

# Biodiversity and Conservation

## Biodiversity

- There are more than **20,000 species** of ants, **3,00,000 species** of beetles, **28,000 species** of fishes and nearly **20,000 species** of orchids.
- Biodiversity is the term popularized by the sociobiologist **Edward Wilson** to describe the combined diversity at all the levels of biological organization
- Biodiversity can be described as the sum total of genes, species and ecosystem of a region**

### (i) Genetic diversity

- A single species might show high diversity at the genetic level over its distributional range  
Eg: The genetic variation shown by the medicinal plant ***Rauwolfia vomitoria*** growing in different Himalayan ranges might be in terms of the potency and concentration of the active chemical (**reserpine**) that the plant produces.
- India has more than **50,000** genetically different strains of **rice**, and **1,000 varieties** of **mango**.

### (ii) Species diversity:

- The diversity at the species level.  
Eg: the Western Ghats have a greater amphibian species diversity than the Eastern Ghats.

### (iii) Ecological diversity:

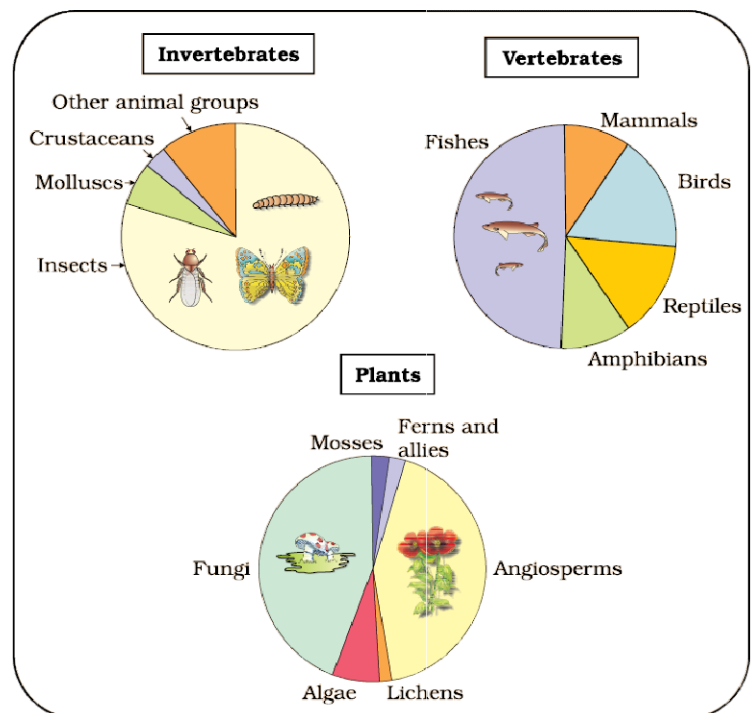
- The diversity at the ecosystem level.  
Eg: India has variety of ecosystem like **deserts, rain forests, mangroves, coral reefs, wetlands, estuaries, and alpine meadows** has a greater ecosystem diversity than a Scandinavian country like Norway.

## How Many Species are there on Earth and How Many in India?

- According to the **IUCN (2004)**, the total number of plant and animal species described so far is slightly **more than 1.5 million**.
- According to **Robert May** total the global species diversity is about **7 million**.

More than **70 per cent** of all the species recorded are **animals**, while plants (including algae, fungi, bryophytes, gymnosperms and angiosperms) comprise no more than **22 per cent** of the total.

- Among animals, **insects** are the most species-rich taxonomic group, making up more than **70 per cent** of the total (**it means that, out of every 10 animals on this planet, 7 are insects.**)
- The number of **fungi species in the world is more than the combined total of the species of fishes, amphibians, reptiles and mammals.**
- The number of **fishes among vertebrates are more than total number of mammals, Birds, reptiles and Amphibians !**



- Biologists are not sure about how many prokaryotic species there might be India has only **2.4 per cent** of the world's land area, its share of the global species diversity is an impressive **8.1 per cent**. (This makes our country one of the **12 mega diversity** countries of the world.)
- Nearly **45,000 species** of plants and twice as many of animals have been recorded from India.
- If we accept May's global estimates, only **22 per cent** of the total species have been

recorded so far. Applying this proportion to India's diversity figures, we estimate that there are probably more than **1,00,000 plant species and more than 3,00,000 animal species yet to be discovered and described !**

## Patterns of Biodiversity

### (i) Latitudinal gradients:

- The diversity of plants and animals is not uniform throughout the world.
- In general, species diversity decreases as we move **away from** the equator towards the poles. **With very few exceptions, tropics** (latitudinal range of 23.5° N to 23.5° S) harbour **more species than temperate or polar areas**.
- Colombia located near the equator has nearly 1,400 species of birds while New York at 41° N has 105 species and Greenland at 71° N only 56 species. India, with much of its land area in the tropical latitudes, has more than 1,200 species of birds.
- A forest in a tropical region like Ecuador has up to 10 times as many species of vascular plants as a forest of equal area in a temperate region like the Midwest of the USA.
- The largely tropical Amazonian rain forest in South **America has the greatest biodiversity on earth**- it is home to more than 40,000 species of plants, 3,000 of fishes, 1,300 of birds, 427 of mammals, 427 of amphibians, 378 of reptiles and of more than 1,25,000 invertebrates. Scientists estimate that in these rain forests there might be at least **two million insect species waiting to be discovered and named !!!!**

### Reason for the great diversity in the tropical regions

Ecologists and evolutionary biologists have proposed various hypotheses; some important ones are

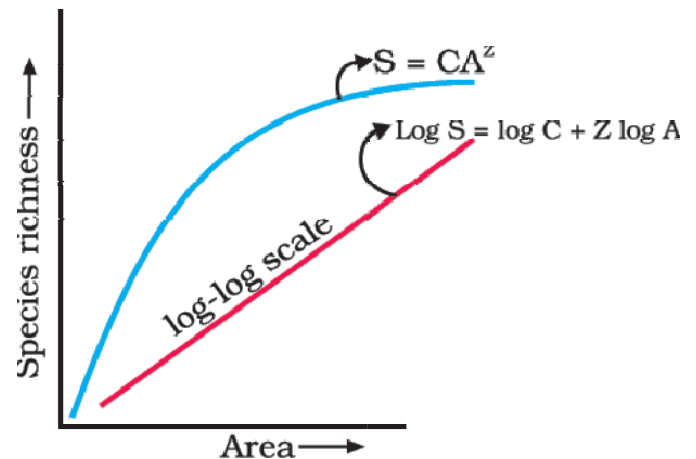
- (1) Tropical regions have remained relatively undisturbed for millions of years and thus had a long time for species diversification.
- (2) Tropical environments, unlike temperate ones, are less seasonal, relatively more constant and predictable. Such constant environments

promote niche specialisation and lead to a greater species diversity.

(3) There is more solar energy available in the tropics, which contributes to higher productivity; this in turn might contribute indirectly to greater diversity.

### (ii) Species-Area relationships:

- During his pioneering and extensive explorations in the wilderness of **South American jungles**, the great German naturalist and geographer **Alexander von Humboldt** observed that **within a region species richness increased with increasing explored area, but only up to a limit**
- The relationship between species richness and area for a wide variety of taxa (angiosperm plants, birds, bats, freshwater fishes) turns out to be a **rectangular hyperbola**. **On a logarithmic scale, the relationship is a straight line** described by the equation



- $\log S = \log C + Z \log A$
- where
  - S= Species richness A= Area
  - Z = slope of the line (regression coefficient)
  - C = Y-intercept

✓ Ecologists have discovered that the value of Z lies in the range of **0.1 to 0.2**, regardless of the taxonomic group or the region (whether it is the plants in Britain, birds in California or molluscs in New York state, the slopes of the regression line are amazingly similar)

✓ The species-area relationships among very large areas like the entire continents, you will find that the slope of the line to be much steeper (**Z values in the range of 0.6 to 1.2**).

For example, for frugivorous (fruit-eating) birds and mammals in the tropical forests of different continents, the slope is found to be **1.15**

## **The importance of Species Diversity to the Ecosystem**

- A community with more species tend to be more stable than those with less stable.
- A community which should not show too much variation in productivity from year to year called **Stable community**. Such community are resistant to occasional disturbance (Natural or Man made) and resistant to alien species invasion.
- **David Tilman** conducted some long term experiments using outdoor plots, explained that increased diversity contributed to higher productivity. Rich diversity and higher productivity are not only essential for a healthy ecosystem but also important for the survival of human race

### **RIVET POPPER HYPOTHESIS**

- Proposed by Stanford ecologist Paul Ehrlich.
- In an airplane (ecosystem) all parts are joined together using thousands of rivets (species).
- If every passenger travelling in it starts popping a rivet to take home (causing a species to become extinct), it may not affect flight safety (proper functioning of the ecosystem) initially, but as more and more rivets are removed, the plane becomes dangerously weak over a period of time.
- Furthermore, which rivet is removed may also be critical. Loss of rivets on the wings (**key species that drive major ecosystem functions**) is obviously a more serious threat to flight safety than loss of a few rivets on the seats or windows inside the plane.

## **Loss of Biodiversity**

- The colonisation of tropical Pacific Islands by humans is said to have led to the extinction of more than 2,000 species of native birds.
- The IUCN Red List (2004) documents the extinction of **784 species (including 338 vertebrates, 359 invertebrates and 87 plants)** in the last 500 years.
- Some examples of recent extinctions include
  - Dodo (Mauritius),
  - Quagga (Africa),
  - Thylacine (Australia),
  - Steller's Sea Cow (Russia) and
  - Three subspecies of tiger (Bali, Javan, Caspian)

The last twenty years alone have witnessed the disappearance of 27 species more than **15,500 species** world-wide are facing the threat of extinction.

Presently, **12 %** of all bird species, **23%** of all mammal species, **32 %** of all amphibian species and **31%** of all gymnosperm species in the world face the **threat of extinction**.

- Loss of biodiversity in a region may lead to
  - (a) Decline in plant production,
  - (b) Lowered resistance to environmental perturbations such as drought
  - (c) Increased variability in certain ecosystem processes such as plant productivity, water use, and pest and disease cycle.

### **Causes of biodiversity losses:**

There are four major causes (**'The Evil Quartet'** is the sobriquet)

#### **(i) Habitat loss and fragmentation:**

This is the most important cause driving animals and plants to extinction. The most dramatic examples of habitat loss come from **tropical rain forests**. Once covering more than **14 % of the earth's land surface**, these rain forests now cover **not more than 6 %**. They are being destroyed fast. By the time you finish reading this Printout of zoology, **1000 more hectares of rain forest** would have been lost.

The Amazon rain forest (it is so huge that it is called the 'lungs of the planet') harbouring probably millions of species is being cut and cleared for cultivating **soya beans** or for conversion to grasslands for raising beef cattle.

Besides total loss, the degradation of many habitats by pollution also threatens the survival of many species.

When large habitats are broken up into small fragments (**Fragmentation**) due to various human activities, mammals and birds requiring large territories and certain animals with migratory habits are badly affected, leading to population declines.

### (ii) Over-exploitation:

Humans have always depended on nature for food and shelter, but when 'need' turns to 'greed' it leads to **over-exploitation of natural resources**.

Eg: Many species extinctions in the last 500 years (**Steller's sea cow, passenger pigeon**) were due to overexploitation by humans.

### (iii) Alien species invasions:

When alien species are introduced unintentionally or deliberately for whatever purpose, some of them turn invasive, and cause decline or extinction of indigenous species.

**Eg 1: The Nile perch introduced into Lake Victoria in east Africa** led eventually to the extinction of an ecologically unique assemblage of more than 200 species of **cichlid fish in the lake**.

**Eg 2: the environmental damage caused and threat posed to our native species by invasive weed species like carrot grass (*Parthenium*), Lantana and water hyacinth (*Eichhornia*).**

**Eg 3: The recent illegal introduction of the African catfish *Clarias gariepinus* for aquaculture purposes is posing a threat to the indigenous catfishes in our rivers.**

### (iv) Co-extinctions:

When a species becomes extinct, the plant and animal species associated with it in any way also become extinct.

**Eg 1:** When a host fish species becomes extinct, its unique assemblage of parasites also meets the same fate.

**Eg 2:** Coevolved plant-pollinator mutualism where extinction of one invariably leads to the extinction of the other.

## **BIODIVERSITY CONSERVATION**

### **Why Should We Conserve Biodiversity?**

The great biodiversity on Earth is vital for the existence of mankind. The reason for conserving biodiversity are the following

#### **a) Narrow Utilitarian**

The **narrowly utilitarian** arguments for conserving biodiversity are obvious; humans derive countless direct economic benefits from nature food (cereals, pulses, fruits), firewood, fibre, construction material, industrial products (tannins, lubricants, dyes, resins, perfumes ) and products of medicinal importance.

- More than **25 %** of the drugs currently sold in the market worldwide are derived from plants and **25,000** species of plants contribute to the traditional medicines used by native peoples around the world. Nobody knows how many more medicinally useful plants there are in tropical rain forests waiting to be explored.
- With increasing resources put into '**bioprospecting**' (exploring molecular, genetic and species-level diversity for products of economic importance), nations endowed with rich biodiversity can expect to reap enormous benefits.

#### **b) Broadly utilitarian:**

The **broadly utilitarian** argument says that biodiversity plays a major role in many ecosystem services that nature provides. The fast- dwindling **Amazon forest (Lungs of Planet)** is estimated to produce, through photosynthesis, **20 per cent** of the total oxygen in the earth's atmosphere.

Pollination (without which plants cannot give us fruits or seeds) is another service, ecosystems provide through pollinators layer – bees, bumblebees, birds and bats.

There are other intangible benefits – that we derive from nature—the aesthetic pleasures of walking through thick woods, watching spring flowers in full bloom or waking up to a bulbul's song in the morning etc give pleasure

### **c) Ethical argument**

Philosophically or spiritually, we need to realise that Every species has an intrinsic value, even if it may not be of current or any economic value to us. We have a moral duty to care for their well-being and pass on our biological legacy in good order to future generations.

### **How do we conserve Biodiversity?**

Conservation of biodiversity can be done by two ways

a) In-situ conservation

b) Ex-situ conservation

#### **a) In-situ (On site) 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.

ie: In-situ conservation refers to the practice of protecting plant and animal species within their natural habitats

Eg:

- National park
- Sanctuaries
- Biosphere reserves,
- Natural monuments,
- Hot spots
- sacred grooves
- cultural landscapes
- India has
  - 14 biosphere reserves,
  - 90 national parks and
  - 448 wildlife sanctuaries.
- Sacred groves are found in Khasi and Jaintia Hills in Meghalaya, Aravalli Hills of Rajasthan, Western Ghat regions of Karnataka and Maharashtra and the Sarguja, Chanda and Bastar areas of Madhya Pradesh. In Meghalaya, the sacred groves are the last refuges for a large number of rare and threatened plants

#### **Hotspots:**

Scientists identified certain regions with very high level of species richness and high degree of Endemism (species that is confined to that region and not found anywhere else) to protect biodiversity. Hot spots are the richest and most threatened reservoirs of plants and animal life on earth.

- Initially 25 biodiversity hotspots were identified but subsequently nine more have been added to the list, bringing the total number of **biodiversity hotspots in the world to 34**. These hotspots are also regions of accelerated habitat loss.
- Three of these hotspots – **Western Ghats and Sri Lanka, Indo-Burma and Himalaya** – cover our country's exceptionally high biodiversity regions.
- Although all the biodiversity hotspots put together cover less than **2% of the earth's land area**, the number of species they collectively harbour is extremely high and strict protection of these hotspots could reduce the **ongoing mass extinctions by almost 30 per cent**.

#### **(b) Ex situ (off site) Conservation**

- When there are situations **where an animal or plant is endangered or threatened (organisms facing a very high risk of extinction in the wild in the near future) and needs urgent measures to save it from extinction**, ex situ (off site) conservation is the desirable approach.
- Conservation **outside their habitat** is called ex-situ conservation.
- In this approach, 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.

Eg :

- Cryopreservation,
- Zoological parks,
- Botanical gardens
- Wildlife safari parks

#### **Cryopreservation**

- Storage of materials (Like seeds, gametes) at very low temperature is called cryopreservation.
- Now gametes of threatened species can be preserved in viable and fertile condition for long periods using cryopreservation techniques, eggs can be fertilised in vitro, and plants can be propagated using tissue culture methods.
- In recent years ex situ conservation has advanced beyond keeping threatened species in enclosures. Seeds of different

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

- Biodiversity knows no political boundaries and its conservation is therefore a collective responsibility of all nations.
- ✓ The historic Convention on Biological Diversity ('The Earth Summit') held in Rio de Janeiro in 1992, called upon all nations to take appropriate measures **for conservation of biodiversity and sustainable utilisation of its benefits**.
- ✓ In a follow-up, the World Summit on Sustainable Development held in 2002 in Johannesburg, South Africa, 190 countries pledged their commitment to achieve by 2010, a significant reduction in the current rate of biodiversity loss at global, regional and local levels.



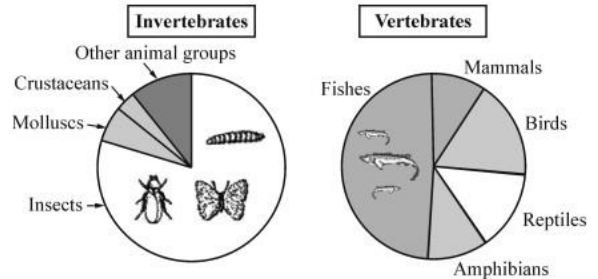
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## BIODIVERSITY AND CONSERVATION

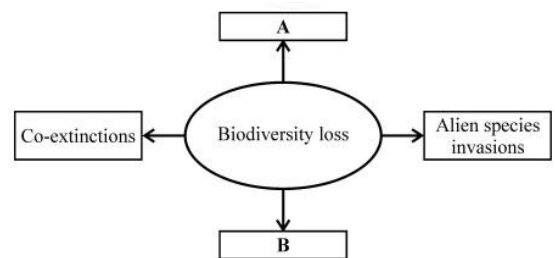
1. Biodiversity is the term popularized by the sociobiologist\_\_\_\_\_ to describe the combined diversity at all the levels of biological organization .(HSE-March-2024)(1)
2. Biodiversity and its conservation are now vital environmental issues of international concern as more and more people around the world begin to realise the critical importance of biodiversity for our survival and well being on this planet. (HSE-March-2024)(3)
  - (a) Which are the four major causes of biodiversity losses ? (1)
  - (b) Name two different methods of biodiversity conservation. (1)
  - (c) What is so special about tropics that might account for their greater biological diversity ? (1)
3. "Evil Quartet" is the sobriquet used to describe biodiversity loss. If so,
  - (a) List out the four major causes of biodiversity loss.
  - (b) Mention the two major approaches of biodiversity conservation (HSE-June-2024)(3)
4. Identify two ex-situ conservation approaches of organisms from the following list : (HSE March 2023)(1)  
(Zoological Park, Biosphere Reserve, National Park, Botanical Garden)

5. A figure showing the global biodiversity of invertebrates and vertebrates are given :

(HSE March 2023)(2)



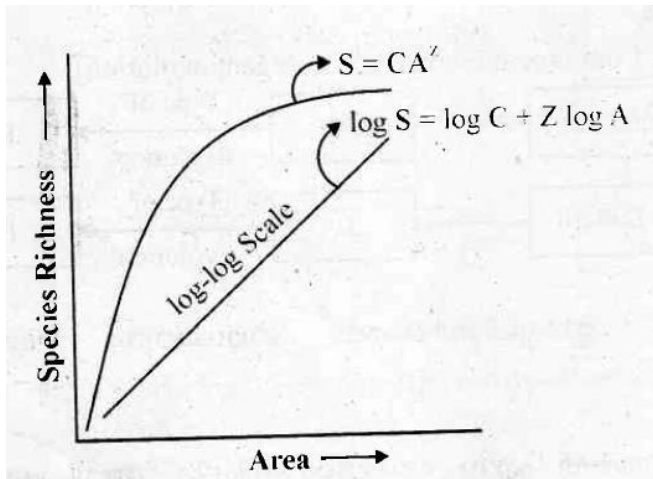
- (A) Identify the most diverse groups of vertebrates and invertebrates.
  - (B) What are the three important levels of biodiversity ?
6. The given illustration shows 'Evil Quartet' of biodiversity loss :



- (i) Fill up 'A' and 'B'.
  - (ii) Explain Co-extinction and Alien species invasion with suitable examples (HSE March 2023)(3)
7. Differentiate between in-situ and ex-situ approaches of biodiversity conservation with two examples each (HSE July 2022)(2)
8. The term 'Biodiversity' was popularised by the scientist \_\_\_\_\_. (HSE-March 2022)(1)
9. (a)Write four major causes of Biodiversity loss.

- (b) Give one example for in-situ conservation and ex-situ conservation of Biodiversity.  
(HSE-March 2022)(3)
10. Biodiversity can be described at 3 levels of biological organizations  
a) Mention three levels of biological diversity ?  
b) Who popularized the term "Biodiversity" (HSE-August-2021) (2)
11. Mention the two conservative approaches to protect our biodiversity. Give one example for each conservative approach ?  
(HSE-August-2021) (2)
12. Now-a-days, the world is facing a problem of increased rate of species extinction due to human activities'. Write major causes of biodiversity losses (HSE March 2021)(2)
13. "Species diversity is greater in tropical regions than in temperate regions." Give reasons.  
(HSE March 2021)(2)
14. (a) The term 'biodiversity' was popularised by\_\_\_\_\_.  
(b) Name the two types of biodiversity conservation.  
(c) Write any three causes of biodiversity loss.  
(HSE-July 2020)(3)
15. Select the cause of extinction of Cichlid fish in lake Victoria of East Africa. (HSE-March 2020)(1)  
(a) Habitat loss and fragmentation  
(b) Over-exploitation  
(c) Alien species invasions  
(d) Co-extinctions
16. Tropical Amazonian rainforest in South America has the greatest biodiversity on earth. Do you agree with this? Explain.  
(HSE-March 2020)(2)
17. In your school the Science Club decided to conduct a seminar about "Biodiversity conservation - Approaches". You are invited to present a paper on this seminar. List out the main points you included in the presentation.  
(Hint : In Situ, Ex-Situ conservation)  
(HSE-June-2019)(3)
18. Which among the following belongs to ex-situ conservation?  
**Wildlife sanctuaries, Bio sphere reserves, Zoological parks, National parks, Sacred groves**  
(HSE-March-2019)(1)
19. The causes of biodiversity loss are designated as "EVIL QUARTET". Explain the Evil Quartet in biodiversity loss.  
(HSE-March-2019)(2)
20. Human beings can conserve and protect ecosystem and biodiversity. Prepare a handout to show different methods of biodiversity conservation? (HSE-June 2018)(2)
21. Observe the graph and answer the following questions  
(HSE-March 2018)(3)



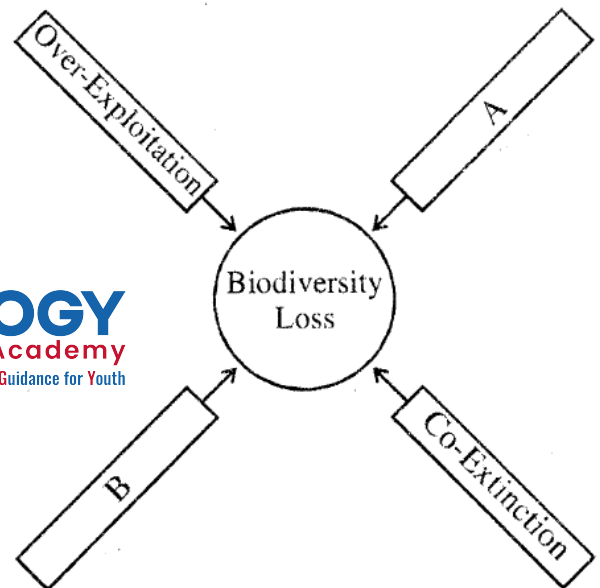


- a) Name S, A, C and Z in the graph  
b) Name the scientist who explained species-area relationship
22. "The accelerated rates of species extinction that the world is facing today is largely due to human activities". (HSE-Model 2018)(3)  
Do you agree with this statement. Justify your answer.
23. Explain the levels of biodiversity? (HSE-JUNE-2017)(3)
24. Explain different types of biodiversity conservation with example (HSE-JUNE-2017)(3)
25. Distinguish between *in situ* conservation from *ex situ* conservation with one example each? (HSE-March-2017)(2)
26. "When we conserve and protect the whole ecosystem, its biodiversity at all levels is protected". Based on this statement explain the strategies of biodiversity conservation (HSE-June 2016)(3)
27. "when need turns to greed, it leads to biodiversity loss". Substantiate this statement by explaining two causes of biodiversity loss.

(HSE-June 2016)(3)

28. Observe the concept diagram of Evil Quartet of biodiversity loss

(HSE-March 2016)(2)

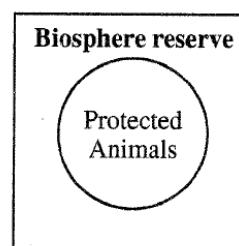


- a) Write A and B  
b) What is co-extinction?

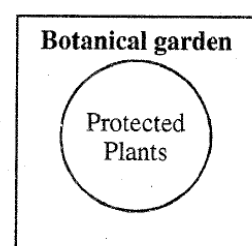
29. Read the statement and choose the correct option (HSE-March 2014)(1)

- A : Sacred grooves are examples of *in situ* conservation  
B : Biodiversity hotspots have low degree of endemism.  
C : Biodiversity increases when number of organisms in a particular species increases.
- (a) Statement 'A' alone is correct.  
(b) Statements 'A' and 'B' are correct.  
(c) Statements 'A' and 'C' are correct.  
(d) Statement 'C' alone is correct.

30. Two approaches for the conservation of biodiversity is shown as A and B (HSE-June 2015)(3)



A



B

- a) Identify the type of conservation shown in A and B?

b) Write the difference between two types of biodiversity conservation shown in A and B?

c) Which of the above approach is more desirable when there is an urgent need to save species?

31. We have moral responsibility to take good care of earth's biodiversity and pass it on in good order to next generation.

a) Define biodiversity?

b) Write causes for biodiversity loss?

c) Name two types of biodiversity conservation? (HSE-March 2015)(3)

32. a) Variety of species are present around us, what they constitute and comment?

b) Comment on in situ conservation and ex situ conservation?

c) In these aspects explain the concept of hot spot with example- give importance to recent issues with regard to western ghat

(HSE-June 2014)(3)

33. "Nature provides all for the need of man but not for his greed"

a) Do you agree with this statement? Justify your answer

b) Distinguish between two types of biodiversity conservation?

(HSE-March 2014)(3)

34. While preparing the species-area relationship graph of 4 areas, the following Z values are obtained

Area A = 0.1

Area B = 0.8

Area C = 1.2

Area D = 0.3

a) Which area shows maximum species richness?

b) What are the expected reasons for the loss of biodiversity in area with low species richness?

(HSE-May 2013)(3)

35. "Nature does a lot of service for which an economic value or price tag can be put" substantiates giving examples. (HSE-March 2013)(2)

36. "Conservation of biodiversity is a collective responsibility of all nations". Write a slogan stressing the significance of biodiversity conservation? (HSE-March 2013)(1)

37. Last twenty years alone have witnessed the disappearance of 27 animal species from earth.

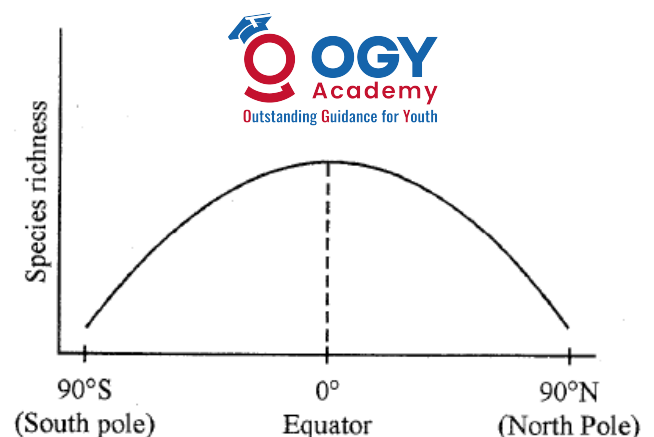
(June 2012)(3)

a) Name the animal disappeared recently

b) What may be the causes of this loss?

c) How can we conserve biodiversity?

38. The given graph shows the distribution of insects in different latitudes of earth (March-2012)(3)



- a)What is your observation ?b)List the three reasons for greater biodiversity in tropical region ?  
c)Write 2 causes of biodiversity loss ?



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