Learning Guide for Module 2

Introduction

Energy Flow through Ecosystems

- Ecosystems exist underground, on land, at sea, and in the air.
- Organisms in an ecosystem acquire energy in a variety of ways, which is transferred between trophic levels as the energy flows from the base to the top of the food web, with energy being lost at each transfer. There is energy lost at each trophic level, so the lengths of food chains are limited because there is a point where not enough energy remains to support a population of consumers.
- Fat soluble compounds biomagnify up a food chain causing damage to top consumers even when environmental concentrations of a toxin are low.

Biogeochemical Cycles

- Mineral nutrients are cycled through ecosystems and their environment. Of particular importance are water, carbon, nitrogen, phosphorus, and sulfur. All of these cycles have major impacts on ecosystem structure and function.
- As human activities have caused major disturbances to these cycles, their study and modeling is especially important. Ecosystems have been damaged by a variety of human activities that alter the natural biogeochemical cycles due to pollution, oil spills, and events causing global climate change.
- The health of the biosphere depends on understanding these cycles and how to protect the environment from irreversible damage.

Terrestrial Biomes

- Earth has terrestrial and aquatic biomes. Aquatic biomes include both freshwater and marine environments.
- There are eight major terrestrial biomes: tropical rainforests, savannas, subtropical deserts, chaparral, temperate grasslands, temperate forests, boreal forests, and Arctic tundra. The same biome can occur in different geographic locations with similar climates.
- Temperature and precipitation, and variations in both, are key abiotic factors that shape the composition of animal and plant communities in terrestrial biomes.
- Some biomes, such as temperate grasslands and temperate forests, have distinct seasons with cold and hot weather alternating throughout the year.
- In warm, moist biomes, such as the tropical rainforest, net primary productivity is high as warm temperatures, abundant water, and a year-round growing season fuel plant growth.
- Other biomes, such as deserts and tundra, have low primary productivity due to extreme temperatures and a shortage of water.

Aquatic and Marine Biomes

- Aquatic biomes include both saltwater and freshwater biomes.
- The abiotic factors important for the structuring of aquatic biomes can be different than those seen in terrestrial biomes. Sunlight is an important factor in bodies of water, especially those that are very deep, because of the role of photosynthesis in sustaining certain organisms.
- Other important factors include temperature, water movement, and salt content.
- Oceans may be thought of as consisting of different zones based on water depth, distance from the shoreline, and light penetrance.
- Different kinds of organisms are adapted to the conditions found in each zone. Coral reefs are unique marine ecosystems that are home to a wide variety of species. Estuaries are found where rivers meet the ocean; their shallow waters provide nourishment and shelter for young crustaceans, mollusks, fishes, and many other species.
- Freshwater biomes include lakes, ponds, rivers, streams, and wetlands.
- Bogs are an interesting type of wetland characterized by standing water, a lower pH, and a lack of nitrogen.

Population Demographics and Dynamics

- Populations are individuals of a species that live in a particular habitat.
- Ecologists measure characteristics of populations: size, density, and distribution pattern.
- Life tables are useful to calculate life expectancies of individual population members. Survivorship curves show the number of individuals surviving at each age interval plotted versus time.

Population Growth and Regulation

- Populations with unlimited resources grow exponentially—with an accelerating growth rate. When resources become limiting, populations follow a logistic growth curve in which population size will level off at the carrying capacity.

- Populations are regulated by a variety of density-dependent and density-independent factors.
- Life history characteristics, such as age at first reproduction or numbers of offspring, are characteristics that evolve in populations just as anatomy or behavior can evolve over time. The model of r- and K selection suggests that characters, and possibly suites of characters, may evolve adaptations to population stability near the carrying capacity (K-selection) or rapid population growth and collapse (r-selection).
- Species will exhibit adaptations somewhere on a continuum between these two extremes.

The Human Population

- Earth's human population is growing exponentially.
- Humans have increased their carrying capacity through technology, urbanization, and harnessing the energy of fossil fuels. The age structure of a population allows us to predict population growth. Unchecked human population growth could have dire long-term effects on human welfare and Earth's ecosystems.

Community Ecology

- Communities include all the different species living in a given area.
- The variety of these species is referred to as biodiversity. Many organisms have developed defenses against predation and herbivory, including mechanical defenses, warning coloration, and mimicry. Two species cannot exist indefinitely in the same habitat competing directly for the same resources. Species may form symbiotic relationships such as commensalism, mutualism, or parasitism.
- Community structure is described by its foundation and keystone species. Communities respond to environmental disturbances by succession: the predictable appearance of different types of plant species, until a stable community structure is established.

Selected key terms

biogeochemical cycle—the cycling of minerals and nutrients through the biotic and abiotic world.

biomagnification—an increasing concentration of persistent, toxic substances in organisms at each trophic level, from the producers to the apex consumers.

biome—a large-scale community of organisms, primarily defined on land by the dominant plant types that exist in geographic regions of the planet with similar climatic conditions.

carrying capacity—the maximum number of individuals of a population that can be supported by the limited resources of a habitat.

ecosystem-- a community of living organisms and their interactions with their abiotic environment.

foundation species—species which often forms the major structural portion of the habitat.

keystone species—species whose presence is key to maintaining biodiversity in an ecosystem and to upholding an ecological community's structure.

population density—the number of population members divided by the area being measured.

zero population growth—the steady population size where birth rates and death rates are equal.