BIODIVERSITY AND CONSERVATION

Biodiversity is the diversity of biological organisation ranging from cellular macromolecules to biomes.
**Edward Wilson** popularized the term 'biodiversity'.

LEVELS OF BIODIVERSITY

1. **Genetic diversity:** Diversity shown by a single species at **genetic level.** E.g. *Rauwolfia vomitoria* **(Himalaya)** shows genetic variation in the **potency** & **concentration** of the chemical **reserpine.** India has more than **50,000** different strains of **rice** and **1000 varieties** of **mango.**

2. **Species diversity:** Diversity at **species level.** E.g. **Western Ghats** have greater **amphibian species** than **Eastern Ghats.**

3. **Ecological diversity:** Diversity at **ecosystem level.**
   E.g. In India, **deserts, rain forests, mangroves, coral reefs, wet lands, estuaries** & **alpine meadows** are seen.

NUMBER OF SPECIES ON EARTH (GLOBAL SPECIES DIVERSITY)

○ According to **IUCN (2004),** more than **1.5 million species** described so far.

○ According to **Robert May's Global estimate,** about **7 million** species would have on earth. (He considered the species to be discovered in the tropics. i.e. only **22%** of the total species have been recorded so far).

○ **Animals** are more diverse (**above 70%**) than **plants** including Plantae and Fungi (**22%**).

○ Among animals, **insects** are most species rich group **(70%,** i.e. out of every 10 animals, 7 are insects).

○ Number of fungi species is more than the combined total of the species of fishes, amphibians, reptiles & mammals.

Invertebrates   **Vertebrates**
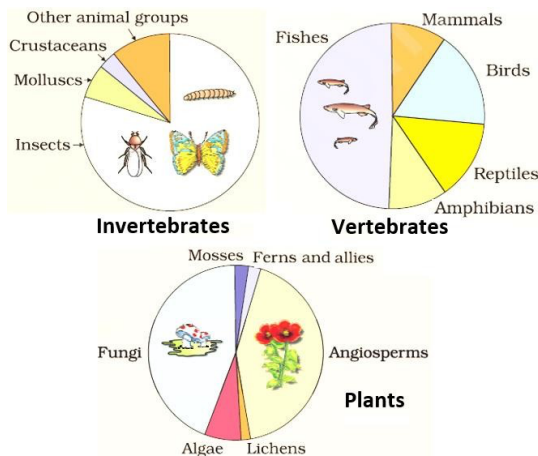
Plants

○ India has only **2.4%** of world's land area, but has **8.1%** of the species diversity. India is one of the **12 mega diversity** countries of the world. Nearly **45,000 plant species** and **twice** as many of **animals** have been recorded from India.

○ Applying **May's global estimates,** India would have more than 1 lakh plant species and 3 lakh animal species.

○ Biologists are not sure about total number of prokaryotic species because
   • Conventional taxonomic methods are not suitable for identifying microbial species.
   • In laboratory, many species cannot be cultured.

PATTERNS OF BIODIVERSITY

i. Latitudinal gradients

- Species diversity decreases from the equator to the poles.
- **Tropics** (latitudinal range of 23.5° N to 23.5° S) have more species than temperate or polar areas.
  E.g. Number of **bird species** in different latitudes:
  ○ **Colombia** (near equator): about **1400 species.**
  ○ **India** (in tropics): **> 1200 species.**
  ○ **New York (41° N): 105 species.**
  ○ **Greenland (71° N): 56 species.**
- Tropical forest region like **Equador** has up to **10 times** of vascular plant species as compared to a temperate forest region like the **Midwest of USA.**
- **Tropical Amazonian rain forest** (South America) is the greatest biodiversity on earth. It contains
   ○ > 40000 species of plants
   ○ 3000 species of fishes
   ○ 1300 species of birds
   ○ 427 species of mammals
   ○ 427 species of amphibians
   ○ 378 species of reptiles
   ○ > 1,25,000 species of invertebrates
- Biodiversity (species richness) is highest in tropics because
   ○ Tropics had more evolutionary time.
   ○ Relatively constant environment (less seasonal).
   ○ They receive more solar energy which contributes to greater productivity.

ii. Species- Area relationship

According to the study of **Alexander von Humboldt** in South American jungles, within a region, species richness increases with increasing explored area, but only up to a limit.
Relation between species richness and area gives a **rectangular hyperbola.**
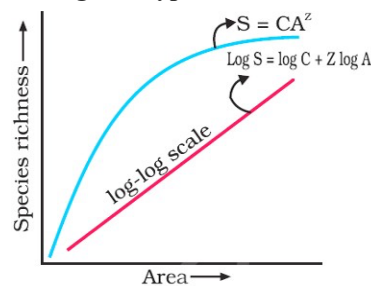
$$S = CA^z$$

Where,
S= Species richness
A= Area
C= Y-intercept
Z= slope of the line (regression co-efficient)

- On a logarithmic scale, the relationship is a straight line described the equation **Log S = log C + Z log A**
- Generally, for small areas, the Z value is **0.1 to 0.2.**
- But for large areas (e.g. entire continents), slope of the line is steeper **(Z value: 0.6 to 1.2).**
- E.g. for frugivorous birds and mammals in the tropical forests of different continents, the Z value is **1.15.**

IMPORTANCE OF SPECIES DIVERSITY

- According to **David Tilman,** plots with more species shows less year-to-year variation in total biomass.
- Increased diversity contributes to higher productivity. It is essential for ecosystem health and survival of human race.

- **'Rivet popper hypothesis':** It is an analogy used to understand the importance of biodiversity.

  It is proposed by Stanford ecologist **Paul Ehrlich.**

  In an airplane **(ecosystem),** all parts are joined with many rivets **(species).** If passengers pop a rivet (extinction of a species), it may not affect flight safety **(functioning of the ecosystem).** But as more and more rivets are removed, the plane becomes dangerously weak. Loss of rivets on the wings **(key species** that drive major ecosystem functions) is more dangerous than loss of a few rivets on the seats or windows.

LOSS OF BIODIVERSITY

- **IUCN Red List (2004)** says that 784 species (338 vertebrates, 359 invertebrates & 87 plants) were extinct in the last 500 years. E.g. **Dodo (Mauritius), Quagga (Africa), Thylacine (Australia), Stellar's sea cow (Russia)** and **3 subspecies (Bali, Javan, Caspian) of tiger.**
- **27 species** have been disappeared in the last 20 years.
- More than **15,500 species** are facing threat of extinction.
- **12% birds, 23% mammals, 32% amphibians, 31% gymnosperm species** face the threat of extinction.
- The current extinction rate is 100 - 1000 times faster than in the pre-human times. If this trend continues, nearly 50% species might be extinct within next 100 years.

Impacts of Loss of biodiversity

o Decline in plant production.
o Environmental perturbations such as drought.
o Increased variability in ecosystem processes such as plant productivity, water use and pest & disease cycles.

Causes of Biodiversity losses ('The Evil Quartet')

1. **Habitat loss and fragmentation:** Most important cause.
   - E.g. Tropical rain forests (loss from 14% to 6%).
   - Thousands of hectares of rain forests are being lost within hours.
   - **The Amazon rain forest** is being cut for cultivating soya beans or for conversion of grass lands for cattle.
   - Fragmentation badly affects animals requiring large territories and migratory animals.
2. **Over-exploitation: Stellar's sea cow, Passenger pigeon** etc. extinct due to over exploitation.
3. **Alien species invasions:** Alien species cause decline or extinction of **indigenous species.** E.g.
   - **Nile Perch** introduced in **Lake Victoria (East Africa)** caused extinction of more than 200 species of **cichlid fish.**
   - Invasive weed species like *Parthenium* (carrot grass), **Lantana** and *Eicchornia* (water hyacinth) caused damage to our native species.
   - Illegal introduction of the **African Catfish (***Clarias gariepinus***)** for aquaculture is a threat to the indigenous catfishes in our rivers.
4. **Co-extinction:** When a species becomes extinct, the species associated with it also extinct. E.g.
   - Extinction of the **parasites** when the **host** is extinct.
   - In co-evolved **plant-pollinator mutualism,** extinction of one causes the extinction of the other.

BIODIVERSITY CONSERVATION

There are 3 categories of reasons for conservation.

a. Narrowly utilitarian arguments

- Human derive economic benefits from nature such as food, firewood, fibre, construction material, industrial products (tannins, lubricants, dyes, resins, perfumes) and medicines.
- More than 25% of the drugs are derived from plants.
- 25,000 species of plants have medicinal value.

b. Broadly utilitarian arguments

Biodiversity has many ecosystem services. E.g.

- Amazon forest *('lung of the planet')* produces 20% of total O_2 in the earth's atmosphere.
- Pollination through bees, bumblebees, birds and bats.
- Aesthetic pleasures.

c. Ethical arguments

- Every species has an **intrinsic value**. We have a moral duty to care for their well-being.

Biodiversity conservation is 2 types: *In situ* **(on site)** conservation and *Ex situ* **(off site)** conservation.

a. *In situ* conservation (on site)

It is the conservation of genetic resources within natural or human-made ecosystems in which they occur. E.g. Protected areas such as **National Parks, Sanctuaries, Biosphere reserves, cultural landscapes, natural monuments etc.**

- **National Park:** Strictly reserved for the welfare of the wildlife where private ownership, cultivation, grazing etc. are prohibited. E.g. **Eravikulam National Park in Kerala.**
- **Sanctuary:** Here, protection is given only to the animals. Collection of timbers, minor forest products and private ownership are allowed so long as they do not harm the animals. E.g. **Periyar wildlife sanctuary in Kerala.**
- **Biosphere Reserves:** Areas of land or coastal ecosystems for conservation and sustainable use.
- **Sacred forests (Sacred groves):** Forest fragments which are communally protected based on religious beliefs. E.g.
  o Sacred groves in **Khasi** & **Jaintia Hills** in Meghalaya.
  o **Aravalli Hills** of **Rajasthan.**
  o **Western Ghat** regions of Karnataka & Maharashtra.
  o **Sarguja, Chanda** & **Bastar** areas (Madhya Pradesh).

India has **14 Biosphere Reserves, 90 National Parks** and **448 wildlife sanctuaries.**

b. *Ex situ* conservation (off site)

It is the conservation of organisms outside their habitats. E.g. genetic resource centres, zoological parks, wildlife safari parks, botanical gardens, gene banks, cryopreservation etc.

Hotspots

- These are the regions with very high species richness, high degree of **endemism** (species confined only to a specific region) but most threatened.
- There are **34 hotspots** in the world.
- **3 hotspots** cover India's biodiversity regions- **Western Ghats & Sri Lanka, Indo-Burma and Himalaya.**

- All hotspots together cover only < 2% of the earth's land area. But the species richness is extremely high. Protection of hotspots reduced the ongoing extinctions by 30%.

International Efforts for conserving biodiversity

- **The Earth Summit** or **Convention on Biological Diversity (Rio de Jeneiro, 1992)** - 3 objectives:
 a. Conservation of biodiversity.
  b. Sustainable use of biodiversity.
  c. Sharing of benefits arising from genetic resources.
- **The World Summit on Sustainable Development (Johannesburg, South Africa, 2002):** 190 countries pledged to reduce the current rate of biodiversity loss.

MODEL QUESTIONS

1. There are about 20,000 species of ants 3,00,000 species of beetles and 28,000 species of fishes in the world.
   a. Which organization is dealing with the population of organisms in the world?
   b. What are the causes of bio-diversity losses?
2. Anil said: "Mosquitoes are harmful, Snakes are poisonous, and Insects damage crops. It is high time to destroy all these organisms for the welfare of human beings".
   a. Can you agree with this statement?
   b. As a biology student, how can you convince this person about the importance of each organism in the nature?
3. Amazonian rain forests have the greatest biodiversity on earth. Give 3 hypotheses to explain the reason for this.
4. "The biological wealth of our planet has been declining rapidly and the accusing finger is clearly pointing to human activities."
   a. Mention any two human activities leading to the loss of biodiversity.
   b. Mention the different ways to conserve biodiversity.
5. Introduction of exotic species is one of the major threats of biodiversity. Cite any two examples.
6. The given bar diagram shows the population of Asiatic leopard and tiger for the last 50 years in India.
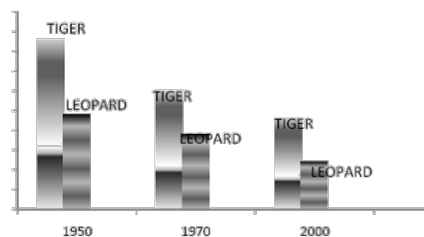
   a. Analyse the figure, whether the population of tiger and leopard increasing or decreasing. Find reason.
   b. Does the decreasing population of the organisms affect the stability of the ecosystem? If yes state how?
   c. Suggest measures for protecting the population of these organisms.
7. Classify the following words into two categories and give suitable titles.
   Genetic resource centres, National parks, Botanical gardens, Sanctuaries, Biosphere reserves, Gene banks, Cultural landscapes, Zoological parks, Natural monuments, Sacred forests.
8. Distinguish between National park and Sanctuary giving one example for each.
9. This is a board seen in front of a national park.
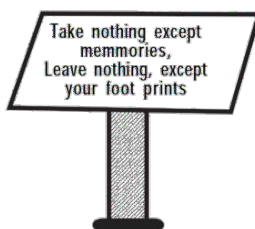
   a. Evaluate the quotation in the board and state your opinion.
   b. Write any four reasons for extinction of animals.
   c. Name three animals extinct recently.
   d. What is the significance of IUCN red list?