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Civil Services Examinations

Environment, Ecology and Biodiversity

SIERRA INNOVATIONS

Environment, Ecology and Biodiversity

1 CHAPTER Ecology

Year		2013		2014		2015		2016		2017		2018		2019		2020		2021		2022		2023	
Pre	Mains	-	-	1	-	-	-	-	-	-	-	-	-	-	1	-	-	2	-	-	-	-	-

Ecology

'Ecology' - Greek words- 'Oikos = household + 'logos' = learning about the ecosystem.
Scientific **study of the interactions** between organisms and their environment.
First coined by **Ernst Haeckel in 1869**.
Objective- to **improve the understanding of different life processes, adaptations and habitats, interactions, and biodiversity** of organisms.

Types of ecology

- Autoecology: Study of individual organism or individual species
- Synecology: Study of group of organisms of different species which are associated together as a unit in the form of a community.

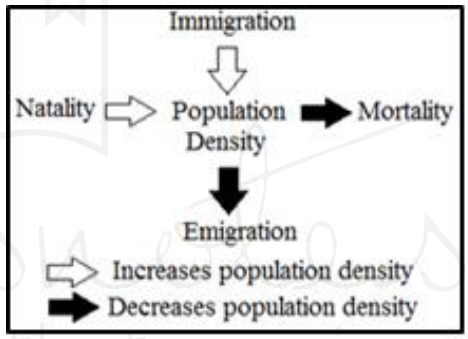
Species Types	Features	Example
Keystone Species	• **Determine the ability of a large number of other species to survive.** • **Extinction of keystone species** → extinction of **other species.**	**Bees** → pollination of fruits and flowers
Indicator Species	• **indicator of the state/**certain processes **of/**within **an ecosystem** • most sensitive species in a region. • **early warning** for ecological threat.	**Lichens** - air pollution, **Mayflies** - quality of freshwater
Endemic Species	• **Endemic to a region** i.e. Exist **only in one geographical region.**	**Asiatic Lion - Gir forest** Kashmir Stag - Kashmir valley
Invasive Alien Species	• **non-native** to an ecosystem • results in **decline or total elimination of native species** through competition, predation, or transmission of pathogens	**Prosopis juliflora** **Lantana Camara**
Flagship/ Charismatic species	• iconic due to their unique appeal. • selected species that are raised **to support biodiversity conservation.**	**Panda,** polar bears, lions, **tigers,** sea turtles etc.
Umbrella species	• Selected **for making conservation-related decisions.**	**Spotted owl, Jaguar, Giant Panda**

	• **Protecting these species protects several other species** that form the ecological community of its habitat.	
Dominant species	• Species **having substantially higher abundance or biomass** than other species in a community. • Exert a **powerful control over the occurrence and distribution** of other species.	**Tidal swamps** in the tropics - dominated by species of mangrove (Rhizophoraceae).
Foundation species	• Play a **major role in creating or maintaining a habitat** that supports other species.	**Corals -** produce the reef structures on which countless other organisms, including human beings, live.
Critical Link Species	• Play an **important role in supporting network species such** as pollinators, dispersal agents, etc.	**Mycorrhizal fungi** helps vascular plants in obtaining inorganic nutrients from soil and organic residues.
Edge Species	• **Found abundantly** in an ecotone boundary.	**Birds**

Levels of Ecological Organisations

Species/ Individual

- **Features:**
  - **Similar genetic makeup**
  - Can **interbreed and produce fertile offspring.** **Population**
- **Community of interbreeding organisms** (same species), occupying a **defined area during a specific time.**
- **Population Growth:**
  - **Variation in population (**Increase or decrease) **when measured at two different times.**
  - Can either be **positive or negative.**
  - Main **factors behind increase- birth** and **immigration.**
  - Main **factors behind decrease - death** and **emigration.**



Biotic Potential

- Maximum rate at which a population can increase when resources are unlimited and environmental conditions are ideal

Patterns of Population Growth:

1. Exponential (Unrestricted) Growth:
   - Occurs when there is **no limitation on growth** within the environment.
   - **'J' shaped** curve.
   - Ex. **Water hyacinth**/ Eichhornia Crassipes (invasive species, lacks natural predators in India, no control on growth, aka **terror of Bengal**)

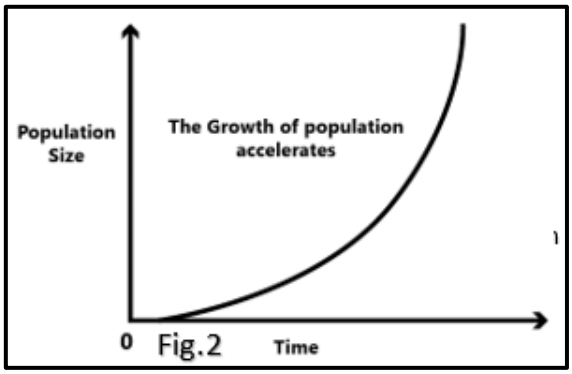
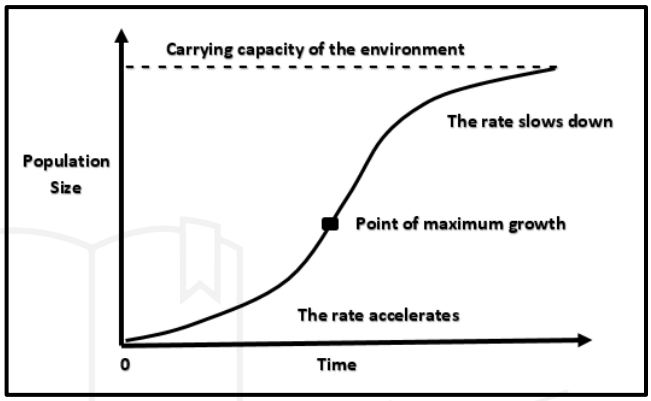


Fig.2

2. Logistical Growth/adapted Growth (K= Carrying Capacity):
   - **Population size ∝ carrying capacity** of the environment.
     - **Carrying capacity (K):** maximum stable population size that a particular environment can support over a relatively long period of time.
   - **'S' shaped** curve.



Q. "Define the concept of carrying capacity of an ecosystem as relevant to an environment. Explain how understanding this concept is vital while planning for the sustainable development of a region."

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Community

- **Different species occupying a defined area during a specific time.**
- **Usually named after dominant plant form.**
- **Neither fixed nor rigid.**
- **Can be small or large.**
- **Classification based on size and level of relative autonomy:**
  - Major Community -
    - **Large Sized**
    - **Well Organized**
    - Relatively **independent**
    - **Only dependent on Sun's** energy
    - **Free of input and outputs of adjoining communities**
  - Minor Community -
    - **Dependent on adjoining communities.**
    - Often called **societies**.
    - **Not independent** completely

1. **Secondary aggregations** within a major community

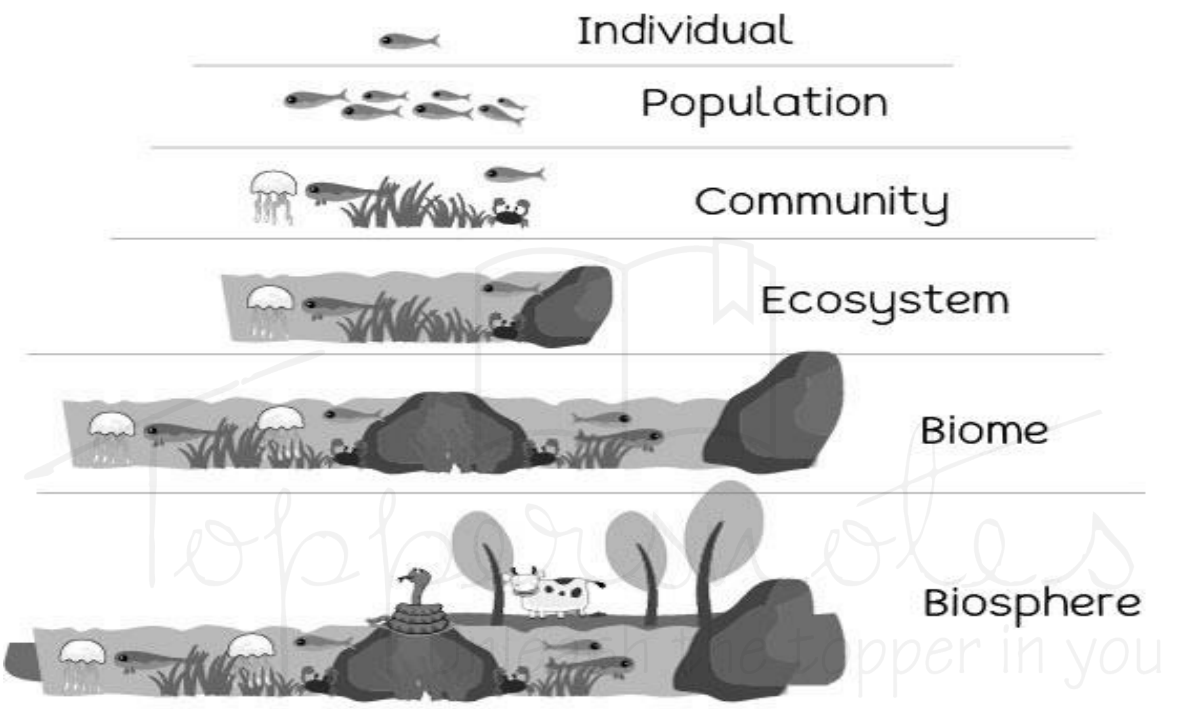
Ecosystem

- A **functional unit where living organisms interact among themselves** and with the surrounding physical environment.

2. Biome

- **Large naturally occurring community of flora and fauna occupying a major habitat.**
- **Plants and animals in a biome have common characteristics due to similar climate.**
- **A biome can comprise a variety of habitats.**
- **E.g. Rainforest biome or tundra biome.**

	Biome	Ecosystem
Definition	Region of vegetation and animals determined by climate and latitude	Interaction among organism in a set area
Climate	Strongly influenced by climatic factors like rainfall and temperature	Not strongly influenced by climatic factors like rainfall and temperature
Latitude	Specifically influenced	Not specifically influenced
Size	Very large, covering vast distances	Small, not covering vast distances
Animal life	Do not necessarily interact with each other	Always interact with each other in trophic levels and food webs
Examples	Tropical rainforest	Coral reef ecosystem



Major Biomes of the world

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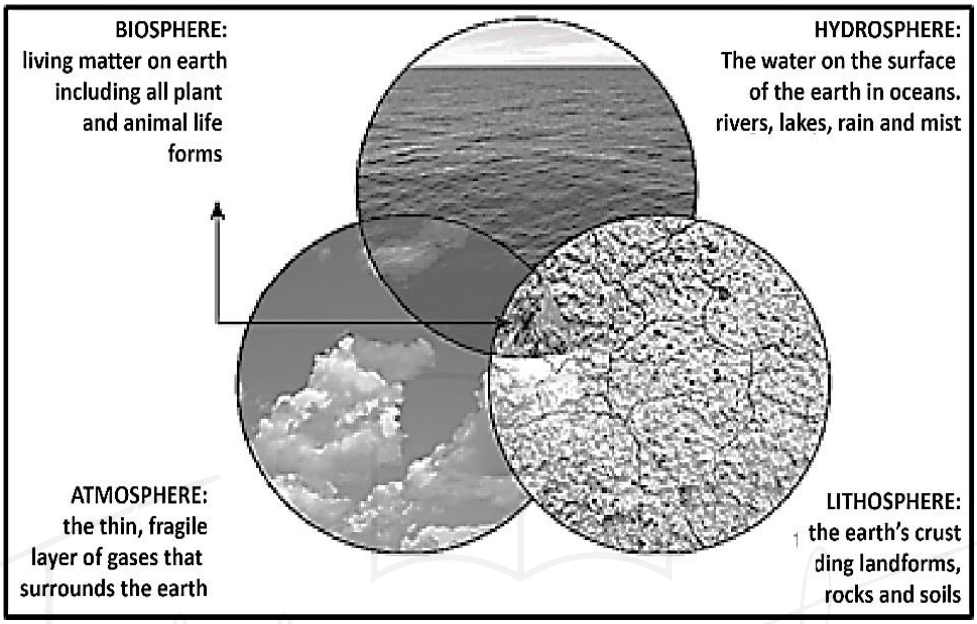
Biomes	Subtypes	Regions	Climatic Characteristics	Soil	Flora and Fauna
Tropical	**Equatorial Forest**	10° N-S	Temp. 20-25°C, evenly distributed	Acidic, poor in nutrients	Multi- layered canopy tall and large trees
	Tropical Deciduous Forest	10°-25° N-S	Temp. 25-30°C, Rainfall: 1,000mm, seasonal	Rich in nutrients	Less dense, trees of medium height; many varieties coexist. Insects, bats, birds and mammals are common species in both
	Temperate Forest	Eastern North America, N.E. Asia, Western and Central Europe	Temp. 20-30° C, Rainfall evenly distributed 750- 1,500 mm, Well defined seasons	Fertile, enriched with decaying litter	Moderately dense broad leaves. Less diversity of plant species. Oak, Beach, Maple etc. are some common species. Squirrels, rabbits, skunks, birds, black bears, mountain lions etc.

	Boreal Forest	Eurasia and North America (Siberia, Alaska, Canada, and Scandinavia)	Short moist moderately warm summers and long cold dry winter. Mostly snowfall	Acidic, poor in nutrients, thin soil cover	Evergreen conifers like pine, fur and spruce etc. Woodpeckers, hawks, bears, wolves, deer, hares and bats are common animals
Desert	**Hot and Dry**	Sahara, Kalahari, Thar, Rub-al-Khali	Temp. 20 - 45°C, Rainfall is less than 50mm	Rich in nutrients with little or no organic matter	Scanty vegetation; few large mammals, insects, reptiles and birds
	Semi arid	Marginal areas of hot deserts	Temp. 21 - 38°C, Rainfall is less than 50mm	Rich in nutrients with little or no organic matter	Scanty vegetation; few large mammals, insects, reptiles and birds
	Coastal	Atacama	Temp. 15 - 35°C, Rainfall is less than 50mm	Rich in nutrients with little or no organic matter	Scanty vegetation; few large mammals, insects, reptiles and birds
	Cold	Tundra regions	Temp. 2 - 25°C, Rainfall is less than 50mm	Rich in nutrients with little or no organic matter	Rabbits, rats, antelopes and ground squirrels
Grassland	**Tropical Savannah**	Large areas of Africa, Australia, South America and India	Warm hot climates, Rainfall 500-1,250 mm	Porous with a thin layer of humus.	Grasses; trees and large shrubs absent; giraffes zebras, buffalos, leopards, hyenas, elephants, mice, moles, snakes and worms etc., are common animals
	Temperate Steppe	Parts of Eurasia and North America	Hot summers and cold winters, Rainfall 500 - 900 mm	Thin flocculated soil, base rich	Grasses; occasional trees such as cottonwoods, oaks and willows; gazelles, zebras, rhinoceros, wild horses, lions, varieties of birds, worms, snakes etc.
Aquatic	**Freshwater**	Lakes, streams, rivers and wetlands	Temp. vary widely with cooler air temperatures and high humidity	Swamps and marshes	Algal and other aquatic and marine plant communities with varieties of water dwelling animals
	Marine	Oceans, coral reefs, lagoons and estuaries	Temp. vary widely with cooler air temperatures and high humidity	Tidal swamps and marshes	Algal and other aquatic and marine plant communities with varieties of water dwelling animals
Altitudinal	----------	Slopes of high mountain ranges like Himalayas, Andes and Rockies	Temperature and precipitation vary depending upon latitudinal zone	Regolith over slopes	Deciduous to tundra vegetation varying according to altitude

3. Biosphere/Ecosphere:

- Narrow zone where **all the spheres of the earth co-exist.**
- **It is the zone where life exists.**
- **Complicated and interconnected web that links all organisms with their physical environment.**
- **Stretches out from the lower part of sea channels to around 8 km over the ocean level.**
- **A zone of cooperation between the other 'spheres'.**
- **Only the biosphere has water in liquid form**
- **Transfer of energy and the cycling of minerals** takes place.



Difference between Ecology, Ecosystem, and Environment

- **Environment -** surroundings, or the area in which living organisms survive
- **Ecosystem-** functional unit of the environment - composed of biotic and abiotic components and their relationships with each other.
- **Ecology-** scientific study of the interactions between organisms, their surroundings occurring within an ecosystem or environment.

Species

Ecological Amplitude

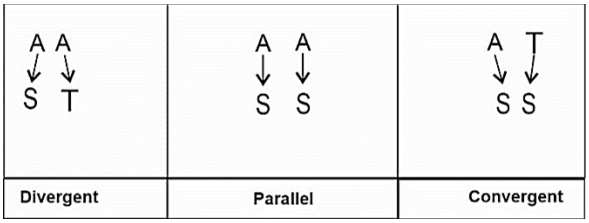
- Every species has a specific range within which it can tolerate ecological changes

Evolution

- **The process of species' features developing over time.**
- **Gradual change in the characteristics of population** that occurs over the course of successive generations as a result of natural selection.
- **Accounts for speciation and extinction, progressive changes as a result of natural selection**, as well as the **diversity of organisms of supposed common ancestry** across geological time.

Types :

- **Convergent evolution**
  - Process by which **two or more unrelated species develop similar traits in different types of environment.**
  - **Eg. Whales and penguins** have decreased limbs and have evolved comparable adaptation features
- **Divergent evolution**
  - Occurs when a single species branches off into more than one
  - Eg. Darwin's Finches
- **Parallel evolution**
  - Happens when two independent species evolve separately while preserving a high level of resemblance.
  - Eg. The woolly mammoth and elephant



- Coevolution
  - Evolution of two biologically-related taxonomic groups at the same time.
  - Eg. blooming plants and the insects that pollinate them.

Adaptation

- Appearance, behaviour, structure, or manner of life of an organism that helps it to survive in a given environment.
- Forms:
  - Morphological — Giraffe's neck grow longer as the trees grew taller;
  - Physiological — In North American deserts, the kangaroo rat, in absence of an external source of water, is able to meet its water needs by oxidising the fat stored in its body;
  - Behavioural — Migration of animals to a less harsh environment.

Acclimatisation

- Modest changes occuring in the body of an organism over a short period of time in order to overcome minor challenges caused by changes in the environment.
- Eg. When we're climbing high mountains, we need to breathe more quickly. Our bodies acclimate to the new conditions on the high mountain after a few days.

Phenotypic Plasticity

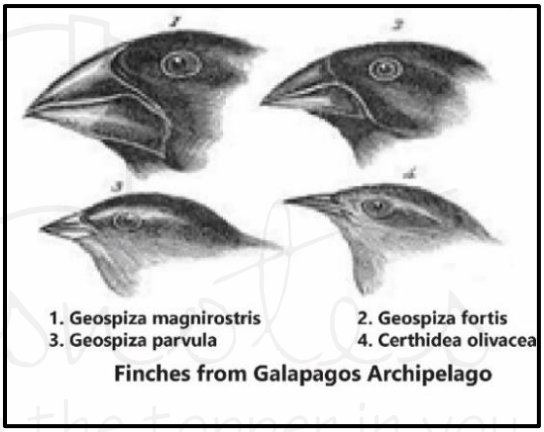
- Refers to the changes in an organism's behaviour, morphology and physiology in response to a unique environment.
- Encompasses all types of environmentally induced changes (e.g. morphological, physiological, behavioural) that may or may not be permanent throughout an individual's lifespan.
- Eg., Genetically identical water flea (Daphnia) clones can differ in their morphology depending on whether they are reared in the absence or presence of a potential predator.

Variation

- Changes in genetic makeup caused by the addition or deletion of certain genes.
- Causes: Mutations, climatic change, geographical barriers, and other factors.
- Eg: Variance in skin colour, hair type (curly or straight), eye colour and blood type among ethnic groups.

Adaptive Radiation

- "Adaptive Radiation refers to the adaptation of an organism that enables them to spread successfully or radiate into other environments."
- Ex. Finch species found in the Galápagos Archipelago have evolved through adaptive radiation, resulting in the diversification of their beak forms, allowing them to utilise a variety of food sources.



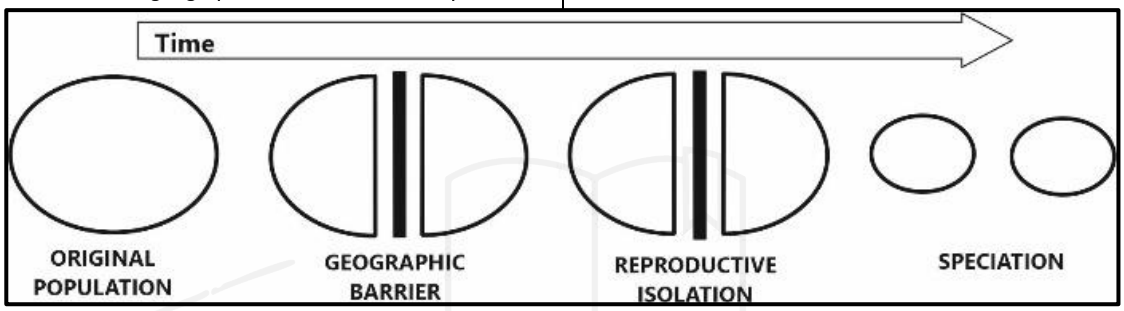
Finches from Galapagos Archipelago

Mutation

- Change in genetic material caused by an error in DNA replication.
- New genes emerge in a population as a result of mutation.
- Meiosis and fertilisation produce a new mix of genes in every generation, in a sexually reproducing population known as recombination.
- As a result, members of the same species are not similar and differ.
- Causes of mutation:
  - Internal Causes: When DNA fails to duplicate correctly.
  - External Causes: When the DNA is exposed to certain chemicals or radiations, that causes the DNA to break down.

Speciation

- **Elaborate process of forming new species** from other existing species.
- Includes **splitting of one species into two or more genetically distinct species.**
- Takes place **through continuous mutation of genes.**
- **Types:**
  - **Allopatric-** occurs **when one particular species moves away from each other because of the geographical barrier,** like waterways or mountain range.
  - **Parapatric- occurs when** species sharing a **common geographical area, breed only within their preferred region**- show varied characteristics and nature.
  - **Peripatric**- Happens **due to change in habitation.** However, in the process, they gain several character traits and pass on their offspring.
  - **Sympatric**- When several members of a species are living closely. However, they **mate with other members based on specific food habits or environment.**
  - **Artificial**- **Results from lab experiments and scientific advancement.** Humans carry research work on other living organisms like fruit flies and create new species.



Extinction

- Process of evolution that **leads to the disappearance of a population or species."**
- **Over 99% of all the species** that **once lived on the Earth** amounting to over five billion species are estimated to have been extinct**.**
- **Types:**
  - **Natural Extinction**: May occur due to tectonic movement, a spike in volcanic activity or global warming
  - **Artificial Extinction**: May be induced by humans
- **Direct causes - Hunting, collecting, or capturing as well as persecution**
- **Indirect causes - Habitat loss, change and fragmentation,** as well as the introduction of exotic species

Important Terms

Ecocide

- Derived from Greek and Latin, it means **"killing one's home**" or "environment."
- It is defined as "**unlawful or reckless acts** committed with the awareness of **causing substantial**, severe, and either widespread or enduring **environmental damage**.
- It **encompasses actions like** port expansions damaging marine life, deforestation, illegal sand-mining, and polluting rivers.
- Several countries, including **Mexico, are considering ecocide legislation**, with calls to elevate it to an international crime akin to genocide.

Ecophene or Ecads

- These are **variations in phenotypes** (observable physical characteristics)
- **Eg.** Indian living in Africa will have higher melanin in skin than one living in India

Ecotype

- A group of organisms, normally a **subdivision of a species,** that is **adapted to a specific environment**.
- It occurs when **ecophenes** remain in their new environment for too long
- The **morphological changes become genetically fixed**.

	Ecophene	Ecotype
Definition	First response or phenotype an organism shows when it arrives in a new environment.	Best adapted phenotype of an organism when it lives in a new environment for a longer time

Adaptation	Temporary	Permanent
Changes in Genes	No	Yes
Reversibility	Yes	No

Homeostasis

- Resistance to change.
- A **mechanism used by organisms to control their internal environment** despite a change in the external environment **through physiological, morphological, and behavioral processes.**
- A self-regulating process **essential for survival.**
- **Eg.** During summers, humans tend to sweat to regulate their body temperatures.

Various Methods

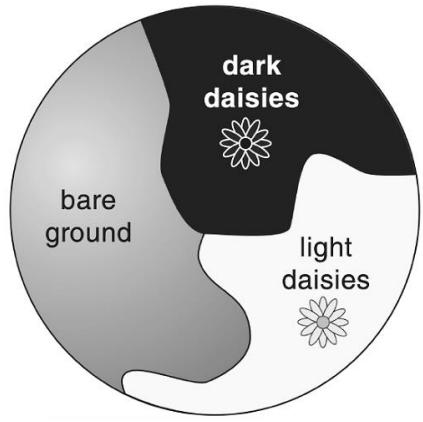
Regulate	• **Physiological** means; ensures constant body temperature, constant osmotic concentration, etc. • **All birds and mammals** are capable of such regulation; **thermoregulation and osmoregulation.** • **Plants** do not have such mechanisms to maintain internal temperatures.
Conform	• Majority of animals and nearly all plants **cannot maintain a constant internal environment.** • Their body temperature changes with the **ambient temperature.** • Eg. In aquatic animals, the **osmotic concentration** of the body fluids changes with that of the **ambient water osmotic concentration.**
Migrate	• **Move away temporarily** to a more hospitable area and return when a stressful period is over. • **Eg.** Keoladeo National Park in Rajasthan + **Migratory birds** from Siberia
Suspend	• Bacteria, fungi and lower plants: Thick-walled spores are formed which help them to **survive unfavourable conditions** • Higher plants seeds and some other vegetative reproductive structures serve as means to **tide over periods of stress besides helping in dispersal.** • Animals if unable to migrate, **hibernate**
	• **Some snails and fish: aestivation** to avoid summer-related problems • **Many zooplanktons: enter diapause,** a stage of suspended development

Brumation

- A state of dormancy or reduced activity observed in **reptiles**, akin to hibernation in mammals.
- It occurs typically during **colder months** when temperatures drop and food becomes scarce.
- Reptiles enter this state to **conserve energy** and **survive adverse environmental conditions.**
- Reptiles may seek refuge in underground burrows, rock crevices, or other sheltered areas where temperatures are relatively stable.

Gaia Hypothesis

- By British chemist James E. Lovelock and U.S. biologist Lynn Margulis.
- It proposes that **living organisms interact with their inorganic surroundings** on Earth to form a synergistic and self-regulating, complex system that helps to **maintain and perpetuate the conditions for life** on the planet.
- **Eg. Ocean salinity in fixed at 3.4% due to bacterial processes** even though there is constant deposition of salt by rivers.
- **Daisyworld:** A mathematical model to predict it.
  - Lovelock and Andrew Watson illustrate the **"biological homeostasis of the global environment"** with daisyworld, a hypothetical Earth containing only light and dark colored daisies.



  - **If the Earth is too cold**, the **dark daisies** proliferate, increasing the absorption of solar radiation.
  - **If too warm, light-colored daisies** proliferate, reflecting more sunlight by increasing the global albedo.

Biotic Interactions

Type	Species A	Species B	Interaction
Mutualism	+	+	Obligate Mutualism: ● Neither can survive without the other, ● Ex. algae and coral polyps (Zooxanthellae algae does photosynthesis and supplies food to coral polyps and coral polyps in turn provide shelter to the algae) Facultative Mutualism (Proto-cooperation): ● One species may survive without the other, ● Ex. Hermit crab and Sea anemone (Sea anemone grows on the back of the Hermit crab, providing camouflage and protection. In turn, the sea anemone is transported to areas of new food sources)
Commensalism	+	0	● One is benefited from the other while the other remains unaffected ● Ex. Cattle egrets (a type of bird) live near cattle because when cattle graze, their movement stirs up insects. The birds have their insects and cattle are unaffected.
Parasitism	+	-	● One is benefited while the other is harmed ● Ex. Fleas are present on the body of dogs. They get shelter and food from them while they harm their host by biting them, sucking their blood and causing itching.
Predation	+	-	● One survives by eating the other and in its absence dies itself. ● Ex. Lion and Deer
Competition	-	-	● Adversely affects both the species. Occurs when resources are scarce. ● inter-specific (within different species- ex. Lion and Cheetah competing for deer) ● intra-specific (within same species- ex. Monkeys fighting for fruits)
Neutralism	0	0	● None is affected by the association.
Amensalism	-	0	● One is harmed while the other remains unaffected ● Ex. Algal bloom kills fishes but algae does not benefit from the death of fishes.

*0 = No effect on species, + = beneficial for species, - = harmful to the species

Important Terms

Allelopathy

- A biological phenomenon by which an **organism produces one or more biochemicals** that influence the germination, growth, survival, and reproduction of other organisms.
- Can be **harmful or beneficial** to another plant species.
- These chemicals can be released through **leaching, volatilization or decomposition of plant residues.**
- Other plants produce chemicals that have a **positive effect** on the growth of other plants, such as the **production of growth hormones.**
- **Examples**
  - Black walnut trees release juglone, a chemical that is toxic to many plants and can inhibit their growth.
  - Eucalyptus trees produce chemicals that can inhibit the growth of many other plant species, allowing them to dominate the surrounding vegetation.

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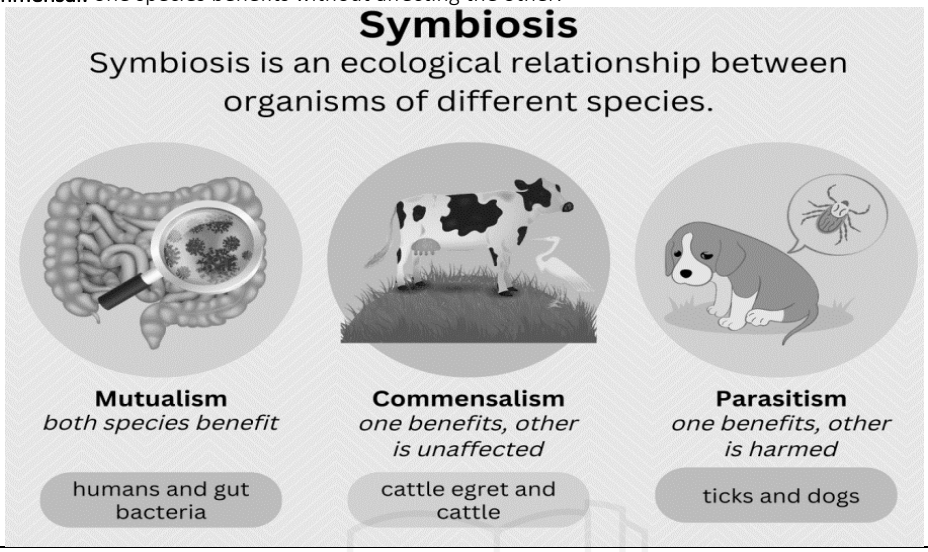
Symbiosis

- Two or more different species **live in close association** with each other.

- **Greek words:** "syn" (together) + "biosis" (living)
- **NOT** all symbiotic relationships are **mutualistic.**
  - **Parasitic:** one species benefits at the expense of the other.
  - **Commensal:** one species benefits without affecting the other.

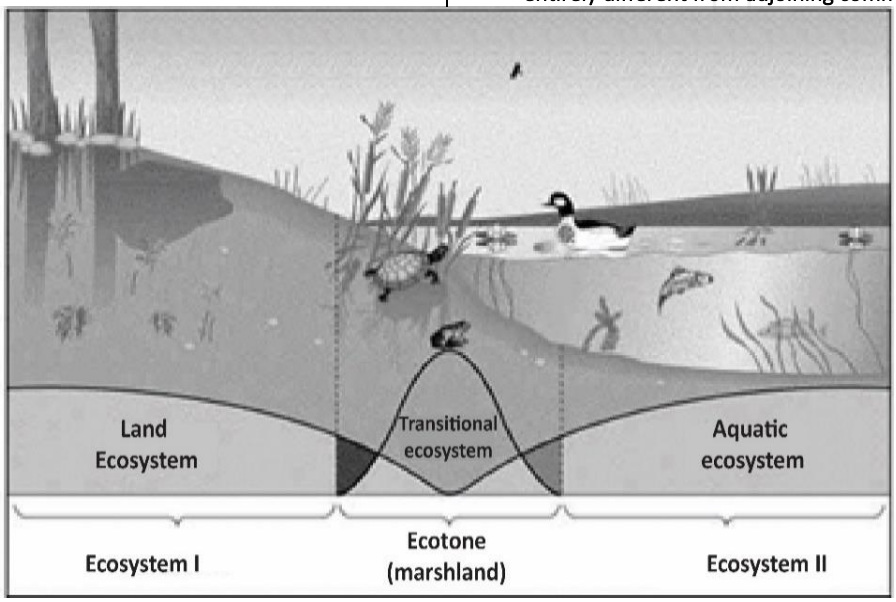


Ecotone

- **Transition area between two biomes** (diverse ecosystems).
- Zone where **two communities meet and integrate.**
- **Eg. the mangrove forests -** ecotone between marine and terrestrial ecosystem, **grassland** (between forest and desert), **estuary** (between freshwater and saltwater) and **marshland** (between dry and wet).

Characteristics of Ecotone

- **Zone of tension** that contains **features of both bordering communities and some species** not found in the overlapping communities.
- **May be narrow** (grassland and forest) **or broad** (forest and desert).
- **Incoming community -** number and **density of species increases**
- **Outgoing community -** number and **density of species decreases.**
- **Well-developed ecotone - when some organisms are entirely different from adjoining communities.**



Ecocline

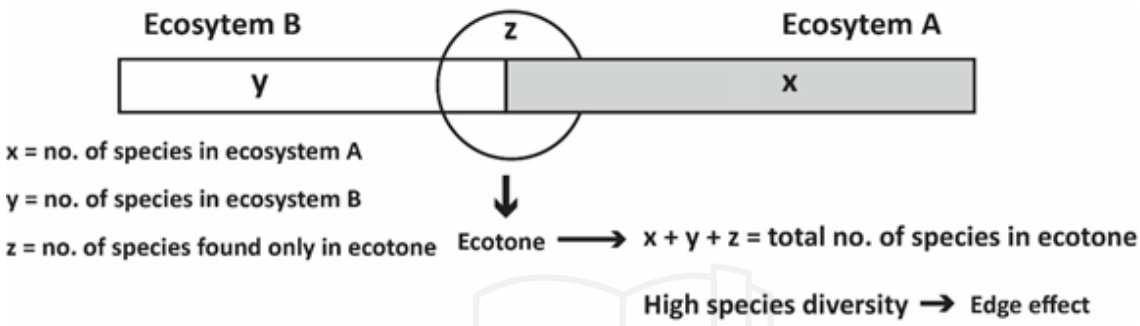
- **Zone of gradual but continuous change from one ecosystem to another** when there is no sharp boundary between the two in terms of species composition.
- Occurs **across the environmental gradient** (gradual change in abiotic factors such as altitude, temperature (thermocline), salinity (halocline),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

Edge Effect

- When the **number and population density of species in the ecotone >> either community - edge effect.**
- **Eg. The density of birds is greater between forest and desert.**

Edge Species

Species that **occur primarily or most abundantly in the ecotone.**



Ecological Niche

- **Joseph Grinnell** has defined Ecological Niche as **the sum of the habitat requirements and behaviours that allow a species to persist and produce offspring**
- **Unique functional role** of a species in an ecosystem

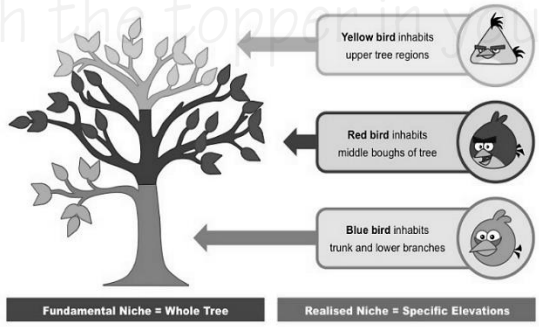
Components of Niche

- **Habitat:** Environment in which an organism lives ; supplies all the required factors for the existence of a species.
- **Food:** Food resources that the **species obtains from its environment.**
- **Environmental condition:** Physical and chemical factors (temperature, soil, humidity).
- **Relationships: Interaction of species** with other organisms in the ecosystem

Types of Ecological Niche

- **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.

- **Fundamental Niche-** Niche that would prevail **in the absence of competition** and limiting factors - **theoretical** in nature.
- **Realized Niche- Due to competition** for resources from other members, **a species only occupies a part of its niche- species live in it**
- **Fundamental niche** is always **> realized niche.**



Characteristics of Niche

- **Describes organism's** life history, **habitat, interactions** with other species **and** its **place in the food chain**
- **Affected by physical conditions of an area**
- **Changes with the change in physical and biological factors**
- Species commonly do not exploit their entire niche due to the presence of other species.

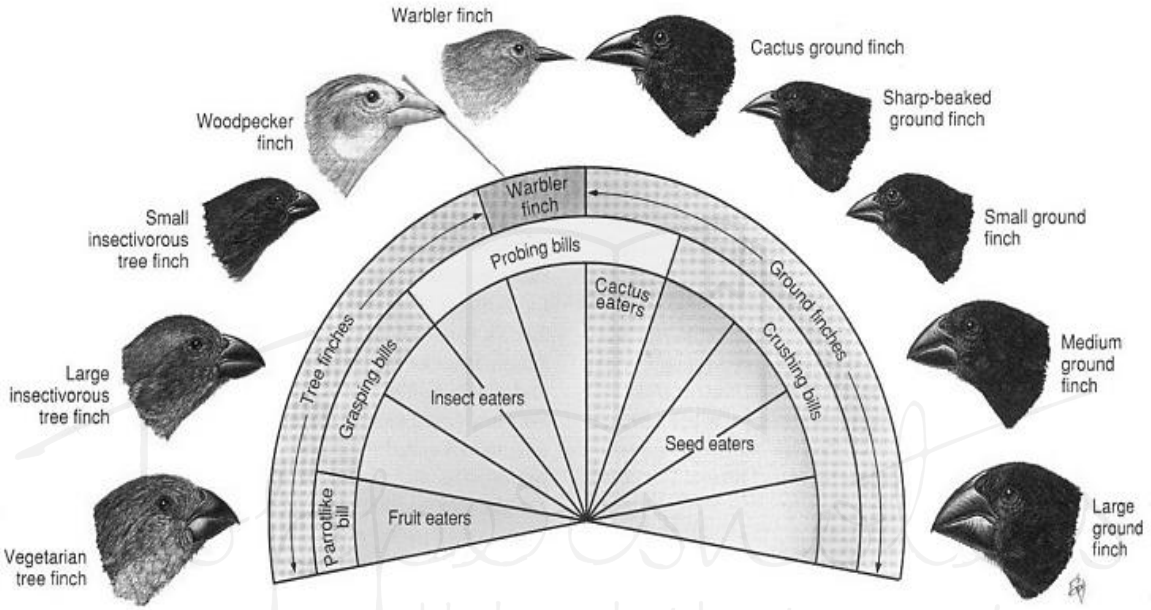
- **No two species can have exactly identical niches.**
- **If so** happens, there will be **competition for the available resources** and the **less** well-**adapted species will be eliminated.**

Niche vs Habitat

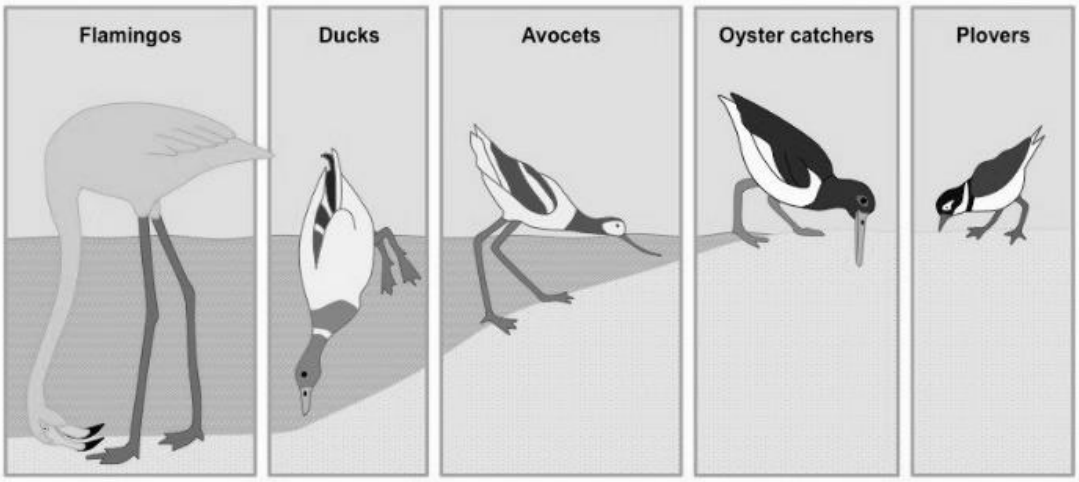
Habitat	Niche
Refers to the place where species live	Role played by species in an environment
Too many species, occupy a single habitat	No two species can have the same niche

Niche Overlap

- **Gauss Law or Competitive Exclusion Principle**
  - In case, two species occupy the same niche, competition will lead to the exclusion of one from that niche.
  - Eg. **Darwin's finches @ Galapagos islands**



- **Resource Partitioning**
  - Niche overlap is reduced by **resource partitioning.**
  - **It** is the division of limited resources by species to help avoid competition in an ecological niche.

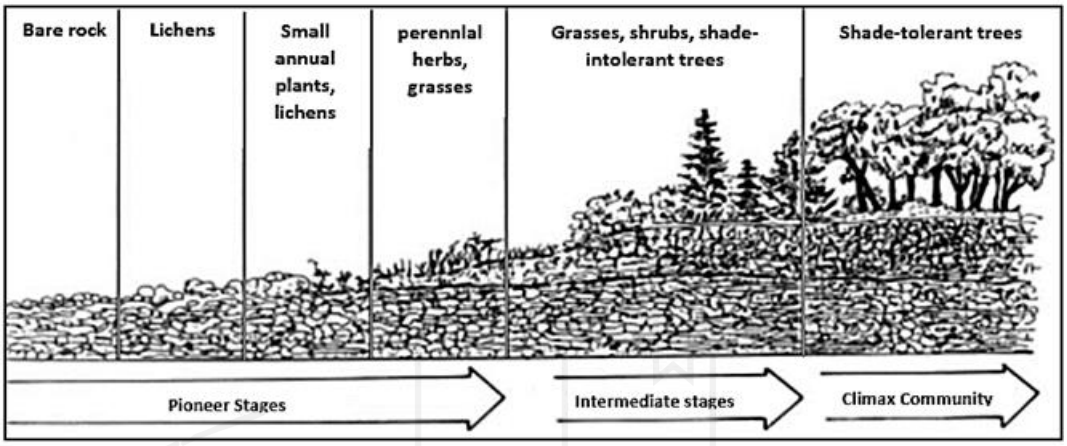


Ecological Succession

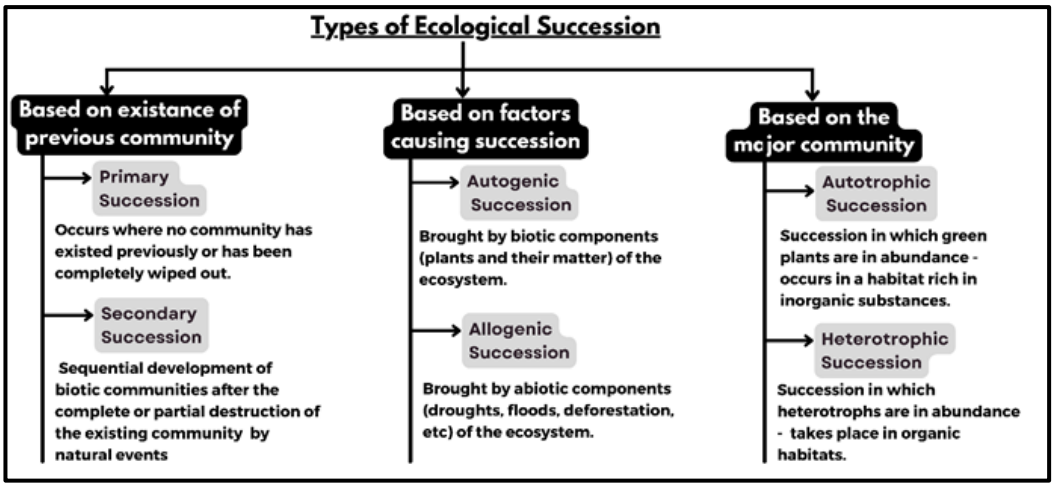
UPSC Pre 2014

- Process by which **communities of plant and animal species in an area are replaced** or changed into another **over a period of time.**
- A universal process of **directional change in vegetation**, on an ecological time scale.
- **Occurs** due to **large scale changes or destruction** (natural or manmade).
- Involves **a progressive series of changes with one community replacing another until a stable, mature, climax community develops.**

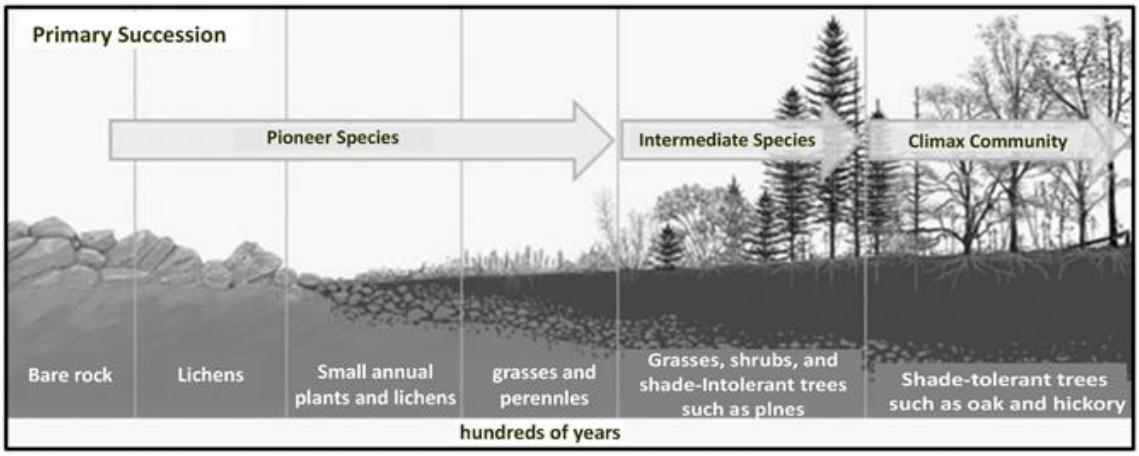
Stages of Succession



- **Pioneer community - First plant to colonize an area.**
- **Climax community- Final stage** of succession- stable, mature, more complex and long-lasting.
- **Successional stages or seres - stage leading to the climax community.**
- Each **transitional community** that is formed and replaced during succession is known as **stage in succession or a seral community.**
- **Succession** is **characterized** by:
  - Increased productivity
  - Shift of nutrients from the reservoirs
  - Increased diversity of organisms
  - Gradual increase in the complexity of food webs.
- **Faster in areas existing in the middle of the large continent** because here seeds of plants belonging to the different species would reach much faster.

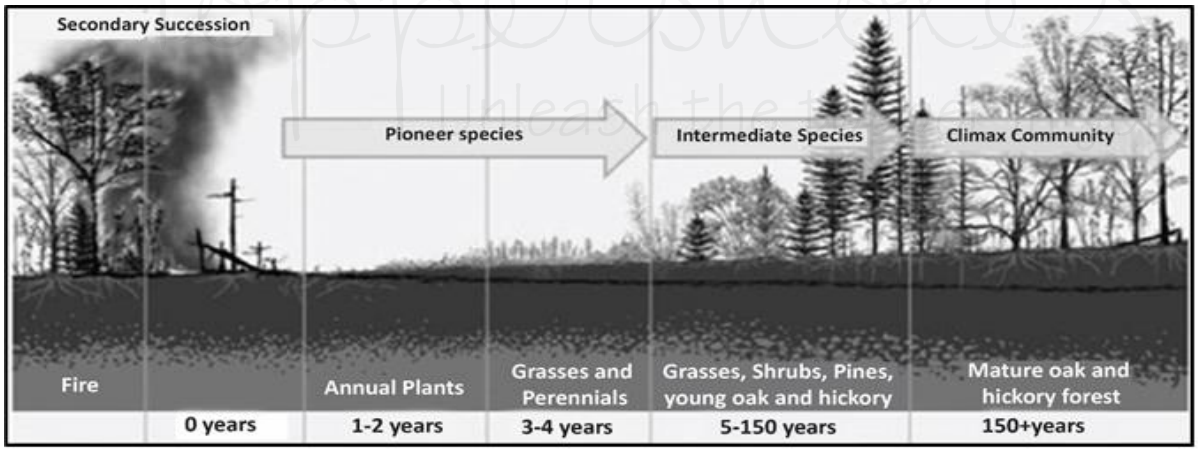


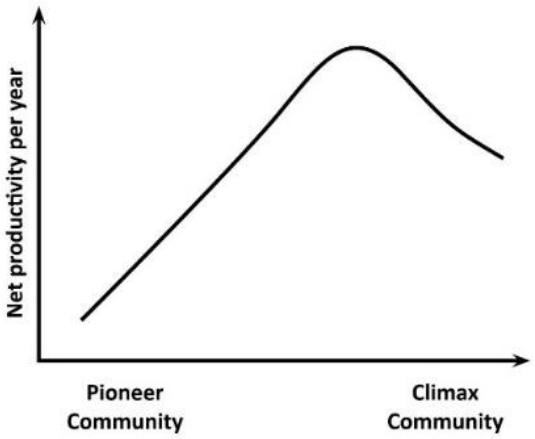
1. Primary Succession
   - Occurs **where no community has existed previously** or has been completely **wiped out.**
   - **Terrestrial site** is first **colonized by a few hardy pioneer species** (**microbes, lichens and mosses**).



   - Successful colonisation of plants is f**ollowed by animals, insects, birds and small invertebrates.**
   - **Areas of occurence** - **rock outcrops**, newly formed **deltas and sand dunes;** emerging **volcano islands and lava flows**, glacial **moraines** (muddy area exposed by a retreating glacier), etc.

2. Secondary Succession
   - Sequential development of biotic communities **after the complete or partial destruction** of the existing community by natural events (floods, droughts, fires, or storms or by human interventions such as deforestation, overgrazing)
   - **Abandoned land** is first **occupied by hardy species of grasses** (that can survive in harsh conditions).
   - **Followed by tall grasses and herbaceous plants** along with **mice, rabbits, insects and seed-eating birds.**
   - Eventually, **some trees grow**, seeds of which may be brought by wind or animals.
   - **Abandoned land** with time becomes dominated by trees and is **transformed into a forest.**





Difference between Primary and Secondary Succession

Primary Succession	Secondary Succession
Starts in areas where no living organisms ever existed.	Occurs in areas where organisms lived previously.
No soil present.	Soil already present.
Would occur after lava cools and hardens into rock.	Would occur after a forest fire or land cleared by humans.
Lichens and Moss grow first.	Grasses are the first plants to grow.
Development of Biotic Community is very slow.	Development of Biotic Community is relatively fast.
Biomass is low.	Biomass is high.

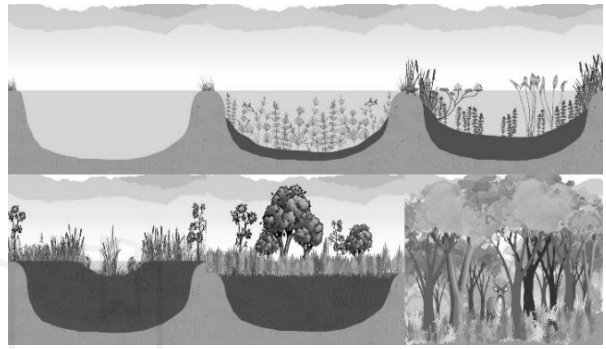
Note:

Cyclic Succession

- Change in the structure of an ecosystem on a cyclic basis.
- Some plants remain dormant for the rest of the year and emerge all at once.
- Drastically changes the structure of an ecosystem.

Succession in Plants

- **Xerarch- Succession that occurs on land** (dry areas) where **moisture content is low.** Eg. on a **bare rock.**
- **Hydrarch- Succession that takes place in a water body. Eg. ponds or lake.**
- Hydrarch and xerarch succession **lead to medium water conditions** (mesic) – neither too dry (xeric) nor too wet (hydric).



Clement's Theory

- 6 Phases
  - **Nudation** : development of a bare site, disturbance
  - **Migration** : arrival of propagules
  - **Ecesis** : establishment of initial growth of vegetation
  - **Competition**: as vegetation becomes well established, grows and spreads, various species compete for space, light and nutrients
  - **Reaction:** autogenic changes affect the habitat resulting in replacement of one plant community by another
  - **Stabilization:** stable climax community

2 CHAPTER Ecosystem

Year		2013		2014		2015		2016		2017		2018		2019		2020		2021		2022		2023	
Pre	Mains	1	-	1	-	1	-	2	-	1	-	-	-	-	-	-	-	5	-	-	-	-	-

Toppers' Analysis
Weightage from the Exam's point of view: **Prelims:** 10-20% of total questions asked from the Environment. **Mains:** Rare chance of direct questions being asked from the chapter, but a current Based Question can be asked. **Pre-requisite of the Chapter:** Class 12 NCERT Biology-Chapter-14 This chapter is crucial to building basic concepts of environment and is highly recommended for understanding day-to-day economic changes. Aspirants must read this chapter before reading Newspapers and track regular policy changes.

Ecosystem

UPSC Pre – 2013, 2015, 2016, 2017

- A **functional unit where organisms interact** among themselves and with the surrounding physical environment.
- **Can be of any size** but usually **encompasses specific and limited species.**
- **Every organism** in an ecosystem is **dependent on other species and elements** in that ecological community.
- **If one part of an ecosystem is damaged, it has an impact on everything else.**

Components of an Ecosystem