Very Short Answer Type Questions

Q.1. What features make a community stable?

A.1. The following characteristics make a community stable:

- Resistance to infrequent disturbances
- Lesser variation in productivity from year to year
- Impedance to invasions by alien species

Q.2. In the past, which factor would have caused a mass extinction of species?

A.2. As per scientists, the following would have triggered the mass extinction:

- Temperature fluctuation
- Meteorite/Asteroid hitting the planet
- Emission of lethal hydrogen sulphide from the sea
- The outburst of gamma radiations/supernova/Nova
- Plate tectonics

Q.3. What is the reason behind the vast diversity in Indian ecology?

A.3. It can be attributed to the geographical diversity in terms of differing topography such as rain forests, deserts, coral reefs etc, thereby resulting in different varieties of ecosystems with diversity.

Q.4. Name an artificial ecosystem with high productivity.

A.4. Agricultural field of wheat or paddy

Q.5. In the IUCN Red List(2004), what does 'Red' represent?

A.5. It is used to refer to the taxa with the highest risk of extinction.

Q.6. How can the prevailing rate of species extinction be declined by 30% solely through the protection of biodiversity hotspots?

A.6. Hotspots are species-rich, precisely those under human threat hence protecting them can significantly decrease the rate of extinction. They can be preserved as sanctuaries and national parks.

Q.7. State a difference between endemic and exotic species.

A.7. Exotic species are derived into a geographical area from another geographical area whereas endemic species are native species restricted to a particular geographical area.

Q.8. Differentiate between species diversity and ecological diversity.

A.8. The distribution and number of species in an area are referred to as species diversity whereas ecological diversity describes the diversity at the ecosystem level.

Q.9. What is the significance of genetic variation in the *Rauwolfia vomitoria* plant?

A.9. This plant is a source of drug reserpine which serves as a tranquillizer. Its genetic variation can be in terms of the concentration of resperin and potency produced by the plant.

Q.10. Define the Red Data Book.

A.10. It is a collection of records or data of species with the risk of extinction maintained by the IUCN.

Q.11. What is a gene pool?

A.11. In a breeding population, it refers to the sum total of all the genes of every individual.

Q.12. What do you mean by 'Frugivorous'?

A.12. It is used to refer to fruit-eating animals.

Q.13. Expand IUCN.

A.13. International Union for Conservation of Nature and Natural Resources.

Q.14. What is a) Bioprospecting b)Endemism

A.14. a) It is used to illustrate the process of discovery and commercialization of new products basis the biological resources. b) Endemism attributes to the species that are unique to a specific region only. They are not found anywhere else.

Q.15. Write the common feature between species A and B.

A

B

A.15. Both the plants are angiospermic flowering plants.

Q.16. Write the common feature between species A and B

A

B

A.16. Both animals are preserved in their natural habitats.

Q.17. What is a biodiversity hotspot?

A.17. A biodiversity hotspot is a biogeographic region with a large amount of biodiversity that is threatened by human habitation.

Short Answer Type Questions

Q.1. State how the current occurrence of species extinction is different from the earlier mass extinction.

A.1. Species extinction in earlier times occurred due to natural calamities such as volcanic eruptions, landslides, floods etc. while in the present times, the cause of species extinction is human activities.

Q.2. Which of the following according to you is the major cause for loss of biodiversity amongst the four main causes of loss of biodiversity (Habitat loss and fragmentation, alien species invasion, over-exploitation and co-extinctions)? Justify your pick.

A.2. Habitat loss and fragmentation. As it is caused by clearing and over-exploitation of forest land for urbanization and industrialization purposes. Overpopulation has destroyed forests and burdened forest resources. Larger habitats are split into smaller fragments causing birds and mammals to migrate in quest of larger territories thereby resulting in population declination.

Q.3. How can the loss of one species lead to the extinction of another?

A.3. It can be explained via co-extinction, where the extinction of two mutually interrelated species takes place. For instance, the extinction of host fish causes the extinction of all parasites located on it.

Q.4. Can the diversity and productivity of a natural community be constant for over a hundred years?

A.4. No, it is not possible as natural habitat is never maintained in real, resources cannot be available in abundance always and environmental conditions for survival keeps fluctuating.

Q.5. Why is there greater biodiversity in subtropical/tropical regions than in temperate regions?

A.5. It is because these regions are not disturbed due to lesser variations in climatic conditions. This is why species had a long evolutionary time for diversity. The environment in temperate regions is more seasonal and unpredictable, hence lesser species diversity.

Q.6. For the assessment of biodiversity in bacteria, why are conventional methods unsuitable?

A.6. It is because bacteria cannot be cultured in normal conditions which makes it difficult to study their biochemical and morphological characteristics. Hence these are clubbed with a few more characteristics to assess the biodiversity of bacteria.

Q.7. What are the factors that determine a species as threatened?

A.7. The following criteria need to be used in categorizing a species as threatened:

- Declination in the number of species at a distressing rate
- Destruction and modification of their habitat
- Increasing activities of poachers

Q.8. In comparison to other animal groups, why are amphibians more vulnerable to extinction?

A.8. It is because of the following:

- Habitat fragmentation
- Habitat Destruction or Modification
- Large scale climate change

Q.9. How do scientists estimate the total number of species on earth?

A.9. Through two methods:

- Estimation rate of discovery of new species
- Statistical association of tropical and temperate species richness of exhaustively studied assemblages of insects. The ratio is then deduced with the current species to predict the total estimate.

Q.10. State two ways through which humans are benefitted from biodiversity.

A.10. We derive economic benefits from the diversity of entities, such as:

- Food, fibre, firewood
- Industrial products, construction material
- Medicinal products from plants
- Pure oxygen, flood and soil erosion control, natural pollinators
- Recycling of wastes by microbes
- Nutrient restoration

Q.11. Define endangered species with an example for endangered plant and animal species.

A.11. It is a population of species on the brink of extinction. Endangered animal – Siberian Tiger, Endangered plant – Venus fly trap

Q.12. Define sacred groves. What is their role in the conservation of biodiversity?

A.12. They are sacred tracts which are of utmost importance to local communities. They are devoted to ancestral spirits and local deities and are guarded by local communities through taboos and social traditions which include ecological and spiritual values. They are rich in biodiversity nurturing rare plant and animal species and are found in Aravalli hills, Meghalaya, western Ghats etc.

Q.13. Is more solar energy available in the tropics? Justify your answer.

A.13. Yes, it is true. It is because of the following reasons:

- The rays of the sun possess less atmosphere to pass through hence lesser energy is lost in reflection and absorption by the atmosphere
- The rays of the sun are more concentrated
- Presence of dense vegetation causes more absorption of radiations in the tropical rainforests

Long Answer Type Questions

Q.1. Explain how species diversity of an area is reduced by the invasion of an alien species.

A.1. When alien species acquaint a particular habitat either purposely or inadvertently, some of these species resort to invasion thereby causing declination or extinction of native species. For instance – Lantana and water hyacinth have turned invasive, Invasion of Nile perch, a large predator fish, into Lake Victoria in East Africa led to extinction of an ecologically unique collection of more than 200 species of Cichlid fish in the lake. As the Cichlid fish became extinct due to a lack of food, the predatory Nile perch died too.

Q.2. How can the loss of biodiversity be prevented?

A.2. The occurrence of different types of habitat, species, ecosystem, gene pool, and a gene in a particular area in biodiversity. It can be conserved with various conservational strategies and management of abiotic and biotic resources. Listed below are a few conservational strategies:

- Natural conservation or protection of useful plants and animals in their natural habitats.
- Conserving crucial habitats like breeding and feeding areas, facilitating the growth and multiplication of endangered species
- Regulation or banning hunting activities
- Through bilateral or multilateral agreements, habitats of migratory entities should be conserved
- Spreading awareness of the significance of conservation of biodiversity
- Avoiding over-exploitation of natural resources

Q.3. Besides the relationship used by Paul Ehrlich, can you arrive at a scientific explanation to explain the direct association between stability and diversity of an ecosystem?

A.3. It could be as follows: Consider a scenario where diverse species are growing, plants nurture a diversity of species on which an assemblage of insect species are dependent for their food requirements. The dependence severely affects the relying insect species due to the unavailability of food, when this particular plant species die. Additionally, if the plant was a nitrogen fixer, the death of the plant would indicate no restoration of soil nutrients with nitrogen. This would also affect the growth of the plants. If this is followed and occurs regularly, it would put forward a negative impact on the whole ecosystem.

Q.4. Explain the ecosystem service. Write any four ecosystem services rendered by the natural ecosystem. Are you in support of or against imposing a charge on the service given by the ecosystem?

A.4. Ecosystem services are the products of ecosystem processes. The major services of ecological services are forests. Some of their services are:

- Water and air purification
- Droughts and flood alleviation
- Cycling nutrients
- Fertile soil generation
- Rendering wildlife habitat
- Promoting biodiversity
- Crop pollination
- Provisions of a storage site for carbon
- Facilitating cultural, aesthetic and spiritual values

No, not in favour of levying a charge. However, it is necessary to understand what nature is offering for free. Misusing or overusing resources may impose a heavy cost.

Q.5. Why does diversity amongst species decline as we move away from the equator?

A.5. It is because a decline in temperature causes the state to become severe. There is a dip in the intensity and amount of solar radiation and also a decrease in the vegetation is observed. Availability of resources is less to support the assemblage of species. Harsh conditions make the adaptation and survival of species difficult, which results in a decrease in biodiversity as we approach the poles.

Q.6. Write notes on the ‘rivet popper hypothesis’ by Paul Ehrlich.

A.6. He suggested the hypothesis to understand the benefaction of species richness which he arrived at by comparing each species with rivet seen in the aeroplane body. It demonstrates that the ecosystem is an aeroplane and the species, the rivets holding together all the parts. If each passenger began to take rivets home (depicting species extinction), it may hardly affect the safety of the flight initially (representing stable functioning of the ecosystem), eventually, the plane becomes fragile and crash, implying species become endangered and ultimately extinct

How do we measure species diversity within a habitat? How do we compare diversity across different types of habitats containing very different numbers and types of organisms? There are many mathematical models that have been developed to quantify species diversity in different habitats. While these models differ in the exact method of diversity estimation, they all include two important components: species richness and species evenness.

Species richness is a measure of the number of different types of species in an ecosystem. A large number of different species in a habitat represents a higher species richness, and an overall more diverse ecosystem. **Species evenness** is a measure of the relative abundance of each species. More evenly represented species (evidenced by similar population sizes) illustrate a higher species evenness and an overall more diverse ecosystem.

Mathematically, we can determine species richness and species evenness of habitat into a single measure of overall diversity using the following equation:

$D=(P_1^{-p1})\ (P_2^{-p2})\ (P_3^{-p3})\ \ldots(P_n^{-n})$

where D is a measure of the total diversity of the ecosystem, and pn is the proportion of species n. You will practice calculating D values and comparing diversity for different ecosystems in Lab 1: Discovering Diversity.

Exercise 2.2.12.2.1

For the following exercise, consider the four insect communities shown below.

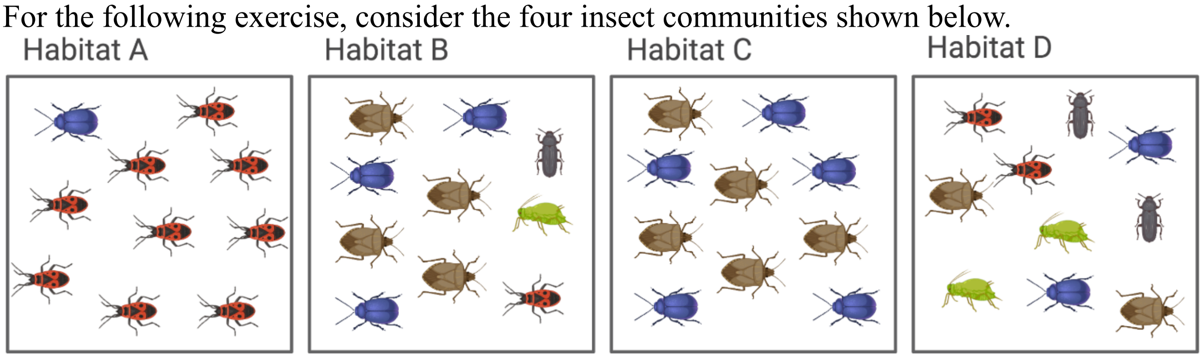


Figure created by L Gerhart-Barley with biorender.com

To determine the diversity value for a given habitat, we must first calculate the number and proportion of species in the habitat and then enter those numbers into the equation provided above.

Habitat A: Habitat A has two species, blue insects and red insects. There are 10 total insects in this habitat, 1 of which is blue and 9 of which are red. Consequently, the proportion of blue insects is 1/10 or 0.1 and the proportion of red insects is 9/10 or 0.9. The D value for Habitat A is then

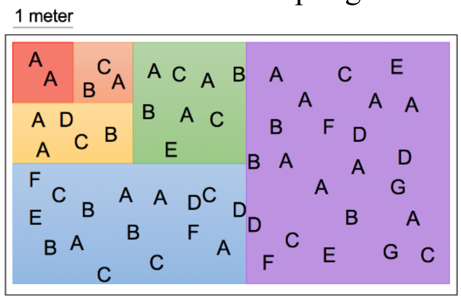
D = (0.1-0.1)(0.9-0.9) = 1.384

Calculate the diversity values for each of the other habitats to determine which habitat has the highest diversity.

Answer

The methodology above is easy to use with small ecosystems that contain a small number of individuals and only a few species. Real ecosystems, however, are very large and can contain hundreds or thousands of species and tens of thousands of individual organisms. In such cases, it is not possible to count every single individual and determine the exact proportion of each species in the entire ecosystem. Instead, we need a method to determine how much sampling is required in order to estimate species diversity with a reasonable degree of accuracy. In this section, we will consider two such methods: species-area curves and rarefaction curves.

Species-area curves show the relationship between the area sampled in an ecosystem (on the x axis) and the number of species found in that area (on the y axis). Figure 1 illustrates how a species-area curve is developed. In the figure, the top box represents the ecosystem being studied, with letters representing individuals of different species. Suppose the researcher begins in the top left corner of the habitat and counts the number of individuals in the 1-meter square box shaded red. There are two individuals, both of Species A, in this area. As the researcher expands the area sampled (into the orange, then yellow, then green, etc areas) the number of individuals counted increases, as does the number of species identified. A summary table of the total area sampled and number of species identified is provided next to the map. In this particular sampling method, the area sampled doubles at each step: the red box is 1 m2, sampling the orange box brings the total area 2 m2, the yellow box to 4 m2, the green box to 8 m2 and so on. The number of species identified in the habitat follows a slightly different pattern. Initially, the number of species found increases rapidly, however, few new species are found as the area increases, to the point that the line in the graph begins to taper off after about 16 m2. The resulting species-area curve suggests that the researcher has likely already found all (or at least the vast majority of) species present in this ecosystem and that additional sampling would not discover more species.



Area (m^2)	Number of Species
1	1
2	3
4	4
8	5
16	6
32	7

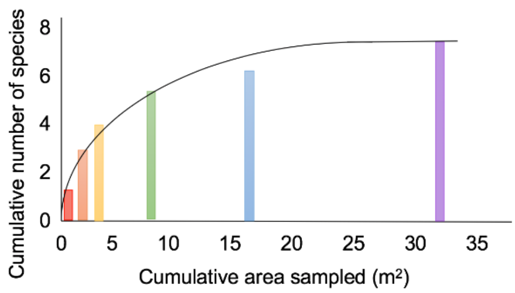
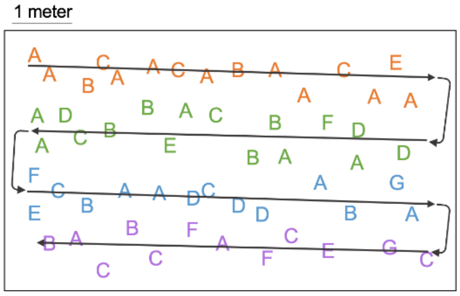


Figure by L Gerhart-Barley

A similar method for estimating ecosystem diversity is a **rarefaction curve**, which is similar to a species-area curve, but focuses on the number of individuals sampled as opposed to the area. Figure 2.2.3 illustrates how a rarefaction curve is developed. Suppose another researcher samples the same area shown in Figure 2 and also begins in the top left corner, following the sampling path represented by the gray arrows. The researcher works their way through the ecosystem noting each individual organism and whether or not it represents a species already found in the ecosystem. A summary table of the number of individuals and species counted is provided next to the map. The number of individuals counted progresses rapidly, while the number of species identified tapers off after about 45 individuals sampled. The resulting rarefaction curve suggests that the researcher has likely already found all (or at least the vast majority of) species present in this ecosystem and that additional sampling would not discover more species.



Number of Individuals	Number of Species
5	3
15	4
25	6
35	6
45	7
57	7

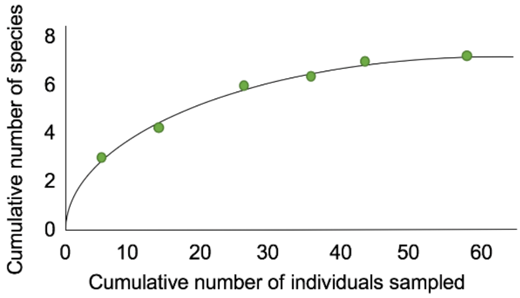


Figure by L Gerhart-Barley

The species-area curve and rarefaction curves look quite similar, and indeed they should, since the primary difference in the two methodologies is how we define sampling 'effort' on the x axis – through area surveyed (species-area curve) or through number of individuals counted (rarefaction curve). In both cases, the researcher sampled the entire area shown in the map, which should result in a similar estimate of species diversity for the ecosystem. Which sampling method is used depends on the characteristics of the ecosystem and species to be sampled. You will practice sampling the diversity of an ecosystem and developing a rarefaction curve of your data in Lab 1: Discovering Diversity.

Earth's Biodiversity

How many species exist on Earth? This is a question that scientists have attempted to answer for centuries, beginning with Carl Linnaeus' first steps towards naming and classifying organisms in *Systema Naturae* in 1735. Linneaus himself described over 12,000 species and in the nearly 300 years since, scientists have formally described and studied over a million more. Have scientists already discovered all, or most, of the species that live on Earth? If not, how many more remain to be discovered? These questions are inherently difficult to answer because they require us to estimate how much we *don't* know; how many species scientists have *not* discovered. This difficulty is compounded by the fact that certain regions of Earth and certain group of organisms have been much more heavily studied than others and so we know the diversity of organisms that is currently documented is somewhat biased.

Many studies have attempted to estimate the total biodiversity of Earth and, with varying methodologies, have produced estimates anywhere from 2 million to over 100 million species. Recently, Dr. Camilo Mora (at the University of Hawai'i, Mānoa) and his colleagues reviewed the various estimates and tested a new methodology to narrow down this large range to a plausible estimate. In the study, Mora used a similar strategy to the species-area and rarefaction curves described above; however, the estimate of 'effort' on the x-axis was not the area or number of individuals sampled, but time. Scientists have been described approximately 1.2 million species since the mid 1700's; has the number of new species described every year begun to level off? If so, that might indicate that most species have been discovered. If not, perhaps we can use the trend in new species discovered through time to predict where the graph might begin to level off. Mora's team also considered higher taxonomic levels; we can be relatively certain that scientists have not yet discovered every single species on Earth, but might scientists have already described all the genera, families, orders, classes, or phyla? The results of Mora's analysis are shown in Fig 3. By using the pattern of discovery of new organisms at different taxonomic levels (Fig 3A-F) and the relationship between maximum diversity of each level (Fig 3G), Mora's team arrived at an overall estimate of 8.7 million species on Earth. Since scientists have currently described approximately 1.2 million species, this estimate indicates that approximately 86% of species on Earth have not yet been discovered. At our current rate of discovery, Mora's team estimated that it will take scientists another 1,200 years to identify all species on Earth.