CHAPTER 52 – INTRODUCTION TO ECOLOGY AND THE BIOSPHERE

I. WHAT DOES ECOLOGY STUDY?

- **Ecology** - the study of interactions between organisms and the environment
- Organisms all live in complex environment that include:
  - **Abiotic** components – the nonliving components of the environment such as water, light, temperature, nutrients, soil
  - **Biotic** components – the living components of the environment such as other organisms as foods, other resources, or predators
- These environmental factors limit the geographic range (distribution) and the abundance of species.

- Ecology is studied on several levels of organization
  - **Organism** – physiology, evolution, behavior of organisms in relation to environmental factors
  - **Population** – interactions of individuals of the same species, living in the same environment
  - **Community** – studies the interactions of all living organisms that are living in the same area
  - **Ecosystem** – emphasizes energy flow and chemical cycling among organisms (biotic components) and the abiotic environment
  - **Landscape** – describes how ecosystems are arranged within a region
  - **Biome** – includes all of the biotic and abiotic components as well as the climate in a particular area
  - **Biosphere** – includes the entire portion of Earth that is inhabited by life - studies global effects of climate change, ozone depletion, mass extinction etc.

II. Climate

- Four major abiotic components make up climate - **temperature, water, sunlight, and wind**
- Climate patterns can be described on two scales
  - **macroclimate** - patterns on the global, regional, and local level
  - **microclimate** - very fine patterns, such as those encountered by the community of organisms underneath a fallen log
- Earth’s global climate patterns – determined largely by the input of solar energy and the planet’s movement in space
  - Sunlight intensity

![Litudinal Variation in Sunlight Intensity](image)

**Seasonal Variation in Sunlight Intensity**

- **June solstice**: Northern Hemisphere tilted toward sun; summer begins; water freezes in Northern Hemisphere
- **March equinox**: Equator faces sun directly; neither pole tilted toward sun; all regions on Earth experience 12 hours of daylight and 12 hours of darkness
- **September equinox**: Equator faces sun directly; neither pole tilted toward sun; all regions on Earth experience 12 hours of daylight and 12 hours of darkness
- **December solstice**: Northern Hemisphere tilted away from sun; winter begins in Northern Hemisphere; summer begins in Southern Hemisphere
o Air circulation and wind patterns

GLOBAL AIR CIRCULATION AND PRECIPITATION PATTERNS

o Oceans and their currents, and large lakes moderate the climate of nearby terrestrial environments

Lakes – sensitive to seasonal temperature change and experience seasonal turnover

1. In winter, the coldest water in the lake (0°C) sits just below the surface ice; water is progressively warmer at deeper levels of the lake, typically 4-5°C at the bottom.

2. In spring, as the sun melts the ice, the surface water warms to 4°C and sinks below the cooler layers immediately below, eliminating the thermal stratification. Spring winds mix the water to great depth, bringing oxygen (O₂) to the bottom waters (see graphs) and nutrients to the surface.

3. In autumn, as surface water cools rapidly, it sinks below the underlying layers, remixing the water until the surface begins to freeze and the winter temperature profile is reestablished.

4. In summer, the lake regains a distinctive thermal profile, with warm surface water separated from cold bottom water by a narrow vertical zone of rapid temperature change, called a thermocline.

o Mountains have a significant effect on the amount of sunlight reaching an area, local temperature and rainfall
III. TERRESTRIAL BIOMES:

- **Biomes** – major types of ecological associations that occupy broad geographic regions of land or water
- **Climographs** (plots of temperature and precipitation to show the distribution of various biomes) are mostly constructed for plants in a particular region

- Annual means for temperature and rainfall are well correlated with the biomes that exist in different regions.
- Other factors that determine the type of terrestrial biome are the pattern of climatic variation, bedrock type, soil type because they affect vegetation.
- General features of terrestrial biomes:
  - Named for major physical and climatic features and dominant vegetation
  - Include plants, microorganisms, fungi and animals
  - The shapes and sizes of plants define layering (ex. Canopy – low trees – shrubs – herbaceous plants – forest floor – root layer)
  - There is constant disturbance in biomes by various factors so they show patchiness and variety
<table>
<thead>
<tr>
<th>BIOME</th>
<th>CHARACTERISTICS</th>
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<tbody>
<tr>
<td>Tropical Rainforest</td>
<td>equatorial; greatest biodiversity; intense vertical stratification; canopy so dense/little light gets through; very wet; warm year-round; rapid turnover of nutrients; many plants &amp; animals, epiphytes (plant live on other plants)</td>
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<tr>
<td>Savanna (Tropical Grassland)</td>
<td>grasses and scattered trees; dominant herbivores = insects; fire = dominant abiotic factor; many plants fire-adapted/drought tolerant; plant growth is substantial in rainy season; large animals must migrate during regular seasons of drought; temperature: always warm</td>
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<td>Desert</td>
<td>sparse rainfall; plants &amp; animals adapted to conserve/store water; many CAM plants and plants adapted to prevent being eaten (spines on cacti); temperature: varies daily/seasonally, hot &amp; cold extremes; sparse vegetation &amp; animals: cacti, succulents, drought tolerant, reptiles, insects, rodents, birds</td>
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<td>Chaparral</td>
<td>dominant: dense, spiny evergreen shrubs; coastal area w/cool rainy winters and long, hot, dry summers; scrubby vegetation; plants are drought/fire adapted; herbivores, amphibians, birds, insects</td>
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<tr>
<td>Temperate Grassland (Prairie)</td>
<td>seasonal drought w/ occasional fires; many herbivores; large grazing animals; precipitation: seasonal, dry season/wet season; cold winters/hot summers; prairie grasses fire/drought adapted, few trees; deep, fertile soil good for agriculture</td>
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<tr>
<td>Temperate Deciduous Forest (Temperate Broadleaf Forest)</td>
<td>dense stands of deciduous (drop leaves in fall) trees; forests more open/not as tall as rain forests; stratified: top layer trees; shrubs, herbaceous layer; precipitation: adequate, summer rains, winter snow; temperature: moderate warm summer/cool winter; many mammals hibernate/birds migrate</td>
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<tr>
<td>Coniferous Forest (Taiga/Boreal Forest)</td>
<td>dominant: conifers; adequate to dry rainfall (temperate rain forest on coast); cool year round; diverse mammals, birds, insects</td>
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<td>Tundra (Artic &amp; Alpine)</td>
<td>permafrost (permanently frozen layer of soil); very cold temps year round; high winds; little rain; NO trees or tall plants; 20% or Earth’s terrestrial surface; lichens &amp; mosses, migrating animals &amp; resident herbivores</td>
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IV. AQUATIC BIOMES

- Aquatic biomes account for the largest part of the biosphere in terms of area. Ecologists usually distinguish between fresh water biomes (salt concentration is less than 1 %) and marine biomes (salt concentration is more than 3 %)
- Aquatic biomes are physically and chemically stratified:

  ![Zonation in a lake](image)

  ![Marine zonation](image)

  - Light intensity decreases sufficiently because water and photosynthetic organisms absorb it.
    - **Photic zone** – has sufficient light for photosynthesis
    - **Aphotic zone** – does not have sufficient light for photosynthesis
    - **Benthic zone** – the bottom of all aquatic biomes, mostly made up of sand and organic and inorganic sediments. Mostly detritus eaters (organisms that eat dead, decomposing organic matter) live there and predators that eat them.
    - **Thermocline** – narrow zone of rapidly changing temperature that separates the warm upper and cold lower layers of lakes and oceans.

- Lakes are the most important standing water biomes. **Oligotrophic lakes** are deep lakes that are usually poor in nutrients (organic materials) but rich in oxygen with lower temperatures, and low phytoplankton concentration. **Eutrophic lakes** are shallower, rich in nutrients with lower concentration of oxygen and higher phytoplankton concentration.
- Aquatic biomes can be described by analyzing salinity, oxygen content, organic content, turbulence, light intensity, temperature

V. SPECIES DISTRIBUTION AND DISPERSAL

- **Dispersal** – the movement of organisms from centers of high density or from center of origin to other areas
- Dispersal can be two kinds:
  - **Natural range expansions** – organisms move into previously uninhabited areas as a natural way of expanding the population
  - **Species transplants** – species artificially or accidentally introduced and reproduce in new location

http://www.youtube.com/watch?v=V5513w1XSK - invasive species
http://www.youtube.com/watch?v=ROsstvMHz4 - Burmese python
Factors that influence the distribution of species:

- **Behavior and habitat selection** - Certain behaviors like mating, reproduction, nest building habits, etc., can eliminate habitats that otherwise would be very suitable. (ex. European corn borer only deposits its eggs on corn although they eat a wide variety of plants)

- **Biotic Factors** - Some host species may be necessary for parasites to reproduce in new areas or pollination cannot occur without certain pollinator species, specific nutrient requirements may be necessary (ex. Koalas only eat eucalyptus leaves; parasites that cause malaria need the Anopheles mosquito to infect humans)

- **Abiotic factors** - Temperature - affects biological processes such as germination or enzyme activities. Water - some organisms can tolerate only fresh water, while others only sea water (different osmoregulation). Terrestrial organisms face a constant threat of dehydration. Sunlight - Driving force of photosynthetic organisms and also influence the daily activities of other organisms (photoperiod regulation). Wind - influence temperature control, growth of plants and water loss. Rocks and soil - its composition, pH limit the distribution of plants and of the animals that feed on them.

- **Climate** - Temperature, water, sunlight and wind are the major abiotic components of climate - the prevailing weather conditions in a particular area.