VALUE ADDED NOTES

ILP-2020

IASBABA

Contents

BIODIVERSITY

Hello IASbaba Family,

Before we start this module, let us look into the dimensions which are important for upcoming topics. We hope you have been looking into previous years Prelims questions of UPSC!

You must by now be well-familiar with the kind of questions being asked in UPSC Prelims from every subject. It will help you gauge and intuit the concept while going the respective topics and sub-topics. **Let's say, what kind of questions can be asked from 'Biodiversity and Conservation' related concepts. What are the dimensions to look for?**

Topics to be covered in various parts:

- Biodiversity
- Indian Biodiversity
- Animal Diversity of India
- Plant Diversity of India
- Marine Organism
- Protected Area Networks and Conservation Efforts -Tiger Reserves, Elephant Reserves, National Parks, Wildlife Sanctuaries etc.

One of the advanced levels of question can be this: Focus on the dimension picked for below question.

Q.) Western Ghats has very rich biodiversity as compared to Eastern Ghats, because -

1. *Western Ghats are continuous mountains.*
2. *Western Ghats is area of high orographic precipitation.*
3. *Many major rivers have its source at Western Ghats.*

Select the correct answer using the codes given below:

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

Solution (d)

Western Ghats are **continuous mountains** from south Kerala to Maharashtra. Its average height is also very high at more than 1000m. But Eastern Ghats is not that much continuous being split by many major rivers. Its average height is around 600m.

Usually more biodiversity is found in tropical rainforests which receives very heavy annual rainfall. During southwest monsoon Western Ghats acts as a barrier for the moisture winds from Arabian Sea causing very heavy rainfall. Hence Western Ghats is full of rainforests. But Eastern Ghats is parallel to the north east monsoon winds. So rainfall is low compared to Western Ghats.

Monsoon winds from Arabian sea gets blocked by Western Ghats and gets lifted over the ranges and precipitates leaving dry winds to blow over Peninsular India. **Orographic rainfall results in heavier rainfall along the western side of Western Ghats. Southwest monsoon rainfall acts as source for many major rivers which makes** it very fertile forming rainforests. These rainforests in Western Ghats acts as a home for more flora and fauna. This is the reason for more biodiversity in Western Ghats.

As you know IUCN and related concepts are very important, so one of the questions can be:
Focus on the dimension picked for below question.

Q.) Consider the following statement about Red Data Book.

1. *Increase in the number of red pages indicates increase in number of critically endangered species.*
2. *Increase in number of green page indicates the increase in conservation efforts.*

Which of the above statements is/are correct?

a) 1 only
b) 2 only
c) Both 1 and 2
d) None

Q.) Solution (b)

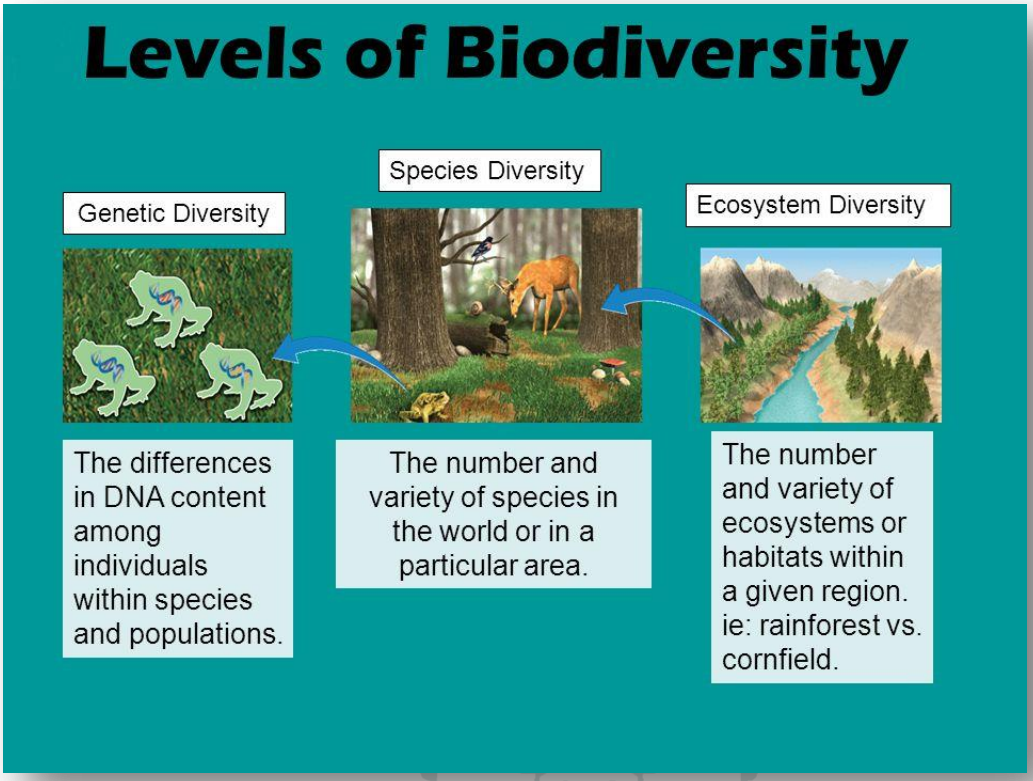
The Red Data Book, information for endangered mammals and birds are more extensive than for other groups of animals and plants, coverage is also given to less prominent organisms facing extinction.

The pink pages in this publication include the critically endangered species. With passing time, the number of **pink pages continues to increase which indicates increasing number of critically endangered species.**

Green pages are used for those species that were formerly endangered but have now recovered to a point where they are no longer threatened. **So, increase in green pages indicates the increase in conservation efforts.**

Note- It is not only about finding the species under Vulnerable, Endangered or Critically Endangered list ☺

LEVELS OF BIODIVERSITY



Biodiversity is considered to exist at three levels – genetic, species and ecosystems.

Genetic Diversity

- This is a measure of the diversity of genes in a population or species. Genetic diversity is reflected in the differences among individuals in a population or species, such as fur color or pattern differences in a species of mouse, or differences in the activity of an enzyme that breaks down a toxin in food.
- Each individual species possesses genes which are the source of its own unique features: In human beings, for example, the huge variety of people's faces reflects each person's genetic individuality.
- The term genetic diversity also covers distinct populations of a single species, such as the thousands of breeds of different dogs or the numerous varieties of roses.

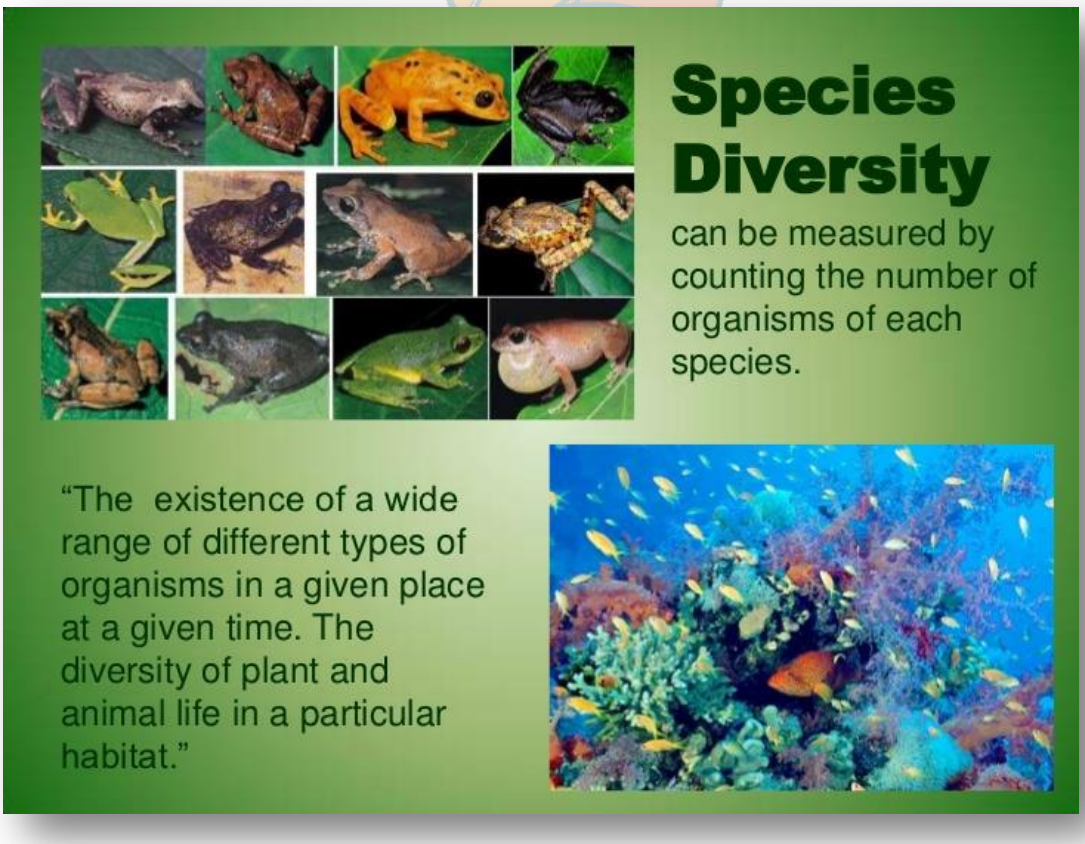
While some individuals might be able to tolerate an increased load of pollutants in their environment, others, carrying different genes, might suffer from infertility or even die under the exact same environmental conditions. Whilst the former will continue to live in the

environment the latter will either have to leave it or die. This process is called natural selection and it leads to the loss of genetic diversity in certain habitats. However, the individuals that are no longer present might have carried genes for faster growth or for the ability to cope better with other stress factors.

Species Diversity

Species diversity is a term used to describe the measurement of biological diversity to be found in a specific ecological community.
It includes the species richness or number of species to be found in an ecological community, the abundance (or number of individuals per species) and distribution or evenness of species.

Note- Species richness is a simple count of species, taxonomic or phylogenetic diversity is the genetic relationship between different groups of species, whereas **species evenness** quantifies how equal the abundances of the species are.

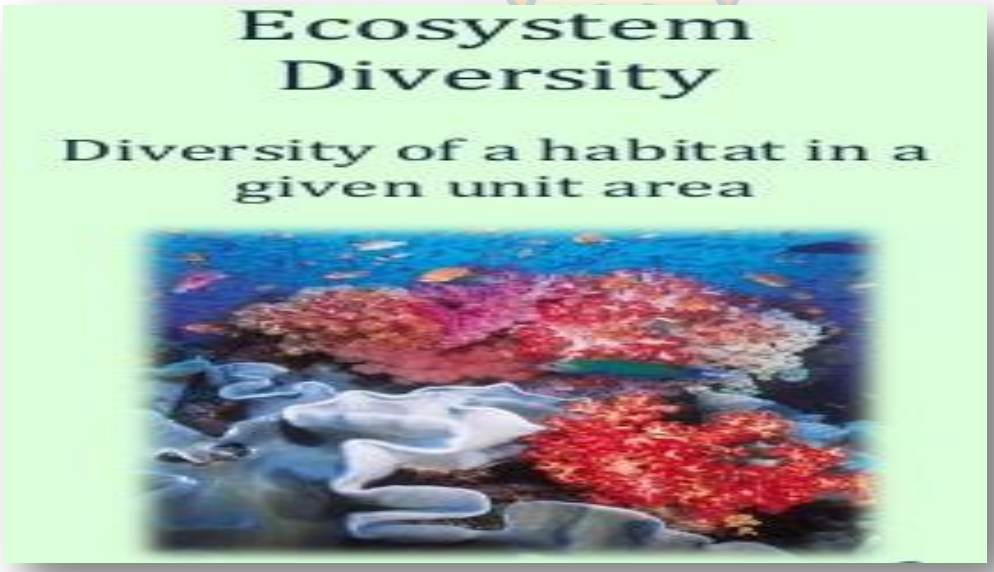


Mathematically, it is the ratio of one species population over total number of organism across all species in a given biome. 'Zero' would be infinite diversity and 'one' represents only one specie present in a biome.

Ecosystem / Community Diversity

Ecosystem diversity deals with the variations in ecosystems within a geographical location and its overall impact on human existence and the environment.

- Ecological diversity is a type of biodiversity. It is the variation in the ecosystems found in a region or the variation in ecosystems over the whole planet. Ecological diversity includes the variation in both terrestrial and aquatic ecosystems.
- Ecological diversity can also take into account the variation in the complexity of a biological community, including the number of different niches, the number of trophic levels and other ecological processes.
- An example of ecological diversity on a global scale would be the variation in ecosystems, such as deserts, forests, grasslands, wetlands and oceans.



- Ecological diversity is the largest scale of biodiversity, and within each ecosystem, there is a great deal of both species and genetic diversity.
- It refers to **different types of habitats**.
    - A **habitat** is the cumulative factor of the climate, vegetation and geography of a region.

- World consists of several types of habitat. E.g. Corals, Grasslands, Wetlands, Desert, Mangrove and Tropical rain forests.
- Each species adapts itself to a particular kind of environment.
- As the environment changes, species best adapted to that environment becomes predominant. Thus, the **variety or the biodiversity of species in the ecosystem is influenced by the nature of the ecosystem**. E.g. species have more diversity in the Western Ghats than deserts of the Rajasthan.

MEASUREMENT OF BIODIVERSITY

A variety of objective measures have been created in order to empirically measure biodiversity. The basic idea of a diversity index is to obtain a quantitative estimate of biological variability that can be used to compare biological entities, composed of direct components, in space or in time. **It is important to distinguish 'richness' from 'diversity'**. Diversity usually implies a measure of both species number and 'equitability' (or 'evenness'). Three types of indices can be distinguished:

Species Richness

Species richness indices: Species richness is a measure for the total number of the species in a community. However, complete inventories of all species present at a certain location, is an almost unattainable goal in practical applications.

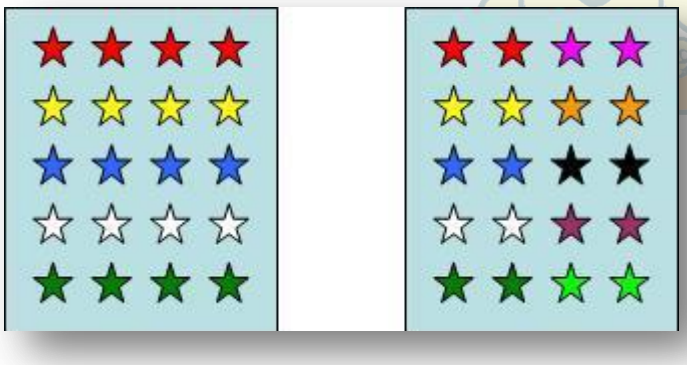


FIG: A visualization of the species richness: with respectively 5 and 10 species.

Species Evenness

Evenness indices: Evenness expresses how evenly the individuals in a community are distributed among the different species.

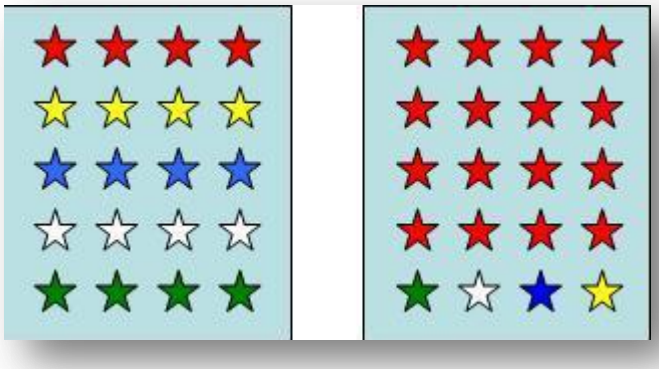


FIG: A visualization of the evenness of 5 species.

Taxonomic indices

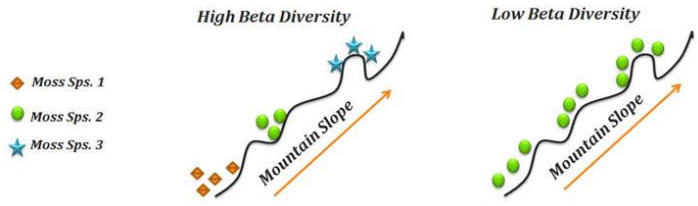
- **Taxonomic indices:** These indices take into account the taxonomic relation between different organisms in a community. Taxonomic diversity, for example, reflects the average taxonomic distance between any two organisms, chosen at random from a sample. The distance can be seen as the length of the path connecting these two organisms along the branches of a phylogenetic tree.

Alpha diversity

- The diversity of species within a particular area or ecosystem, expressed by the number of species (species richness) present there.
- Also known as local diversity.

Beta diversity

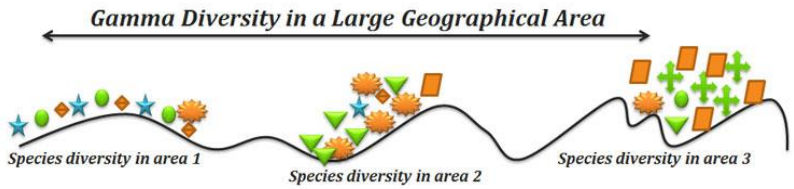
- It is species diversity between ecosystems; this involves comparing the number of taxa that are unique to each of the ecosystems.
- For example, the diversity of mangroves versus the diversity of seagrass beds.



Beta Diversity of Two Habitats (Mountain Slopes)

Gamma Diversity

- It is a measure of the overall diversity for different ecosystems within a region.
- For example, the diversity of the coastal region of Gazi Bay in Kenya.



Gamma Diversity

Q. Biodiversity forms the basis for human existence in the following ways: (2011)

1. Soil formation
2. Prevention of soil erosion
3. Recycling of waste
4. Pollination of crops

Select the correct answer using the codes given below

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

Q. The Millennium Ecosystem Assessment describes the following major categories of ecosystem services—provisioning, supporting, regulating, preserving and cultural. Which one of the following is supporting service?

a) Production of food and water
b) Control of climate and disease
c) Nutrient cycling and crop pollination
d) Maintenance of diversity

Q. Which of the following can be threats to the biodiversity of a geographical area? (2012)

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*

Q. The Himalayan Range is very rich in species diversity. Which one among the following is the most appropriate reason for this phenomenon? (2011)

a) *It has a high rainfall that supports luxuriant vegetative growth*
b) *It is a confluence of different biogeographical zones*
c) *Exotic and invasive species have not been introduced in this region*
d) *It has less human interference*

IMPORTANT TERMS AND CONCEPTS

Eurythermal Organisms

- A eurytherm is an organism, often specifically an ectotherm that can function at a wide range of body temperatures. Examples of Eurytherms include desert pupfish, which can function in waters from 4º to 45ºC.
- The sustained supply of oxygen to body tissues limits the body temperature range of an organism.
- Eurytherms that live in environments with large temperature changes adapt to higher temperatures through a variety of methods. For some species, initial warming results in an increase of oxygen consumption and heart rate, accompanied by a decrease in stroke volume and haemolymph oxygen partial pressure.
- Further warming causes dissolved oxygen levels to decrease below the threshold of full haemocyanin oxygen saturation.
- The progressive release of haemocyanin bound oxygen as a result of heating follows an exponential pattern, saving energy in oxygen transport and resulting in an associated leveling off of metabolic rate.

Flagship Species

- A flagship species is a species selected to act as an ambassador, icon or symbol for a defined habitat, issue, campaign or environmental cause.
- By focusing on, and achieving conservation of that species, the status of many other species which share its habitat – or are vulnerable to the same threats - may also be improved.

- Flagship species are usually relatively large, and considered to be 'charismatic' in western cultures.
- Flagship species may or may not be keystone species and may or may not be good indicators of biological process.

ENDEMISM

- Means that a plant or animal lives only in a particular location, such as a specific island, habitat type, nation or other defined zone.
- For example, many species of lemur are endemic to the island of Madagascar.
- There are two types of endemism - paleoendemism and neoendemism.

Few Examples Endemic Species of India

- Lion Tailed Macaque- found in Western Ghats
- Nilgiri Tahr- Nilgiri Hills
- Malabar Civet- Western Ghats
- Pygmy Hog- Assam

INDICATOR SPECIES

- Indicator species are plants and animals that, by their presence, abundance, or chemical composition, demonstrate some distinctive aspect of the character or quality of the environment.
- An indicator species has a response to stress or any disturbance that can be measured.
- For example, many invertebrate insects such as **mayflies or stoneflies** are indicator species that can assess the amount of oxygen in rivers, which means they are a useful indicator to control river pollution.
- On the other hand, pollinator insects such as **butterflies and bees** can accurately determine the health of plants in certain environment.
- **Salmon Fish** is an indicator species in many ecosystems around the world, especially in North America.
- **Grizzly Bears are** considered an indicator species to assess both health and diversity of species in Alaska.

SPECIATION

- Speciation is the evolutionary process by which populations evolve to become distinct species.

- There are four geographic modes of speciation in nature, based on the extent to which speciating populations are isolated from one another: ***allopatric, peripatric, parapatric, and sympatric.***

BIODIVERSITY- RICH IN TROPICS

- Over geological times the tropics have had more stable climate than the temperate zones. In tropics, therefore, local species continued to live there itself, whereas in temperate they tend to disperse to other areas.
- Tropical communities are older than temperate one's and therefore there has been more time for them to evolve. This could have allowed them greater degree of specialization and local adaptation to occur.
- Warm temperatures and high humidity in most tropical areas provide favourable conditions for many species that are unable to survive in temperate areas.
- In tropics there is greater pressure from pests, parasites and diseases. This does not allow any single species to dominate and thus there is opportunity for many species to co-exist. On the contrary in temperate zones there is reduced pests pressure due to cold, and there is one or few dominating species that exclude many other species.
- Among plant, rates of out-crossing appear to be higher in tropics, which may lead to higher levels of genetic variability.
- Tropical areas receive more solar energy over the year. Thus tropical communities are more productive or greater resource base that can support a wider range of species.

Difference

- **Biome:** A large terrestrial ecosystem characterized by specific plant communities and formations; usually named after the predominant vegetation in the region.
- **Biosphere:** The totality of life on or near Earth's surface.
- **Biota:** The entire complement of species of organisms, plants, and animals, found within a given region.
- **Biotype:** A biotope is an area of uniform environmental conditions providing a living place for a specific assemblage of plants and animals. Biotope is almost synonymous with the term habitat.
- In ecology, a community is an assemblage or association of populations of two or more different species occupying the same geographical area and in a particular time, also known as a **biocoenosis**.

Insectivorous Plants

- Insectivorous plants are a specialized group of plants that grow **in wet, acidic soils.**
- One of the most critical plant nutrients is nitrogen which is usually taken up by plants as nitrates. **Nitrogen is a nutrient that is easily leached out of soils.**
- For this reason, the plants that live in these soils have evolved into carnivorous plants that capture and digest insects as a means of obtaining nitrates. **These plants are usually associated with leached, nutrient-poor soils, or wet and acidic areas that are ill-drained.**

Insectivorous plants of India belong mainly to three families:

- Droseraceae
- Nepenthaceae
- Lentibulariaceae

Herbarium

A **herbarium** (plural: **herbaria**) is a collection of preserved plant specimens and associated data used for scientific study.The term can also refer to the building or room where the specimens are housed, or to the scientific institute that not only stores but uses them for research.

The specimens may be whole plants or plant parts; these will usually be in dried form mounted on a sheet of paper but, depending upon the material, may also be stored in boxes or kept in alcohol or other preservative. The specimens in a herbarium are often used as reference material in describing plant taxa; some specimens may be types.

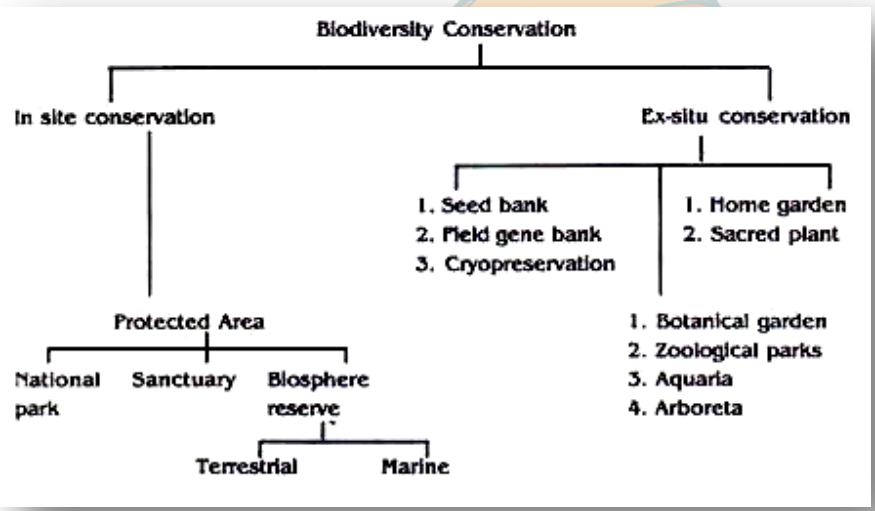
BIODIVERSITY CONSERVATION

Conservation of biodiversity has many objectives –

- To maintain essential ecological processes and life supporting systems.
- To preserve the genetic diversity of species.
- To make sustainable utilization of species and ecosystems.
- It provides a vast knowledge of potential use to the community.

Modes of Conservation

When we conserve and protect the whole ecosystem, its biodiversity at all levels is protected - we save the entire forest to save the tiger. This approach is called **in situ (on site) conservation**. However, when there are situations where an animal or plant is endangered or threatened and needs urgent measures to save it from extinction, **ex situ (off site)** conservation is the desirable approach.



Ex-situ Conservation

- Conserving biodiversity outside the areas where they naturally occur or in other words threatened animals and plants are taken out from their natural habitat and placed in special setting where they can be protected and given special care.
- **Example** - **Zoological parks, botanical gardens and wildlife safari parks**.
- In recent years ex-situ conservation has advanced beyond keeping threatened species in enclosures. Now gametes of threatened species can be preserved in viable and fertile condition for long periods using **cryopreservation** techniques, eggs can be fertilized **in vitro**, and plants can be propagated using **tissue culture** methods. Seeds of different

genetic strains of commercially important plants can be kept for long periods in **seed banks**.

National Gene Bank of India

- It is primarily responsible for **conservation of unique accessions on long-term basis**, as base collections for posterity, predominantly in the form of seeds.

The National Gene Bank is mainly concerned with ex situ conservation in a seed gene bank of the following mandate species:

- Indigenous crops of the region such as sorghum, millets, cowpeas, cucurbits, bambara nuts, traditional vegetables and their wild relatives.
- Utilized wild and weedy plant species such as medicinal plants.
- Introduced crops such as maize, rice, cassava, sweet potato and beans that have become adapted to the region.

Advantages of ex-situ conservation

- It gives **longer life time** and breeding activity to animals.
- Genetic techniques can be utilized in the process.
- Captivity breed species can again be reintroduced in the wild.

Disadvantages

- The favorable conditions may not be maintained always.
- Few life forms cannot evolve.
- This technique involves only few species.

Zoological Parks

A zoo (short for **zoological garden** or **zoological park**, and also called an **animal park or menagerie**) is a facility in which animals are confined within enclosures, displayed to the public, and in which they may also breed.

- Purpose of zoos – initially it was entertainment but over the decades, zoos have got transformed into **centers for wildlife conservation and environmental education**.
- They play role of saving individual animals and species conservation (through captive breeding).
- They are sensitizing visitors regarding the value and need for conservation of wildlife.

Botanical Garden

Botanical garden refers to the scientifically planned collection of living trees, shrubs, herbs, climbers and other plants from various parts of the globe.

Purpose of botanical gardens -

- To **study the taxonomy** as well as growth of plants.
- To study the introduction and acclimatization process of exotic plants.
- It acts as a **germplasm** (the genetic material of germ cells) **collection**.
- It helps **development of new hybrids**.
- It augments **conserving rare and threatened species.**
- It facilitates training of staff.
- It acts as a **source of recreation**.

Safari Park

- A safari park is larger than a zoo and smaller than game reserves (large areas of land where wild animals live safely or are hunted in a controlled way for sport (in Africa)).

In-situ Conservation

- The conservation of species in their natural habitat or natural ecosystem is known as **in situ conservation.**
- In the process, the natural surrounding or ecosystem is protected and maintained so that all the constituent species (known or unknown) are conserved and benefited.
- The established natural habitats are -
    - National parks
    - Sanctuaries
    - Biosphere reserves
    - Biodiversity hotspots
    - Reserved forests
    - Protected forests
    - Nature reserves
- The above natural habitats are covered under **PROTECTED AREA NETWORK- part II of VAN**

Advantages

- If it is a cheap and convenient way of conserving biological diversity.
- It offers a way to preserve a large number of organisms simultaneously, known or unknown to us.
- The existence in natural ecosystem provides opportunity to the living organisms to **adjust to differed' environmental conditions and to evolve in to a better life form**.

Disadvantage

- Only disadvantage - it requires large space of earth which is often difficult because of growing demand for space.