FREE SAMPLE

ENVIRONMENT

LAST MINUTE NOTES

Making Sense of Nature's Chaos for UPSC Bliss

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Important terms

ECOLOGY

Ecology is the study of how living things interact with each other and their environment. For example, ecologists might study how bees (living things) interact with flowers (other living things) and how both are affected by weather (environment).

ECOSYSTEM

An ecosystem is a community of living organisms and their physical environment, working together as a system. For example, a forest ecosystem includes trees, animals, insects, soil, water, and sunlight.

ECAD

Ecads are plants from the same genetic background but look different due to environmental conditions. These changes can be reversed. For instance, dandelions growing in shade might look different from those in full sunlight, but if the shady ones are moved to sunlight, they will change appearance.

ECOTYPE

Ecotypes are groups within a species that are genetically different and adapted to specific environmental conditions. These changes are permanent. For example, yarrow plants in high altitudes are shorter and more compact compared to those at sea level.

ECOLOGICAL SUCCESSION

Ecological succession is the process by which ecosystems change over time.

- **Primary Succession**: This occurs in an area where no life existed before, such as after a volcanic eruption forms new land.
- **Secondary Succession**: This occurs in an area where life existed but was disrupted, like a forest regrowing after a fire.

AUTECOLOGY

Autecology is the study of how a single species interacts with its environment. For example, studying how a specific type of cactus survives in a desert.

SYNECOLOGY

Synecology is the study of how groups of species interact with each other and their environment. For instance, studying how different plants, animals, and insects in a rainforest interact.

EDAPHIC

Edaphic refers to factors related to soil, such as its texture, composition, and moisture content. For example, how the sandy soil in deserts affects plant growth.

ECOLOGICAL NICHE

An ecological niche is the role a species plays in its environment, including how it gets its food, where it lives, and how it interacts with other species. For example, a bee's niche involves pollinating flowers and collecting nectar.

ECOLOGICAL EQUIVALENTS

Ecological equivalents are species that occupy similar niches in different geographical regions but are not related to each other. For example, the cactus in American deserts and the euphorbia in African deserts both store water and have spines, even though they are not related.

THERMS (Classification based on temperature survival)

- **MEGA**: Species that thrive in high temperatures, like those in tropical rainforests. Example: Jaguars.
- **MESO**: Species that can survive alternating high and low temperatures, such as those in tropical deciduous forests. Example: Monkeys.

- **MICRO**: Species that live in low temperatures throughout the year, found in mixed coniferous forests. Example: Moose.
- **HEKISTO**: Species that survive in extremely low temperatures, like those in alpine forests. Example: Snow leopards.

BIOME

A biome is a large area classified by its climate, plants, and animals. For instance, a desert biome has very little rainfall, sandy soil, and specialized plants like cacti and animals like camels.

ADAPTATION

Adaptation refers to traits that help an organism survive and reproduce in its environment. For example, cacti have thick stems to store water and spines to reduce water loss and protect from herbivores.

CLIMAX

Climax refers to a stable and mature state of an ecosystem where it has reached a balance with its environment. It has a wide variety of species and complex food webs. For example, a mature rainforest.

POLYCLIMAX

Polyclimax suggests that there are several stable climax communities within a region, each adapted to specific conditions. For example, different types of forests (like deciduous and coniferous) in a large area can represent multiple climax communities.

PRIMARY SUCCESSION

Primary succession starts in a barren area where no life existed before. For example, new land formed by a volcanic eruption initially has no life but gradually gets colonized by pioneer species like lichens and mosses.

SECONDARY SUCCESSION

Secondary succession occurs in areas where life existed before but was disturbed. For example, after a forest fire, grasses and shrubs might first grow back, followed by trees.

PIONEER SPECIES

Pioneer species are the first organisms to colonize a barren or disturbed environment. They help create conditions that allow other species to move in. For example, lichens and mosses are often pioneer species in primary succession.

Habitat

A habitat is the natural environment where an organism lives, grows, and thrives. It provides the necessary conditions for the survival and reproduction of the species, including food, water, shelter, and space.

Key Points About Habitat:

1. **Components of Habitat**:
    - **Food**: Provides the necessary nutrients for survival.
    - **Water**: Essential for all living organisms.
    - **Shelter**: Offers protection from predators and harsh weather.
    - **Space**: Needed for living, breeding, and finding resources.
2. **Types of Habitats**:
    - **Terrestrial Habitats**: Found on land, such as forests, grasslands, deserts, and mountains.
    - **Aquatic Habitats**: Found in water, including freshwater (rivers, lakes) and marine (oceans, seas) environments.

Ecological Succession

1. **Nudation (Bare Area):** This is the starting point where there's an empty area with no life. Think of it as a blank canvas, like a field with no plants or animals.
2. **Invasion (Pioneer Stage):** This is when the first species arrive and start to live in the bare area. These pioneers are like the first settlers in a new land. They establish themselves in the new environment through:
    - **Ecesis:** The process where plants or animals successfully get established in this new area.
    - **Migration:** Movement of species into the new area.
    - **Aggregation:** The population of these pioneer species increases as more individuals settle and reproduce.
3. **Competition and Coaction:** As more species move in, they start competing with each other for resources like food, water, and space. This competition happens both among different species (inter-species) and within the same species (intra-species).
4. **Reaction:** The new species begin to change the environment. For example, plants might alter the soil or provide shade, which affects other species. The environment is gradually modified by the presence and activities of the new species.
5. **Stabilisation (Climax Stage):** Over time, the community of species becomes stable. The ecosystem reaches a new balance where the species and the environment are in harmony. This final, stable community is called the climax community.

In simple terms, this process describes how life establishes and develops in a previously lifeless area, starting with pioneer species, followed by competition and environmental changes, and eventually reaching a stable ecosystem.

Population Interaction

Mutualism	Predation	Competition	Parasitism	Amensalism	Commensalism
++	+ -	- -	+ -	- o	+ o
Both benefit	One benefits, other loses.	Both lose	One benefits, other loses.	Loss to one, no effect to other.	One benefits, no effect to other.
Pollination: Sweet nectar for pollinators like bees and seed dispersal for the plants. Coevolution in both species will always happen in Mutualism.	Predator, tiger, hunts prey, buffalo/deer for food.	Closely related species compete for same resource. The more adapted species survives.	Free residence, transport, food to huge variety from plants to higher vertebrates.	Plants release toxic chemicals into soil to prevent other plants from growing.	Orchids growing on trees for support. Cattle egret and grazing cattle. Sea anemone and clown fish.

		Abingdon tortoise extinct because goats were introduced in Galapagos islands.	Leech sucks blood out of animals. Benefits Leech, loss to animals		

Ecosystem

- Smallest structural and functional unit of nature
- Consisting of both abiotic and biotic community
- Interaction is conducted by energy flow (solar energy) and cycling of materials called nutrient cycles like carbon cycle, nitrogen cycle. Explained in detail further in this chapter.
- Entire biosphere is considered as a global ecosystem, composite of all local ecosystems of earth.

Structure of ecosystem

1. Input(productivity)- amount produced.
2. Transfer of energy (food chain/web, nutrient cycling)- the amount produced goes through several stages in food chain/web and nutrient cycles.
3. Output(degradation and energy loss)- the amount produced finally dissipates.

COMPONENTS OF ECOSYSTEM

- **BIOTIC:** Living component from smallest microbe, fungi to largest animals and plants
- **ABIOTIC:** include inorganic substances (carbon, nitrogen, CO_2,H_2O) involved in natural cycles, air, water and other physical factors, organic compounds (proteins, carbohydrates). Important ones are:
    I. temperature,
    II. light,
    III. water,
    IV. soil.

TEMPERATURE

Most important environmental factor. Spatial distribution of species decreases on either side of equator towards poles and as we go above or below mean sea level. Decrease in temperature can limit biodiversity by causing dessication and chilling.

Temperature based Zonation of water bodies/Thermal stratification in lakes:

1. Epilimnion :vertical gradient of gradually decreasing temp. from surface.
2. Metalimnion: Thermocline.short zone with rapidly decreasing temp.
3. Hypolimnion: Deep zone of cold temp, no further gradient

WATER

Second most important abiotic factor. Life started in water about 3.5 billion years ago. Precipitation is a major source of soil water. On the basis of water, organisms are classified as:

1. Hydrocoles- Aquatic animals needing large quantities of water. Fish
2. Mesocoles: animals needing moderate amount of water. Man
3. Xercoles: terrestrial animals who can tolerate extreme dry conditions and can survive for many days without water. Kangaroo rat
4. Euryhaline: Tolerate wide range of salinities. Bull Shark.
5. Stenohaline: can survive only a limited range of salinity
6. Halophytes: Salinity loving plants
7. Shallow shore region of marine area: Neritic zone
8. Part of water body which have been cut off from river: ox bow lake
9. Estuaries: region where river enters ocean.

SOIL

Soil has composition of minerals(~45%)+water(~25%)+air and other gases(~25%)+organic matter(~5%)+ several organisms.

- Soil formation called as pedogenesis. Slow process. It takes 200-400 years to form 1 cm of soil.
- Study of soil- Pedology
- Loamy soil is best soil for growth of plants. Has high water holding capacity , high aeration, root penetration

Steps of Decomposition

- Duff(partially decomposed)
- Humus(fully decomposed)

1. Fragmentation: breaking into small particles by detrivores like earthworm.
2. Leaching: water soluble nutrients move into soil horizon
3. Catabolism: bacterial and fungal degradation by enzymes
4. Humification and Mineralisation: leading to formation of humus. Minerals formed during soil formation.

8 types of soil by ICAR

-Indian Council for Agricultural Research

Red, Laterite , Black , Alluvial ,Forest , Peaty and Marshy, Desert , Saline and Alkaline

SOIL	CHARACTERISTICS	DEFICIENCY	PLACES
RED	Light texture,porous,friable	Lime,N,kankar,free carbonates,humus,phosphoric acid	Periyar,salem of TN,MP,Andhra,East Rajasthan
LATERITES & LATERITIC	Red to reddish yellow,formed on site,conditions of high rainfall with alternate wet and dry	N,P,K,lime,magnesia	Eastern ghats,entire south India,Satpura,Vidhyan plateau,Maikal,Mahadeo ranges in MP

	periods,rainfall leading leaching producing porosity		
BLACK SOIL	Originating from volcanism, dark brown, suitable for cotton ,rich in Ca,potash,Mg	N , P, organic matter	Deccan plateau(MH),MP plateau,Sourashtra,Malwa
ALLUVIAL	Occurs along rivers and represent soil materials,deposited by rivers during floods	Sometimes N, P, humus	Northern Gangetic plains, Valleys of Narmada, Tapti, Cauvery, Godavari
FOREST AND HILL	High or low elevations, if rainfall sufficient to support trees,very shallow, steep, stony, infertile for productionof field crops ,produce timber and fuel		Himalayan regions, valley basins, less steeply inclined slopes ,depression
DESERT	Low rainfall track,well supplied with soluble salts, high pH, lack of water, subject to wind erosion	N, organic matter	GJ , RJ
SALINE AND ALKALINE	Little more rainfall than desert ,show white incrustationsof salts of Ca ,Mg and Na on surface, poor drainage	Infertile	
PEATY AND MARSHY	When vegetation growing dies it decomposes very slowly due to excessive wetness of soil.After hundreds of years layer of partly decayed organic matter accumulates on surface, giving rise to peaty and marshy soil.Black coloured,heavy and highly acidic soils. When properly drained ,fertilized produce good rice.		Kerala(Kari soil), coastal track of OD, Sunderbans areas of WB

SOIL EROSION

Removal, transport, deposition of soil from one location on Earth crust to another. Occurs naturally but anthropogenic activities have increased it. It lead to decrease in productivity, desertification and finally ecological collapse.

Causes of Soil Erosion

- Water: Sheet erosion, gully, rill.
- Wind: Saltation, Suspension, Surface creep
- Solifluction: gradual movement of wet soil or other material down a slope, especially where frozen sub soil acts as a barrier to percolation of water.
- aRa soil flow age . Seen in tundra in summers. combined with wind erosion, responsible for 84%. degraded land because of permafrost, water cannot percolate below, giving soil particles a saturated , heavy, saggy appearance.
- Slip erosion : aka landslides. Water , gravity in combination moves large amount of matter down the slope
- Steam bank erosion: Rivers during floods splash their water against banks and cuts through them.

Methods of soil conservation:

1. Agronomic Methods:

(a) contour: Alternate furrows with ridges

(b) Mulching: stalk, base, stem etc of plant left on field to form a protective layer called mulch. Ex:

- Sugarcane, maize

(c) crop rotation: Prevention of depletion of minerals by growing alternating crops especially leguminous plants like pulses.

(d) Strip cropping: Planting cropsin strips/rows to prevent water flow.

2. Agrostological Method: Grasses are used as erosion preventing. Ex Lay farming where grasses are used in rotation with field crops.

Eutrophication

Eutrophication is a process where water bodies, like lakes and rivers, become overly enriched with nutrients (mainly nitrogen and phosphorus). This causes a rapid growth of algae and other plants, which can lead to several problems:

1. **Algae Blooms:** The excess nutrients cause algae to grow quickly and cover the water surface.
2. **Oxygen Depletion:** When the algae die, they sink to the bottom and decompose, a process that uses up oxygen in the water.
3. **Harm to Aquatic Life:** The lack of oxygen makes it difficult for fish and other aquatic animals to survive.
4. **Water Quality Issues:** The water can become murky, smelly, and unsuitable for drinking or recreation.

In simple terms, eutrophication is like over-fertilizing a garden, but instead of helping, it makes the water unhealthy and harms the living things in it.

Process of eutrophication-

1. **Nutrient Enrichment:** Excess nutrients, primarily nitrogen and phosphorus, enter a water body. These nutrients often come from agricultural runoff, sewage discharge, industrial effluents, and the use of fertilizers.
2. **Algal Bloom:** The surplus nutrients stimulate the rapid growth of algae and other aquatic plants. This sudden increase in algae is called an algal bloom. The water may turn green or another color depending on the type of algae.
3. **Decomposition:** When the algae die, they settle at the bottom of the water body. Bacteria and other microorganisms decompose the dead algae, using up oxygen in the process.
4. **Oxygen Depletion:** The decomposition process consumes a significant amount of dissolved oxygen in the water. This creates areas with low oxygen levels, known as hypoxic zones, and can even lead to anoxic conditions where oxygen is completely depleted.

5. **Harm to Aquatic Life:** The low oxygen levels make it difficult for fish and other aquatic animals to survive. This can lead to the death of many aquatic organisms, reducing biodiversity and altering the ecosystem.
6. **Water Quality Deterioration:** The water becomes murky, often emitting foul odors. This makes the water less suitable for drinking, swimming, fishing, and other recreational activities.

Productivity

Biomass: Biomass is the total mass of living organisms in a specific area at a specific time. It's like weighing all the plants, animals, and other living things in a particular place.

- **Species Biomass:** This is the weight of all the individuals of a single species in that area. For example, if you took all the oak trees in a forest and weighed them, that would be the species biomass for oak trees.
- **Community Biomass:** This is the weight of all the living things in an area, including plants, animals, and microorganisms. It's like putting everything in the area on a giant scale to see how much it all weighs together.
- **Dry Weight:** Biomass is often measured in terms of dry weight, which means the weight of the organisms after removing all the water. This is usually 60-80% of the total weight because living things contain a lot of water.
- **Organically Bound Carbon:** Another way to measure biomass is by looking at the amount of carbon that is bound up in organic compounds in the organisms. Carbon is a key part of all living things, so this gives a good measure of biomass.

Landing Crop: The landing crop is the total dry weight of all the organisms at a particular level of the food chain (trophic level) in a specific area. It's like taking all the plants (or all the herbivores, or all the predators) in an area, drying them out, and weighing them to see how much biomass they represent at that level of the food chain.

PRIMARY PRODUCTION	PRIMARY PRODUCTIVITY
Total amount of biomass or organic matter produced per unit area. Unit in terms of weight or energy(kcal/m^2) Rate of production is called productivity	Amount of biomass/organic matter(in terms of dry weight) produced per unit area over a time period by plants during photosynthesis. Expressed in terms of weight or energy/area/time

Primary Productivity is of two types:

1. Gross Primary Productivity (GPP): This is the total amount of organic matter (like plant material) produced by plants during photosynthesis. Think of it as the total energy plants capture from sunlight and convert into food.

2. Net Primary Productivity (NPP): This is the amount of organic matter left after the plants have used some of that energy for their own respiration (breathing). It's the energy available to herbivores (animals that eat plants) and decomposers (organisms that break down dead matter). You can think of it as the leftover food after the plants have taken what they need to live.

Secondary Productivity: This is the rate at which consumers (animals) create new organic matter by eating plants or other animals. It's like measuring how much new animal matter (like muscle and fat) is produced from the food they consume.

Energy Flow

1. **Producers:** These are green plants in the ecosystem. They are called producers because they produce their own food through photosynthesis.
    - In land (terrestrial) ecosystems, producers are mainly vascular plants, which are plants with specialized tissues for transporting water and nutrients.
    - In water (aquatic) ecosystems, producers include phytoplankton and algae.
2. **Food Chain:** This is a linear sequence of organisms where each one is eaten by the next one in the chain. It shows how energy and nutrients flow through an ecosystem.
    - It starts with autotrophs (producers like plants that make their own food).
    - Next are herbivores (animals that eat plants).
    - Then come carnivores (animals that eat other animals).
    - It ends with decomposers (organisms like bacteria and fungi that break down dead plants and animals).
3. **Detritus Food Chain/Web:** This starts when any organism dies. Decomposers break down the dead material, returning nutrients to the soil, which plants then use to grow.
4. **Trophic Levels:** These are the different levels in a food chain, representing a step in the flow of energy and nutrients. Typically, there are four trophic levels:
    - First trophic level: Producers (plants)
    - Second trophic level: Herbivores (plant-eating animals)
    - Third trophic level: Carnivores (animals that eat herbivores)
    - Fourth trophic level: Top carnivores (animals that eat other carnivores)

In simple terms, green plants are the producers in an ecosystem, making food that supports all other life forms. A food chain shows who eats whom, starting from plants and ending with decomposers. There are usually four levels in this chain, with energy flowing from plants to herbivores to carnivores and finally to top carnivores. When any organism dies, decomposers recycle its nutrients back into the ecosystem.

Types of Food chain

1. **Grazing Food Chain:** This type of food chain starts with plants or other photosynthetic organisms and is dominant in aquatic ecosystems.
    - **In Aquatic Ecosystem:**
        - Starts with phytoplankton (tiny plant-like organisms).
        - Phytoplankton are eaten by zooplankton (tiny animal-like organisms).
        - Zooplankton are eaten by small fish.
        - Small fish are eaten by larger fish.
    - **In Terrestrial Ecosystem:**