 1971, and came into force on 21 December 1975. It is an **intergovernmental treaty** that provides the **framework for national action and international cooperation** for the conservation and wise use of wetlands and their resources. The Convention provides a framework for national action and international cooperation for the **conservation and wise use of wetlands and their resources**. Originally emphasizing on the conservation and wise use of wetlands primarily to provide a habitat for water birds, the Convention has subsequently broadened its scope to address all aspects of wetland conservation.

Currently, there are 169 parties to Ramsar Convention. Under the "three pillars" of the Convention, the Contracting Parties commit to:

- Work towards the wise use of all their wetlands;
- Designate suitable wetlands for the list of Wetlands of international importance (the "Ramsar List") and ensure their effective management;
- Cooperate internationally on transboundary wetlands, shared wetland systems and shared species.
- Currently India has 75 Ramsar sites.

MONTREUX RECORD

- Montreux Record under the Convention is a register of wetland sites on the List of Wetlands of international importance where changes in ecological character have occurred, are occurring, or are likely to occur as a result of technological developments, pollution or other human interference. It is maintained as part of the Ramsar List.

- Montreux Record is employed to identify priority sites for positive national and international conservation attention. Sites may be added to and removed from the record only with the approval of the Contracting Parties in which they lie.

WORLD WETLAND DAY

World Wetlands Day which is celebrated each year on February 2. It marks the date of the adoption of the Convention on Wetlands on 2 February 1971, in the Iranian city of Ramsar on the shores of the Caspian Sea. Each year since 1997, Government agencies, non-Governmental organizations, and groups of citizens at all levels of the community have taken advantage of the opportunity to undertake actions aimed at raising public awareness of wetland values and benefits in general and the Ramsar Convention in particular.

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TRY SOME PRELIMS PREVIOUS YEAR QUESTIONS

1. Consider the following pairs:

Wetland/Lake - Location

1. Hokera Wetland - Punjab
2. Renuka Wetland – Himachal Pradesh
3. Rudrasagar Lake - Tripura
4. Sasthamkotta Lake - Tamil Nadu

How many pairs given above are correctly matched?

(a) Only one pair (b) Only two pairs
(c) Only three pairs (d) All four pairs

(2022)

Ans. (b)

2. "If rainforests and tropical forests are lungs of the Earth, then surely wetlands function as its kidneys." Which one of the following functions of wetlands best reflects the above statements?

(a) The water cycle in wetlands involves surface runoff, subsoil percolation and evaporation.
(b) Algae form the nutrient base upon which fish, crustaceans, molluscs, birds, reptiles and mammals thrive.
(c) Wetlands play a vital role in maintaining sedimentation balance and soil stabilisation.
(d) Aquatic plants absorb heavy metals and excess nutrients.

(2022)

Ans. (d)

3. Which of the following have species that can establish a symbiotic relationship with other organisms?

1. Cnidarians
2. Fungi
3. Protozoa

Select the correct answer using the code given below

(a) 1 and 2 only
(b) 2 and 3 only
(c) 1 and 3 only
(d) 1, 2 and 3

(2021)

Ans. (d)

4. Which of the following can be threats to the biodiversity of a geographical area?

1. Global warming
2. Fragmentation of habitat
3. Invasion of alien species
4. Promotion of vegetarianism

Select the correct answer using the codes given below:

(a) 1, 2 and 3 only (b) 2 and 3 only
(c) 1 and 4 only (d) 1, 2, 3 and 4

(2012)

Ans. (a)

5. The "Red Data Books" published by the International Union for Conservation of Nature and Natural Resource (IUCN) contain lists of

1. Endemic plant and animal species present in the biodiversity hotspots.
2. Threatened plant and animal species.
3. Protected sites for conservation of nature and natural resources in various countries.

Select the correct answer using the codes given below:

(a) 1 and 3 (b) 2 only
(c) 2 and 3 (d) 3 only

(2011)

Ans. (b)

6. Which one of the following is not a site for the in-situ method of conservation of flora?

(a) Biosphere Reserve
(b) Botanical Garden