



Core Concepts

Ecosystems

Definition: A community of living organisms (biotic) interacting with each other and their physical environment (abiotic).

Key Components:

- Producers (autotrophs)
- Consumers (heterotrophs)
- Decomposers (saprotrophs)
- Abiotic factors: sunlight, water, temperature, nutrients

Trophic Levels: Hierarchical levels in an ecosystem, representing the flow of energy and nutrients.

Examples:

- Primary producers (plants)
- Primary consumers (herbivores)
- Secondary consumers (carnivores)
- Tertiary consumers (top predators)

Ecological Succession: The process of change in the species structure of an ecological community over time.

Types:

- Primary succession: Occurs in lifeless areas (e.g., after volcanic eruption).
- Secondary succession: Occurs in areas disturbed but with soil intact (e.g., after a fire).

Biogeochemical Cycles

Water Cycle (Hydrologic Cycle) Evaporation, transpiration, condensation, precipitation, runoff, infiltration. Crucial for all life; influences weather patterns.

Carbon Cycle Photosynthesis, respiration, decomposition, combustion. Linked to climate change through greenhouse gas emissions (CO2).

Nitrogen Cycle Nitrogen fixation, nitrification, assimilation, ammonification, denitrification. Essential for plant growth; impacted by fertilizers.

Phosphorus Cycle Weathering, absorption by plants, consumption by animals, decomposition. Limiting nutrient in many ecosystems; no atmospheric phase.

Population Ecology

Population Growth:

- Exponential growth: J-shaped curve, occurs under ideal conditions.
- Logistic growth: S-shaped curve, considers carrying capacity (K).

Carrying Capacity (K): The maximum population size that an environment can sustain given available resources.

Factors affecting K: Food, water, shelter, competition, predation, disease.

Population Dynamics: Factors influencing population size and structure over time.

Examples: Birth rate, death rate, immigration, emigration.

Environmental Problems

Climate Change

Causes: Increased greenhouse gas concentrations (CO2, CH4, N2O) due to human activities (fossil fuel combustion, deforestation).

Effects: Rising global temperatures, sea-level rise, altered precipitation patterns, extreme weather events, ocean acidification.

Mitigation Strategies: Reducing greenhouse gas emissions through renewable energy, energy efficiency, carbon capture, and storage.

Adaptation Strategies: Preparing for the impacts of climate change through infrastructure improvements, disaster preparedness, and ecosystem restoration.

Key Agreements:

- Kyoto Protocol: International treaty committing industrialized nations to reduce greenhouse gas emissions.
- Paris Agreement: Global agreement to limit global warming to well below 2 degrees Celsius above pre-industrial levels.

Pollution

Air Pollution Sources: Industrial emissions, vehicle exhaust, burning fossil fuels. Effects: Respiratory problems, acid rain, smog.

Water Pollution Sources: Industrial discharge, agricultural runoff, sewage. Effects: Eutrophication, contaminated drinking water, harm to aquatic life.

Soil Pollution Sources: Pesticides, heavy metals, industrial waste. Effects: Reduced soil fertility, bioaccumulation in food chains.

Plastic Pollution Sources: Improper disposal of plastic products. Effects: Marine debris, harm to wildlife, microplastic contamination.

Biodiversity Loss

Causes: Habitat destruction, invasive species, pollution, overexploitation, climate change.

Effects: Loss of ecosystem services, reduced resilience to environmental changes, increased risk of species extinction.

Conservation Strategies: Habitat preservation, restoration, species management, combating poaching, promoting sustainable use of resources.

Key Organizations:

- IUCN (International Union for Conservation of Nature)
- WWF (World Wildlife Fund)
- Conservation International

Resource Management

Water Resources

Water Scarcity: Insufficient water resources to meet demand.
Causes: Population growth, climate change, overuse, pollution.
Management Strategies: Water conservation, efficient irrigation, wastewater treatment, desalination.
Sustainable Water Use: Using water resources in a way that meets present needs without compromising the ability of future generations to meet their own needs.
Key Practices: Reducing water waste, protecting water quality, managing watersheds.

Energy Resources

Fossil Fuels	Coal, oil, natural gas. Non-renewable, contribute to climate change and air pollution.
Renewable Energy	Solar, wind, hydro, geothermal, biomass. Sustainable alternatives to fossil fuels.
Energy Efficiency	Reducing energy consumption through technological improvements and behavioral changes.

Land Resources

Deforestation: Clearing forests for other land uses (agriculture, urbanization).
Consequences: Soil erosion, habitat loss, climate change.
Sustainable Forestry: Managing forests to meet present needs without compromising the ability of future generations to meet their own needs.
Soil Degradation: Loss of soil fertility and structure.
Causes: Erosion, compaction, nutrient depletion, pollution.
Sustainable Agriculture: Practices that maintain soil health, conserve water, and reduce pollution.

Laws and Policies

Key Environmental Laws

Clean Air Act (CAA): Regulates air emissions from stationary and mobile sources.
Clean Water Act (CWA): Regulates discharges of pollutants into U.S. waters.
Endangered Species Act (ESA): Protects endangered and threatened species and their habitats.
Resource Conservation and Recovery Act (RCRA): Regulates the management of hazardous and non-hazardous solid waste.
Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA): Also known as Superfund, provides for cleanup of hazardous waste sites.

International Agreements

Montreal Protocol	International treaty designed to protect the ozone layer by phasing out the production of numerous substances that are responsible for ozone depletion.
Kyoto Protocol	International treaty committing industrialized countries to reduce greenhouse gas emissions.
Paris Agreement	International agreement to combat climate change and limit global warming to well below 2 degrees Celsius above pre-industrial levels.
Convention on Biological Diversity (CBD)	International treaty to conserve biological diversity, promote the sustainable use of its components, and ensure the fair and equitable sharing of the benefits arising out of the utilization of genetic resources.