Chapter 52: Introduction to Ecology and the Biosphere

1. Global Climate
2. Terrestrial Biomes
3. Aquatic Biomes
4. Factors Affecting Species Distribution
1. Global Climate
Latitude and Sunlight Intensity

The angle at which sunlight strikes the earth is increasingly obtuse further from the equator.

As a result, the sunlight nearer the poles is less intense since its energy is spread over a greater surface area.

This is largely why equatorial regions have warmer climates and polar regions have colder climates.
Due to the earth’s tilt, the angle at which sunlight strikes each part of earth’s surface also changes as earth revolves around the sun. This is the basis of seasons.
Air Circulation Patterns

Global air circulation is driven by 2 factors:

- differences in temperature
- Earth's rotation

Global air circulation and precipitation patterns
Global Cells of Airflow

(arrows indicate general direction of surface airflow)
3 major Global Cells in each hemisphere

• **Hadley Cells** (equator to ~30° N, 30° S)
  • driven by rising warm air at the equator that then flows towards the poles

• **Ferrel Cells** (~30° N, 30° S to ~60° N, 60° S)
  • driven by airflow at the boundaries of Hadley and Polar Cells

• **Polar Cells** (~60° N, 30° S to north, south poles)
  • driven by sinking cold air at the poles that then flows toward the equator

*east/west direction determined by Coriolis Effect which is a consequence of earth’s rotation*
The Coriolis Effect

Below: The spin of the Earth means that anything flying through the air will veer to the right in the northern hemisphere and to the left in the south.

- Earth’s surface rotates fastest at equator, slowest at the poles
- Effects anything airborne moving north or south (including air masses)
- Veer to right in northern hem., veer to left in southern hem.
Solar heating at Earth’s surface cause air to rise, cool, release moisture, flow laterally, then down & back to source.
Deserts tend to form at the Hadley/Ferrel Cell boundaries (~30°) due to loss of moisture in the equatorial regions.
Oceanic Circulation Patterns

Ocean currents heat or cool overlying air masses and have a huge effect on climate.

- e.g., the Gulf Stream and the California Current
The Effect of Coastal Mountains

- every 1000 m (1 km) increase in elevation results in a decrease in temperature of \( \sim 6^\circ \) C.
- the cooler air cannot hold as much moisture resulting in precipitation on the windward side of the mountains.
- the air passing over the mountains on the leeward side is therefore much drier – a phenomenon called **Rain Shadow**.
2. **Terrestrial Biomes**
The Terrestrial Biomes

- Tropical forest
- Savanna
- Desert
- Chaparral
- Temperate grassland
- Temperate broadleaf forest
- Northern coniferous forest
- Tundra
- High mountains
- Polar ice
Biomes Depend on Climate

- Climate is determined by seasonal patterns of temperature (the amount of heat) and precipitation (the amount of water).
- Different climates support different forms of plant life which support different forms of animal life.
Tropical Forest

- Tropical rain forests required constant moisture and warm temperatures
- Tropical dry forests occur when rainfall is seasonal

A tropical rain forest in Costa Rica
Desert

- deserts occur where there is <30 cm of precipitation/year

Desert biomes are not dictated by temperature which can vary dramatically.

- deserts typically occur near 30° north or south where dry air sinks back towards the earth’s surface

Organ Pipe Cactus National Monument, Arizona
Savanna

- temperature is warm year round with alternating seasons of heavy rainfall and extended dryness during which fires are common

- characterized by grasses, scattered trees and shrubs

A savanna in Kenya
Chaparral

- cool rainy winters and hot dry summers characteristic of some coastal regions

- plant life consists of a mixture of small trees, shrubs and grasses

An area of chaparral in California
Temperate Grassland

- seasonal rain, snow with 30-100 cm precipitation per year
- drought and fires are common

- grazing animals along with harsh conditions discourage tree growth

A grassland in Mongolia
Temperate Broadleaf Forest

- higher levels of precipitation (rain and snow) than in grasslands along with cold winters
- dominated by deciduous trees that drop their leaves seasonally
- lack of light reaching the ground during the warmer months discourages grasses

A temperate broadleaf forest in New Jersey
Northern Coniferous Forest

- also known as taiga, characterized by harsh, long winters with periods of drought

- temperate rain forests are cool coastal regions that have very high rainfall, up to 300 cm per year

A coniferous forest in Norway
Tundra

- extremely long, cold winters and permafrost prevent the growth of trees

- dominated by mosses, grasses and lichens
3. Aquatic Biomes
Key Features of Aquatic Biomes

The “climates” of aquatic biomes fluctuate little if at all due to water’s high heat capacity.

Aquatic biomes collectively occupy much more of the earth than terrestrial biomes:

- most the surface of the earth is covered by water
- unlike terrestrial biomes which essentially are spread out on land surfaces in 2 dimensions, aquatic biomes also occupy a 3rd dimension – depth

Aquatic biomes vary primarily in relation to water depth and proximity to land…
Zonation in Aquatic Biomes

The **PELAGIC ZONE** encompasses all open water away from the coasts and includes the following zones:

**PHOTIC ZONE**
- upper layer where there is sufficient light penetration for photosynthesis

**APHOTIC ZONE**
- all water beneath the photic zone
- includes the **abyssal zone** which is everything below 2000 m
- also includes the **benthic zone** at the very bottom
Marine Zonation

The **INTERTIDAL ZONE** is above water at high tide and below water at low tide.

The **NERITIC ZONE** is the coastal marine region before the drop-off of the continental shelf.
Fresh Water (Lake) Zonation

The **LITTORAL ZONE** is the region of water near the coast where light penetrates all the way to the bottom.

The **LIMNETIC ZONE** is the deeper regions of a lake where light does not penetrate to the bottom.
A **THERMOCLINE** is an abrupt transition to colder water at deeper depths due to a lack of light penetration.

Seasonal temperature changes (Spring & Fall) can result in mixing, a process called **TURNOVER** which circulating $O_2$ to greater depths.
Lakes

**OLIGOTROPHIC** lakes are poor in nutrients and typically rich in $O_2$.

**EUTROPHIC** lakes are just the opposite, high in nutrients and poor in $O_2$. 

An oligotrophic lake in Jasper National Park, Alberta

A eutrophic lake in the Okavango Delta, Botswana
Wetlands

Areas dominated by plants that grow in water saturated soils.

A basin wetland in the United Kingdom
Streams & Rivers

Characterized by high water flow and frequently high turbidity.

A headwater stream in Washington

The Loire river in France, far from its headwaters
Estuaries

Transitions between a river (freshwater) and the sea (salt water).

An estuary in southern Spain
Intertidal Zones

Coastal marine environments that alternate on a daily basis between being submerged under seawater and exposed to the air due to the tides.

A rocky intertidal zone on the Oregon coast
Ocean Pelagic Zones

The open ocean which is the largest biome on earth.
Marine Benthic Zones

The sea floor below the photic zone which contains ecosystems dependent on organic detritus drifting down from above or chemoautotrophs that thrive in hydrothermal vent regions.
Coral Reefs

Built on the calcium carbonate skeletons of corals which build up over time.

The most biologically diverse aquatic biome.

A coral reef in the Red Sea
4. Factors Affecting Species Distribution
Species Distribution Factors

ABIOTIC Factors

• factors that don’t involve living things such as temperature, water availability, light, mineral nutrients, pH, oxygen, salinity, soil

BIOTIC Factors

• factors that do involve living things such as predators, pathogens, pollinators, grazing animals, the capacity of a species to physically disperse
Distribution of Saguaro Cacti

**ABIOTIC Factors**

- do not tolerate freezing
- you saguaros do not tolerate extended droughts

**BIOTIC Factors**

- young saguaros eaten by herbivores
- depend on bat pollinators
- vulnerable to certain bacterial pathogens
Sea Urchins Limit Seaweed Distribution

Both sea urchins and limpets graze on seaweed.

This experiment shows that urchins are the primary biotic factor limiting the dispersal of seaweeds in this particular region.
Position of the Tree Line

Above certain elevations trees don’t grow due to abiotic factors – too much UV light, lack of water, extreme cold.