

Unit 6: Ecology

Introduction

What is Ecology?

Ecology is the branch of biology that studies the interactions among organisms and their environment. It helps us understand how living things, from tiny bacteria to large animals, interact with each other and with their surroundings. Scientists who study ecology are called ecologists. They often focus on ecosystems, which are specific areas where living things (biotic factors) and non-living things (abiotic factors) interact.

Key Terms

- **Ecosystem:** A system comprising all living organisms and non-living components in a particular area.
- **Biotic Factors:** The living components of an ecosystem, such as plants, animals, bacteria, and fungi.
- **Abiotic Factors:** The non-living components of an ecosystem, such as light, temperature, water, and nutrients.

Abiotic Factors

Abiotic factors are the physical and chemical aspects of the environment that influence living organisms. Some important abiotic factors include:

- **Light:** Essential for photosynthesis in plants. In aquatic environments, light penetrates only to a certain depth.
- **Temperature:** Affects the metabolic rates of organisms. Most organisms thrive within a specific temperature range.
- **Water:** Crucial for all life. Terrestrial organisms face issues with water loss, while aquatic organisms depend on dissolved oxygen.
- **Nutrients:** Vital for plant growth. Soil composition and nutrient availability can influence plant distribution.
- **Salinity:** The salt concentration in water affects organisms in aquatic ecosystems.
- **Wind:** Influences water loss and temperature on land.

Biotic Factors

Biotic factors involve interactions between living organisms. These interactions can include:

- **Predation:** When one organism (predator) kills and eats another (prey).

- **Herbivory:** When organisms (herbivores) eat plants.
- **Pollination:** The transfer of pollen from one flower to another, facilitating reproduction in plants.
- **Competition:** Organisms compete for resources like food, water, and mates.

Ecological Levels

Ecologists study different levels of biological organization to understand the complexity of interactions:

1. **Organism:** An individual living entity.
2. **Population:** A group of individuals of the same species living in a specific area.
3. **Community:** All the populations of different species living and interacting in a particular area.
4. **Ecosystem:** The community of organisms interacting with their abiotic environment.
5. **Biosphere:** The global sum of all ecosystems, encompassing all living beings and their relationships.

Ecosystems

An ecosystem includes both biotic and abiotic components:

- **Example:** A lake ecosystem consists of aquatic plants, fish, birds, and the water, soil, and sunlight they depend on.
- **Types:**
 - **Terrestrial Ecosystems:** Found on land (e.g., forests, fields).
 - **Aquatic Ecosystems:** Found in water (e.g., ponds, lakes, oceans).

Ecosystems are self-sustaining. Plants and algae use sunlight for photosynthesis, animals feed on plants and other animals, and decomposers break down dead organisms, recycling nutrients back into the environment.

By understanding these ecological concepts, we can better appreciate the delicate balance of nature and the importance of preserving our environments.

Biomes

Biomes are major ecological communities defined by their climate, vegetation, and animal life. They can be broadly categorized into terrestrial and aquatic biomes.

Terrestrial Biomes

1. Tropical Rain Forests

- **Location:** Between latitudes 10° north and south of the equator (e.g., Amazon Basin, Congo Basin).
- **Climate:** Warm temperatures (25°C or 77°F) and high rainfall (130-200 cm annually) year-round.
- **Vegetation:** Dense, multi-layered forests with broad-leaf evergreen trees. Intense competition for light.
- **Fauna:** High biodiversity, including amphibians, birds, reptiles, mammals, and arthropods.
- **Threats:** Deforestation due to logging and agriculture, reducing the ability to absorb CO₂.

2. Deserts

- **Location:** About 30° north and south latitude (e.g., Atacama Desert, Gobi Desert).
- **Climate:** Very low rainfall (<10 cm annually) and extreme temperatures (hot deserts >50°C, cold deserts <-30°C).
- **Vegetation:** Succulents (cacti), shrubs, and herbs adapted to conserve water.
- **Fauna:** Snakes, lizards, scorpions, ants, beetles, migratory birds, and rodents. Many species are nocturnal to avoid daytime heat.
- **Threats:** Urbanization and agriculture reduce biodiversity.

3. Savannas

- **Location:** Between tropical forests and deserts (e.g., African savannas, parts of India and Australia).
- **Climate:** Warm temperatures (24-29°C) with seasonal rainfall (30-50 cm annually) and long dry periods.
- **Vegetation:** Scattered trees, grasses, and small plants adapted to fire and drought.
- **Fauna:** Large herbivores (giraffes, zebras) and carnivores (lions, hyenas). Migration patterns depend on seasonal forage availability.
- **Threats:** Overgrazing, deforestation, and fire management issues.

4. Temperate Grasslands

- **Location:** North America's prairies (e.g., Great Plains).
- **Climate:** Warm summers and cold winters, with annual rainfall (25-100 cm).
- **Vegetation:** Grasses with deep roots that prevent erosion. Historically supported large herds of herbivores.
- **Fauna:** Bison, pronghorn antelope, and predators like wolves. Much has been converted to farmland.
- **Threats:** Agricultural expansion and habitat loss.

5. Boreal Forests (Taiga)

- **Location:** South of the Arctic Circle (e.g., Canada, Russia).
 - **Climate:** Cold winters, short cool summers, and annual snowfall (40-100 cm).
 - **Vegetation:** Coniferous trees (pines, spruces) adapted to cold. Soils are acidic and low in nitrogen.
 - **Fauna:** Cold-tolerant species such as moose, bears, and wolves. Plant diversity is lower than in temperate forests.
 - **Threats:** Logging and climate change.
6. **Temperate Broad-Leaved Forests**
- **Location:** Mid-latitudes in the Northern Hemisphere (e.g., eastern North America, parts of Europe).
 - **Climate:** Warm summers, cold winters, and varied rainfall (70-200 cm).
 - **Vegetation:** Deciduous trees that shed leaves in winter. Forests recover well from disturbances.
 - **Fauna:** Mammals hibernate and birds migrate. These forests have been heavily logged but are recovering.
 - **Threats:** Urban development and deforestation.
7. **Tundras**
- **Location:** Arctic regions and high mountains (e.g., Alaska, Siberia).
 - **Climate:** Very cold with low temperatures (<10°C in summer) and low precipitation (20-60 cm).
 - **Vegetation:** Low-growing plants such as mosses, grasses, and lichens. Permafrost restricts root growth.
 - **Fauna:** Musk oxen, caribou, bears, and migratory birds. Mineral and oil extraction impact these areas.
 - **Threats:** Climate change and resource extraction.

Aquatic Biomes

1. **Lakes**
- **Description:** Standing bodies of water ranging from small ponds to large lakes.
 - **Characteristics:** Vary in salinity, oxygen, and nutrients. Aquatic plants and algae are primary producers.
 - **Threats:** Pollution, nutrient enrichment (algal blooms), and habitat degradation.
2. **Wetlands**
- **Description:** Shallow areas with soil saturated by water. Includes marshes, swamps, and bogs.
 - **Characteristics:** High productivity and nutrient filtering. Dominated by specific plants like sphagnum moss in bogs.
 - **Threats:** Drainage and land conversion for agriculture.
3. **Streams and Rivers**

- **Description:** Flowing water systems that vary from cold and clear headwaters to warmer, sediment-rich downstream areas.
- **Characteristics:** Water quality and biodiversity decrease with pollution and damming.
- **Threats:** Pollution, habitat disruption, and altered flow regimes.

4. Estuaries

- **Description:** Areas where freshwater meets seawater, such as river mouths and coastal bays.
- **Characteristics:** Highly productive, with varying salinity and rich in nutrients. Important breeding grounds for marine species.
- **Threats:** Pollution, land reclamation, and habitat disruption.

Understanding these biomes helps us appreciate the diversity of life on Earth and the importance of conserving these ecosystems for future generations.

Ecological Relationships

In ecology, organisms interact with each other and their environment in various ways. These interactions are known as ecological relationships and can significantly influence survival and reproduction. Here's an overview of the key types of interspecific interactions:

1. Competition (-/-)

What is Competition? Competition occurs when individuals of different species (or the same species) vie for the same limited resources, such as food, water, or space. This interaction can negatively impact both species because the resource is insufficient to meet the needs of all individuals.

Example:

- **Weeds vs. Garden Plants:** Weeds compete with cultivated plants for soil nutrients and water, potentially harming the growth of the garden plants.
- **Predators:** Different predators may compete for the same prey, such as lions competing for antelopes.

2. Predation (+/-)

What is Predation? Predation involves one species, the predator, killing and consuming another species, the prey. This interaction benefits the predator but harms the prey.

Example:

- **Rotifer and Protist:** A rotifer, a small aquatic animal, preys on a protist by eating it.

3. Herbivory (+/-)

What is Herbivory? Herbivory is when an herbivore eats parts of a plant or alga, damaging the plant but not necessarily killing it. Herbivores can be mammals or insects, and they often have adaptations to help them consume and process vegetation.

Example:

- **Giraffes and Trees:** Giraffes feed on leaves from trees, which can harm the trees but generally doesn't kill them.
- **Grasshoppers:** They have specialized mouthparts for consuming plant material.

4. Parasitism (+/-)

What is Parasitism? Parasitism involves one organism, the parasite, benefiting at the expense of another organism, the host. The parasite derives nourishment from the host, which is harmed in the process.

Example:

- **Ticks and Mammals:** Ticks attach to mammals and feed on their blood.
- **Blood Fluke:** Requires both humans and freshwater snails to complete its life cycle.

5. Mutualism (+/+)

What is Mutualism? Mutualism is a relationship where both interacting species benefit. Each partner provides something that the other needs, leading to a mutually beneficial interaction.

Example:

- **Mycorrhizae:** Fungi and plant roots exchange nutrients; fungi receive carbohydrates from the plants, and plants get essential minerals like phosphorus from the fungi.
- **Pollinators and Flowers:** Pollinators like bees help flowers reproduce by transferring pollen, while they get nectar for themselves.

6. Commensalism (+/0)

What is Commensalism? Commensalism is a relationship where one species benefits while the other is neither helped nor harmed. The benefiting species gains something from the interaction, but the other species is unaffected.

Example:

- **Cattle Egrets and Herbivores:** Cattle egrets feed on insects disturbed by grazing herbivores. The egrets benefit from the increased food, while the herbivores are generally unaffected.

Summary

Ecological relationships are crucial for understanding how organisms interact within their ecosystems. These relationships can shape community structure, influence survival, and affect biodiversity. By studying these interactions, we gain insights into the complexities of natural environments and the dynamic interplay between different species.