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UPSC CSE PRELIMS

ENVIRONMENT & ECOLOGY

for CIVIL SERVICES EXAM

- 360° coverage of the syllabus of Environment & Ecology for Prelims including Hidden Dimensions
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ENVIRONMENT & ECOLOGY

for UPSC PRELIMS

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Preface

In the last decade, Environment and Ecology has created a niche for itself. Every year at least 8-10 questions are asked in the Prelims Examination. These questions can be a game changer and hence one should focus on not getting these questions wrong. This book has summarised all the important topics in a very lucid and effective manner. We have also assimilated the Previous Year Questions in the book in order to keep the preparation as per the UPSC framework.

This book comprises topics related to Ecology and Ecosystem, Functions of an Ecosystem, Population Ecology, Adaptation and Interaction of Species, Types of Ecosystems, Nutrient Cycling, Biodiversity & its Conservation, Aquatic Ecosystems and Forest Resources, Pollution and Degradation, Water Degradation, Waste Management, Climate, Climate Change Management, Renewable Energy, Environmental Governance, Environmental Impact Assessment, and Sustainable Practices. The topics and their sub-topics have been comprehensively covered in the book.

One of the distinguishing characteristics of the book is that it covers a wide canvas of Environment and Ecology. The text of the book has been written in a lucid, cogent, and convincing style, document with interesting data, diagrams, and illustrations with apt and appropriate examples. The material covers all important and relevant facts and material required to be studied by aspirants in a single booklet. This helps to ease their preparation and provides consolidated and complete UPSC Prelims notes in one place.

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CONTENTS

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Unit 1

ECOLOGY & ECOSYSTEM

CHAPTER
1.1

ORIGIN OF LIFE FORMS

EVOLUTION OF EARTH

- Geologists estimate that the earth is somewhat **4.5 billion year old.**
- The beginning of geological era, the Precambrian, which extended from **4.5 to 0.5 billion** year's ago, witnessed the production of an atmosphere and a hydrosphere. The evolution of preliving components and their autotrophic life takes place thereafter.
- The internal reorganization of Earth and the development of ocean basins and continents took place simultaneously.
- On the whole over the years of the geological past, the Earth's geomorphology, climate and biotic community changed gradually. In early Paleozoic era (just after Precambrian) some million years ago, there were separate land masses existed in earth viz Asia, North America and Europe and Gondwanaland (which includes present day Africa, South America, Australia, New Zealand and Antartica).
- During late Palaeozoic era around **420 million** years ago, North America and Africa lay close together around the south pole and the rest of Gondwanaland lay on the far side of the south pole, pointing towards the equator. Subsequently such land mass slowly moved northward by carboniferious period **(340 millions years ago).**
- During the Permian periods, however, all three blocks of land masses joined together forming a single landmass called **"Pangaea"**, which further moved north ward, and began to break apart slowly by mid Mesozoic period.
- Subsequently, by the mid-cretaceous (about 100 million years ago), Africa and South America had split apart and also by the end of cretaceous period, Gondwanaland had broken up. But North America land remained intact till lower Eocene period.
- Then it split into North America and Europe connected by Greenland and Scandinavia. Thus the formation, breakup and northward drift of continents resulted in broad climate changes and the formation of geological barriers that affected evolving plant and animal's life.

ORIGIN OF LIFE FORMS

- Aerobic life cannot exist without oxygen, which was not a part of the original atmosphere. However, life in the form of primeval bacteria and algae evolved without oxygen; these life-forms consumed carbon dioxide and nitrogen, which were in the original atmosphere, and emitted oxygen as a waste.
- In addition to adding oxygen to the atmosphere, this process also formed the ozone layer, which filters out harmful ultraviolet radiation from the sun. The first life-forms evolved in the seas.
- As indicated in Table, there is evidence of life-forms as early as **3,500 mya,** of an **ozone layer 2,500 mya**, and of a **breathable oxygenated atmosphere 1,700 mya.** Such early life-forms were not affected by the absence of an ozone layer because they lived below the surface of the water.
- Oxygen-breathing life, initially single and later multi-celled, appeared following the creation of a suitable atmosphere. **Soft-bodied** animals, comparable to jellyfish, evolved **650 mya,** and **shelled animals** about **70 million years** later.
- Human ancestors diverged from the **ape line** approximately **6 mya.** The most compelling evidence of a common origin is that humans and chimpanzees differ in only about 1 per cent of their genes; this means that these species could not have been evolving separately for more than about 6 million years.

Eons	Era	Period	Epoch	Age/Years Before Present	Life/Major Events
	Cainozoic (From 65 million years to the present times)	Quaternary	Holocene	0 - 10,000	Modern Man
			Pleistocene	10,000 - 2 Million	Homo Sapiens
		Tertiary	Pliocene	2 - 5 Million	Early Human Ancestor
			Miocene	5 - 24 Million	Ape: Flowering Plants and Trees
			Oligocene	24 - 37 Million	Anthropoid Ape
			Eocene	37 - 58 Million	Rabbits and Hare
			Palaeocene	57 - 65 Million	Small Mammals: Rats - Mice
	Mesozoic 65-245 Million	Cretaceous		65 - 144 Million	Extinction of Dinosaurs
		Jurassic		144 - 208 Million	Age of Dinosaurs
		Triassic		208 - 245 Million	Frogs and turtles
	Palaeozoic 245 - 570 Million	Permian		245 - 286 Million	Reptile dominate-replace amphibians
		Carboniferous		286 - 360 Million	First Reptiles: Vertebrates: Coal beds
		Devonian		360 - 408 Million	Amphibians
		Silurian		408 - 438 Million	First trace of life on land: Plants
		Ordovician		438 - 505 Million	First Fish
		Cambria		505 - 570 Million	No terrestrial Life: Marine Invertebrate
Proterozoic	**Pre Cambrian** 570 Million - 4.800 Million			570 - 2,500 Million	Soft-bodied arthropods
Archean				2,500 - 3,800 Million	Blue green Algae: Unicellular bacteria
Hadean				3,800 - 4,800 Million	Oceans and Continents form - Ocean and Atmosphere are rich in Carbon dioxide
Origin of Stars	5,000 - 13,700 Million			5,000 Million	Origin of the sun
Supernova				12,000 Million	Origin of the universe
Big Bang				13,700 Million	

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CHAPTER
1.2

ECOLOGY & ECOSYSTEM

ENVIRONMENT

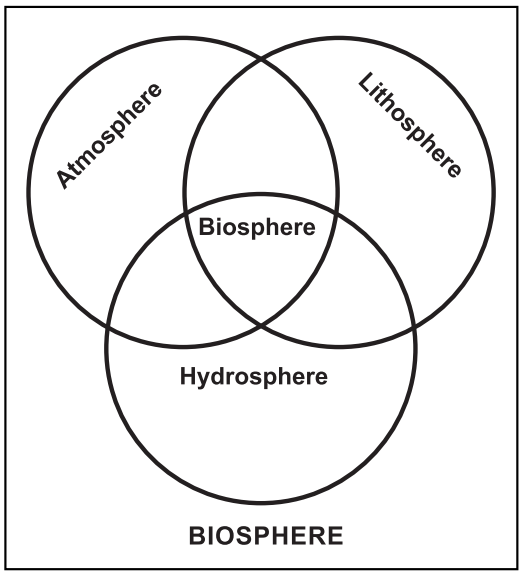
- The environment is defined as 'the sum total of living, nonliving components; influences and events, surrounding an organism'.
- Everything that surrounds or affects an organism during its life time is collectively known as its environment which comprises both living (biotic) and nonliving (abiotic) components.

Components of Environment:

- Abiotic Components: Soil, Topography, Water, Atmosphere etc.
- Biotic Components: Green Plants, Non-Green Plants, Animals, Parasites, Decomposers etc.
- The environment is not static. Both biotic and abiotic factors are in a flux and keeps changing.

WHAT IS BIOSPHERE?

- Biosphere is the life supporting layer which surrounds the earth and makes existence of life possible without any protective layer.
- The biosphere consists of living organisms, physical environment and energy. It is the zone of assemblage of lithosphere, atmosphere, hydrosphere and living organisms together.
- There are three components of biosphere, are:
  Biotic or organic components: It includes micro-organisms, plants and animals including man.
  - **Inorganic or abiotic component:** It includes physical environment of soil, water, air, temperature and sunlight.
  - **Energy component:** Solar and geothermal energy etc.
- Biosphere is termed as an open system as there is continuous inward and outward flow of energy and matter.



- Biosphere always tends to maintain an equilibrium between flow of energy and output of the matter. If this equilibrium is maintained environmental and ecological balances are also maintained. Disturbances in the biosphere equilibrium bring ecological and environmental disturbances which have long term or short term effects on the very existence of living beings.
- Biosphere is affected and modified by certain factors directly or indirectly. These factors are called as **modifiers.** Three types of biosphere modifiers are known:
  - **Physical modifiers:** They affect the biosphere by change in air quality, air flow, temperature changes, water flow, fire, excavation and construction works.
  - **Chemical modifiers:** It alters the chemical composition of air, water and soil. It may be brought in due to multitude of pollutants.
  - **Biological modifiers:** Biological factors like cropping patterns, population pressures, manipulations of species density or distribution and species genetics can also modify the biosphere equilibrium.

WHAT IS ECOLOGY?

- Ecology deals with the inter-relationships amongst organisms and interactions between organisms and their environment. In other words, Ecology is the study of organism in relation with the surrounding in which they live. The surrounding is the environment of the living organisms and nonliving things in the vicinity.
- The term Ecology is being derived from two Greek words namely, **'Oikos' meaning home or place to live in and 'logos' means study**. It means the study of the home of nature.

DIFFERENCE BETWEEN ECOLOGY, ENVIRONMENT AND ECOSYSTEM

- **Ecology** is the scientific study of the reciprocal relation between organisms, including microbes, plants, animals as well as man, with their environment.
- The term **Environment** is defined as "the sum total of living, nonliving components; influences and events, surrounding an organism".
- The complex natural organisation with their living and non-living environments that controls them and from which the living organisms derive their sustenance are technically called as **'Ecosystem'** or an **'ecological system'**.

Types of Ecology

- **Autecology/Species Ecology:** The study of reciprocal relationships between every stage of development of a population/species and its environment is called autecology.
- **Synecology:** It is the study of reciprocal relationships between composition, organization and development of communities and their environment. Synecology is further divided into following:
- **Population Ecology:** Study of interactions of individuals- population of single species with each other.
- **Community Ecology:** The study of inter-relationships and inter-dependencies of groups of individuals of distinct species of plants, animals and micro-organisms together.
- **Biome Ecology:** The study of interactions and interrelationships of more than one biological communities in various stages of succession under similar climatic condition of the area concerned in the study.
- **Ecosystem Ecology:** The study of interactions and inter-relationships of all organisms among themselves and with their environment.
- **Habitat Ecology:** Habitat is an ecological area which is inhabited by a species of living being. Habitat ecology studies variation in habitats in terms of their physical characteristics like topography, soils, insolation, temperature, water, minerals, weather and climate etc. Habitat ecology is further divided on the basis of different habitats and their mutual relationship with their inhabitants into forest ecology, grassland ecology, fresh water ecology, estuarine ecology, island ecology, marine ecology, coral reef ecology etc.
- **Applied Ecology:** It is the study of specialized field of ecology which are concerned with conservation and economic exploitation of organisms e.g., agronomy, agriculture, animal husbandry, forestry, wildlife management, conservation ecology, pollution ecology.
- **Systems Ecology:** Branch of ecology dealing with interpretation of ecological concepts and processes in terms of mathematical models and formulae.
- **Genecology:** Study of genetic composition and changes in relation to the origin of ecotypes, new species, etc.
- **Social Ecology:** It is a critical social theory of American socialist **Murray Bookchin**. It advocates a constructive and transformative outlook on current social and environmental issues. It suggests that the roots of the current ecological and social problems can be traced in the unordered modes of social organization. It says that apart from the natural disasters, majority of the concurrent ecological dislocations have ethnic, economic, cultural and gender conflicts among others. It also says that the present ecological problems cannot be resolved without dealing with the problems of society.

Levels of Organisations in Ecology

- **Individual (Organism):**
  - It is the basic unit of ecological hierarchy.
  - Every individual functions separate from those in other individuals. It continuously exchanges materials and information with its environment.
  - New individuals develop from pre-existing ones. Hereditary characters are transferred during this process. The constituents of an individual cannot survive independently.
- **Population:**
  - It is a grouping of similar individuals in a geographical area or space during specific time.
  - The different populations of the same organism

present in any geographical area are called **local populations/ demes.**

- A local population adapted genetically to its environment is called **ecotype**. There may be several ecotypes of the same organism which show variations amongst them.

Biological or Biotic Community:

- It is an assemblage of populations of distinct species of plants, animals, bacteria and fungi which live in a particular area and interact with one another through several positive and negative interactions among them.

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Q1: Which one of the following is the best description of the term "ecosystem"?

(a) A community of organisms interacting with one another
(b) That part of the Earth which is inhabited by living organisms
(c) A community of organisms together with the environment in which they live
(d) The flora and fauna of a geographical area

Correct Option: (c)

- Each biotic community has a specific composition and structure, e.g., pond community.
- On the basis of size and degree of relative independence communities may be divided into two types: Major Communities and Minor Communities.
  - ***Major Communities:*** These are large sized, well organized and relatively independent. They depend only on the sun's energy from outside. Eg: Tropical evergreen forests.
  - ***Minor Communities:*** These are dependent on neighbouring communities and are often called societies. They are secondary aggregations within a major community and therefore are not completely independent. Eg: A mat of lichen on a cow dung pad.

Ecosystem:

- It is a segment of nature consisting of a biological community and its physical environment both interacting and exchanging materials as well as energy, e.g., pond ecosystem.

Biome:

- A large regional unit delimited by a specific climatic zone, having a particular major vegetation zone and its associated fauna, e.g., tundra desert, temperature deciduous forest, tropical rain forest, ocean.
- **No two biomes are alike.** The climate determines the boundaries of biomes and abundance of plants and animals found in each one of them. The most important climatic factors are temperature and precipitation.

Biosphere:

- It is biologically inhabited part of earth along with its physical environment consisting of lower atmosphere, land and water bodies.

WHAT IS ECOSYSTEM?

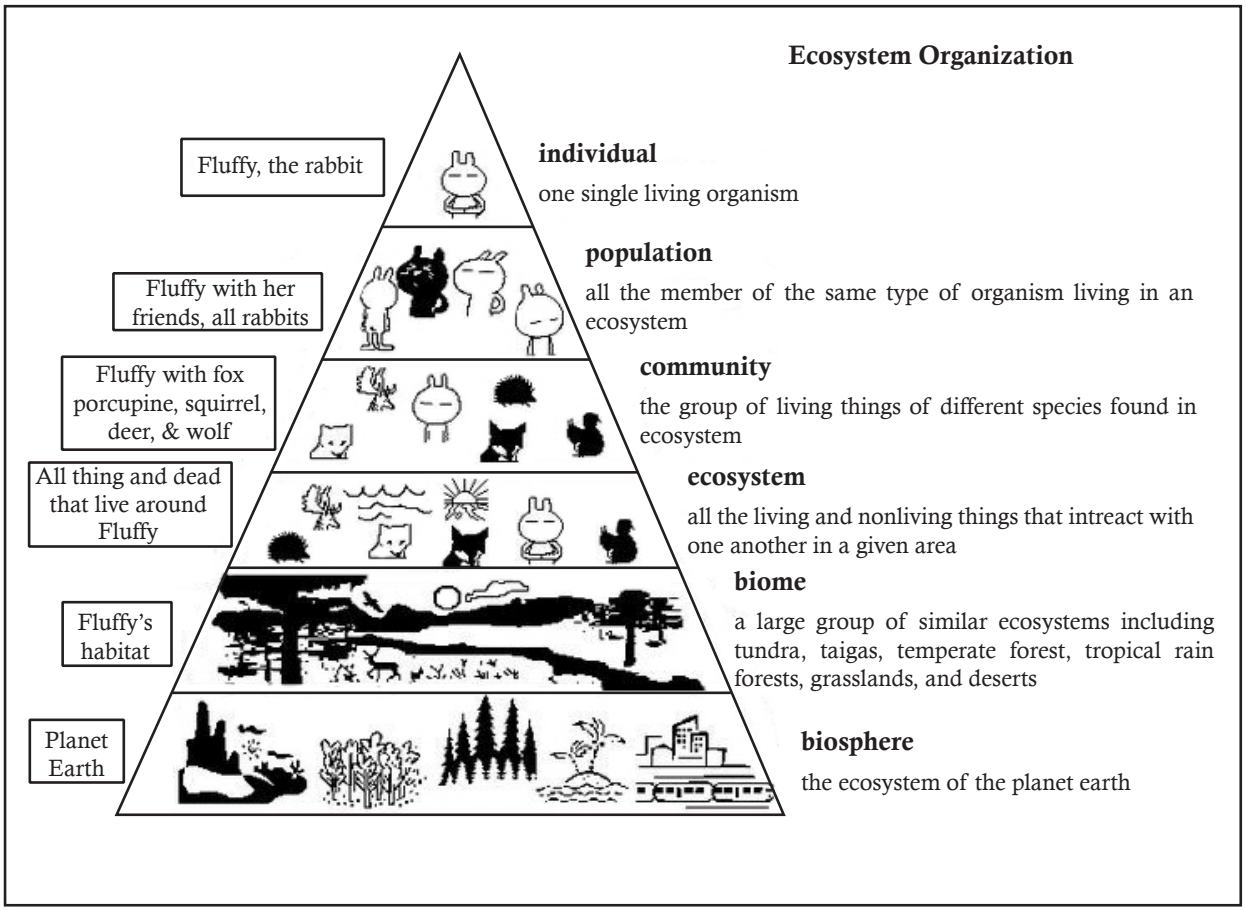
- An ecosystem is defined as a structural and functional unit of biosphere consisting of community of living beings and physical environment, both interacting and exchanging materials between them. Ecosystem is a self-contained, dynamic system composed of a natural community along with its physical environment.

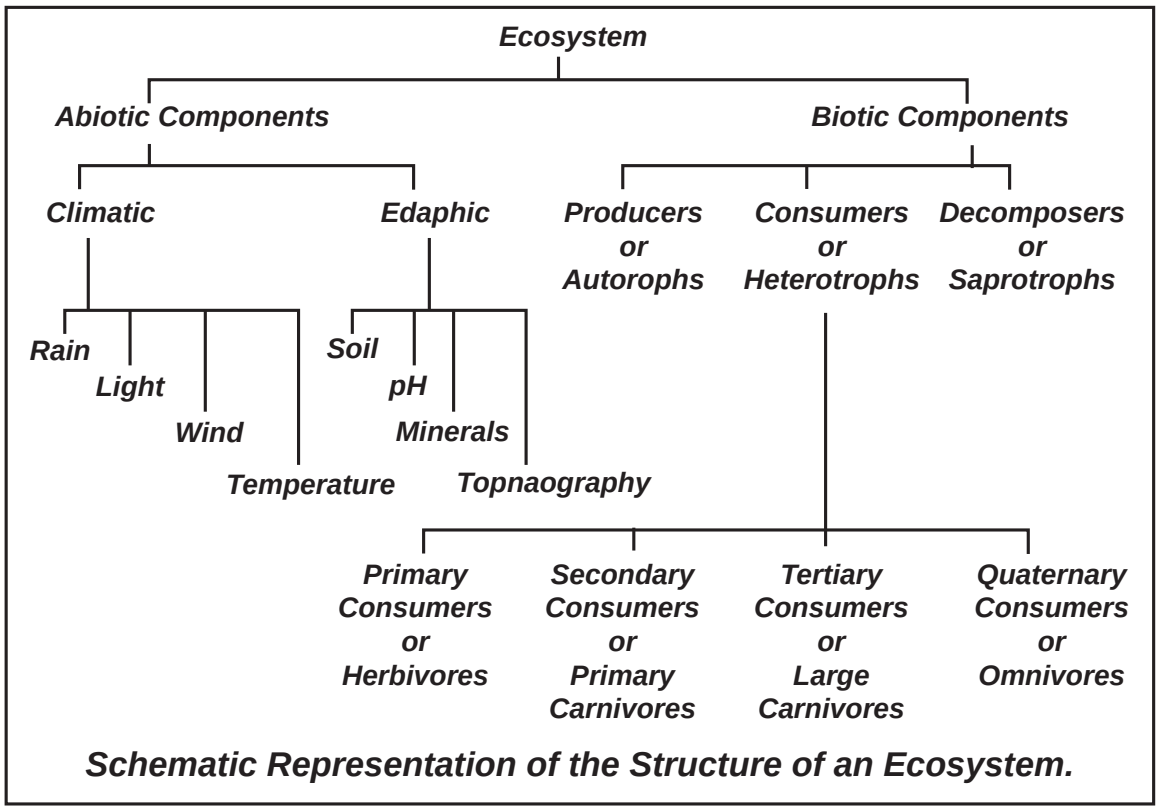
Classification of Ecosystem:

- Terrestrial ecosystems:Forest, grassland and desert are some examples of terrestrial ecosystems
- Aquatic ecosystems:Pond, lake, wetland, river and estuary are some examples of aquatic ecosystems.
- Human-made ecosystems:Crop fields and an aquarium are human-made ecosystems.

Components of Ecosystem

- The components of the ecosystem are divided as:
- **Abiotic Components**
  - Abiotic components are non-living chemical and physical factors on an ecosystem. The non-living factors are either resources or conditions. Important abiotic components can be listed as follows:
  - **Physical factors:** They sustain and limit the growth of organisms in an ecosystem.
    - **Light:** Light energy (sunlight) is the primary source of energy in nearly all ecosystems. It is the energy that is used by green plants (which contain chlorophyll) during the process of photosynthesis; a process during which plants manufacture organic substances by combining inorganic substances.
    - **Temperature:** The distribution of plants and animals is greatly influenced by extremes in temperature.
    - **Water:** The life on earth originated in water and is unsustainable without water.





Schematic Representation of the Structure of an Ecosystem.

- **Atmospheric gases:** The most important gases used by plants and animals are oxygen, carbon dioxide and nitrogen. Oxygen is used by all living organisms during respiration. Carbon dioxide is used by green plants during photosynthesis. Nitrogen is made available to plants by certain bacteria and through the action of lightning.

- **Soil:** Various characteristics of the soil such as soil composition, grain size and aggregation determine the percolation and water holding capacity of the soils. These characteristics along with parameters such as pH, mineral composition and topography determine to a large extent the vegetation in any area. This in turn dictates the type of animals that can be supported.

➤ **Organic compounds:** They are the building blocks of living systems and therefore, make a link between the biotic and abiotic components. Examples are: Carbohydrates, proteins, lipids and humic substances.

➤ **Inorganic compounds:** Such as carbon, carbon dioxide, sulphur, nitrates, phosphates and ions of other metals are necessary for survival.

⊙ **Biotic Components**

➤ The biotic components in an ecosystem include the living organisms. They are grouped in to 3 classes based on the organism's role in the flow of material and energy within the ecosystem:

⊙ **Producers (Autotrophs):**

➤ Autotrophs produce organic compounds from carbon dioxide as a carbon source. They take energy from the sun (or from inorganic sources in some cases) to convert it into organic molecules or food, e.g., plants, algae, bacteria, etc.

➤ A portion of food synthesized, is used by autotrophs for their growth and other biological functions and remaining is stored for future use. This stored food in autotrophs is utilized as food by other organisms (called heterotrophs).

⊙ **Consumers (Heterotrophs):**

➤ They are called heterotrophs and they consume food synthesized by the autotrophs. Based on food preferences they can be grouped into three broad categories:

- Herbivores (e.g. cow, deer and rabbit etc.) feed directly on plants, carnivores are animals which eat other animals (eg. lion, cat, dog etc.) and omnivores organisms feeding upon both plants and animals e.g. human, pigs and sparrow.

⊙ **Decomposers:**

➤ Decomposers are organisms (often fungi or bacteria) that break down organic materials to gain nutrients and energy. Decomposition is a natural process but decomposers accelerate it. The role that decomposers perform in an ecosystem is extremely important.

➤ When an organism dies, it leaves behind nutrients that are locked together.

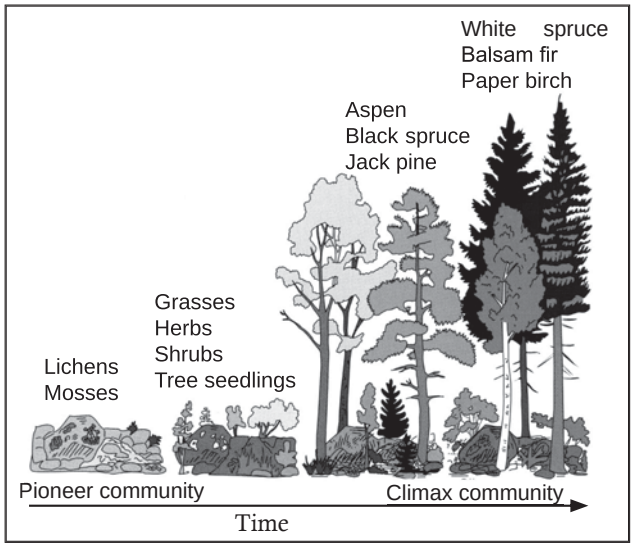
➤ Decomposers unlock these nutrient and release as raw nutrients (such as nitrogen, phosphorus, and magnesium) in a form which are usable for plants. Decomposers also convert organic carbon into Carbon dioxide, which can be trapped by photosynthesizers.

⊙ ECOLOGICAL SUCCESSION

⊙ **Ecological Succession** is the process by which a natural community moves, through a sequential change in the structure and composition, from a simpler level of organization to a more complex community.

⊙ Succession is a long-term cumulative, directional and largely predictable process of natural development of different communities at the same site in a definite sequence over a period of time. Such changes occur either in response to an environmental change or induced by the intrinsic properties of the community itself.

⊙ Succession continues till a community develops maximum equilibrium to the environment. It is called **Climax Community.**



Features of Succession

⊙ Succession is characterised by the following: increased productivity, the shift of nutrients from the reservoirs, increased diversity of organisms with increased niche development, and a gradual increase in the complexity of food webs.

Types of Succession

⊙ Ecological Successions have been described using several criteria. Accordingly, there are several types of succession.

- **Autogenic and Allogenic Succession**
  - When succession is brought by living inhabitants of that community is called Autogenic Succession, while changes brought by outside forces is known as Allogenic Succession.
- **Induced Succession**
  - Man has controlled succession in such a way as to obtain a managed steady state in which good amount of organic matter can be harvested. It is called induced succession. In induced succession, like agriculture, a young state is maintained by various types of inputs and protective measures.
- **Deflected Succession**
  - It is a succession in which the vegetation does not pass through the normal stages of development but either adds or replaces a succession type, e.g., ABB'CDE or AB'CDE instead of the normal ABCDE.
- **Primary Succession**
  - It is the succession that takes on a primary bare area or an area which was not previously inhabited by plants. Such an area is biologically sterile and is, therefore, quite hostile in starting. Succession is also slow.
- **Secondary Succession**
  - It occurs on a site which has become bare secondarily due to destruction of previous vegetation. The area is biologically fertile and hence favourable for reappearance of plant life. Succession is quite rapid.
- **Autotrophic and Heterotrophic Succession**
  - Succession in which initially the green plants are much greater in quantity is know as Autotrophic Succession; and the ones in which the heterotrophs are in greater in quantity is known as Heterotrophic Succession.
- **Cyclic Succession**
  - A pattern of succession where the climax community is destroyed again and again and a similar pattern of secondary succession repeats itself every time.

Primary Succession	Secondary Succession
Begins with no life	Follows removal of existing biota
No Soil present	Soil already present
New area (e.g. volcanic island)	Old area (e.g. following a bush fire)
Lichen and moss come first	Seeds and roots already present
Biomass is low	Biomass is higher

The Process of Succession

- The characteristic sequence of the successional stages includes 8 elementary processes, namely:
  - **Nudation**

    It is the creation of bare area. Nudation can occur due to physiographic, climatic or biotic agents.
  - **Migration**
    - Migration starts when gemmule moves from the parent area and arrive in a new area. A gemmule consists of reproductive structure like seed, spore or propagule. Migration is influenced by four factors–mobility, agent, distance and topography.
  - **Colonization**
    - The nature of topography of the bare area also determines the type of the initial vegetation. For example, on bare rock only the spores of some cyanophytes or the soredia of lichens can stick and germinate while in a saline area only the seeds of some halophytes can grow. The first arrivals in a bare area are called **Pioneers** or **pioneer colonizers**. The occupation of a bare area by the pioneers and other invaders is called **colonization**.
  - **Ecesis**
    - The establishment of plants in a new place is called **ecesis**. It consists of three processes-germination, growth and reproduction.
  - **Aggregation**
    - It is the increase in number of the colonizing individuals. In the beginning the pioneers are few in number and grow far from one another. They produce a large number of disseminules which spread in the open areas and increase the number of pioneers. If invasion continues and the invaders are also able to multiply, the phenomenon is called **Mixed Aggregation.**
  - **Competition**
    - It may be intra-specific (among individuals of the same species) or inter-specific (among individuals of the different species). Competition occurs when the availability of a necessity becomes inadequate to meet the optimum requirement of all the individuals growing in that area.
  - **Invasion**
    - Various other types of plants try to establish in the space left by the elimination of plants due to competition.
  - **Reaction**
    - It is the change brought about by colonizers in the habitats. The first reaction is localized.

It consists of such changes as bindings of soil particles, assisting in weathering or building soil at the bottom of a water reservoir. Death of roots produces channels in the soil for quick absorption of rain water. Humus produced by the death of older or weak plants increases water retention, aeration and nutrition of the soil. The reaction of the early colonizers is such as to make the habitat less favourable to them and more favourable to invaders.

- **Stabilization**
  - Continuous competition invasion and reaction give rise to continuous changes in the environment and structure of vegetation. After a long interval some individuals arise which are in complete harmony with the climate of the area. This is termed as stabilization.
  - The sequence of the above stages is termed as **sere.**
  - Depending upon the nature of the habitat on which the plant succession begins seven types of seres may be distinguished:
    - **1. Hydrosere, 2. Xerosere, 3. Lithosere, 4. Psammosere, 5. Halosere, 6. Senile, 7. Eosere or Geosere**

ECOTONE

- An ecotone is a zone of junction or a transition area between two biomes (diverse ecosystems). It is the zone where two communities meet and integrate. For e.g. the mangrove forests represent an ecotone between marine and terrestrial ecosystem.

Characteristics of Ecotone:

- It may be narrow (between grassland and forest) or wide (between forest and desert).
- It has conditions intermediate to the adjacent ecosystems. Hence it is a zone of tension.
- It is linear as it shows progressive increase in species composition of one in-coming community and a simultaneous decrease in species of the other out-going adjoining community.
- A well-developed ecotone contains some organisms which are entirely different from that of the adjoining communities.
- Sometimes the number of species and the population density of some of the species are much greater in this zone than either community. This is called edge effect.
- The organisms which occur primarily or most abundantly in this zone are known as edge species. In the terrestrial ecosystems edge effect is especially applicable to birds. For example, the density of birds is greater in the ecotone between the forest and the desert.

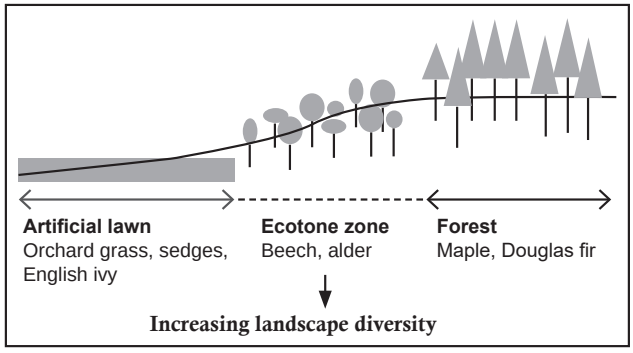
EDGE EFFECT

Ecotone is a transitional area of vegetation between two different plant communities, such as forest and grassland.

- It has some of the characteristics of each bordering biological community and often contains species not found in the overlapping communities.
- An ecotone may exist along a broad belt or in a small pocket, such as a forest clearing, where two local communities blend together.
- The influence of the two bordering communities on each other is known as the **edge effect.**

Ecocline

- It is a zone of gradual but continuous change from one ecosystem to another when there is no sharp boundary between the two in terms of species composition.
- It occurs across the environmental gradient (gradual change in abiotic factors such as altitude, temperature (thermocline), salinity (halocline), depth, etc.).



Niche

- It refers to the unique functional role and position of a species in its habitat or ecosystem.
- The functional characteristics of a species in its habitat are referred to as "niche" in that common habitat.
- In nature, many species occupy the same habitat, but they perform different functions:
  - Habitat niche – where it lives,
  - Food niche – what is eats or decomposes & what species it competes with,
  - Reproductive niche – how and when it reproduces,

- Physical & Chemical niche – temperature, land shape, land slope, humidity & another requirement.

RANGE OF TOLERANCE (MAXIMUM RANGE)

- A factor that limits growth, development, reproduction or activity of an organism by its deficiency or excess is called **limiting factor** while the unfavourable impact of limiting factor is called **limiting functions.** Low temperature is a limiting factor for growth at high altitude, water availability in deserts and low phosphorus for phytoplankton growth in deep lakes.

- **Range of tolerance** is the range between critical minimum and critical maximum limits of environmental factor/factors influencing an organism.
- According to law of tolerance, the abundance and distribution of organisms is controlled by their limits of tolerance (critical minimum and critical maximum) to ecological factors.

- Niche plays an important role in the conservation of organisms. If we have to conserve species in its native habitat, we should have knowledge about the niche requirements of the species.

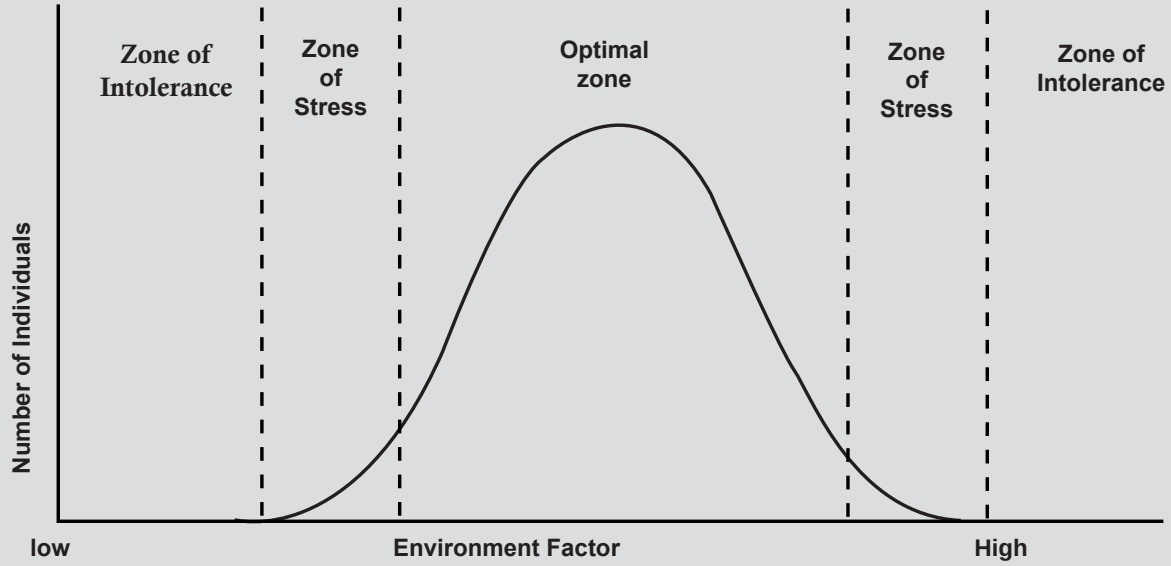


Figure: ShelFord's law of tolerance. A plot of the number of individuals of a species as a function of some environmental factor (such as temperature) produces a bell-shaped curve that can be divided into various tolerance zones.

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5. Art & Culture
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1. Governance
2. Indian Polity
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1. Disaster Management
2. Environment
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4. Indian Economics
5. Internal Security

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3. **Governance**
4. **Indian Society**
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6. **Indian Geography**
7. **Physical Geography**
8. **Environment**
9. **Internal Security**
10. **International Relations**
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1. **Environment & Ecology**
2. **Indian Geography**
3. **Physical Geography**
4. **Human & Economic Geography**
1. **Ancient & Medieval History**
2. **Art & Culture**
4. **Modern History**
4. **Indian Economy**
5. **Science & Technology**
6. **Indian Polity**
7. **Governance**

CONCEPT MAPPING WORKBOOK

1. **Environment & Ecology**
2. **Geography**
3. **History Vol 1 (Modern History)**
4. **History vol 2**
   (Ancient + Medieval + Art & Culture)
5. **Polity & Governance**
6. **Indian Economy**

WORKBOOK

MAINS

GS PAPER 1
1. Geography
2. Modern History
3. Art & Culture
4. World History
5. Indian Society

GS PAPER 2
1. International Relations
2. Indian Polity
3. Governance

GS PAPER 3
1. Indian Economy
2. Environment
3. Internal Security
4. Science & Technology
5. Disaster Management

GS PAPER 4
1. Ethics Section A
2. Case Study

ESSAY WRITING

PRELIMS

1. Prelims Practice Workbook- **NCERT**
2. Prelims Practice Workbook **- Previous Year Questions**
3. Prelims Practice Workbook **- Advance Questions**

OPTIONAL FOUNDATION NOTES

ANTHROPOLOGY
1. Anthropology Paper - 1
2. Anthropology Paper - 2

GEOGRAPHY
1. Economic & Human Geography
2. Indian Geography
3. Physical Geography

HISTORY
1. Ancient History
2. Medieval History
3. Modern History
4. World History

POLITICAL SCIENCE
1. Pol. Science Paper - 1
2. Pol Science Paper - 2

PUBLIC ADMINISTRATION
1. Pub. Ad. Paper - 1
2. Pub. Ad. Paper - 2

SOCIOLOGY
1. Sociology Paper - 1
2. Sociology Paper - 2

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