



Chapter 7: Climate and Terrestrial Biodiversity

APES 2013

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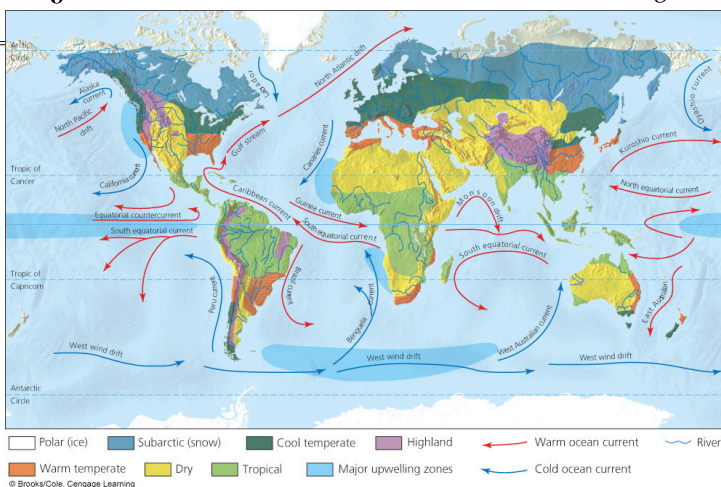
Climate

- ✦ Weather - local area's short-term temperature, precipitation, humidity, wind speed, cloud cover, etc.
- ✦ Climate - an area's general pattern of atmospheric or weather conditions measured over long periods of time (decades to thousands of years)
- ✦ "Climate is what we expect; weather is what we get." - Mark Twain

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Major Climate Zones

Fig. 7-2



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Causes of Climate Differences

- ✦ Mostly because of global air circulation patterns and ocean currents
 - ✦ These forces distribute heat unevenly
- ✦ Major factors:
 - ✦ **Uneven heating of the earth's surface by the sun**
 - ✦ **Rotation of the earth on its axis**
 - ✦ **Properties of air, water, and land**

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Uneven heating of the earth's surface by the sun

- ✦ Sunlight is more direct at the equator so the air there is heated more
- ✦ At the poles, sunlight strikes indirectly and spreads out

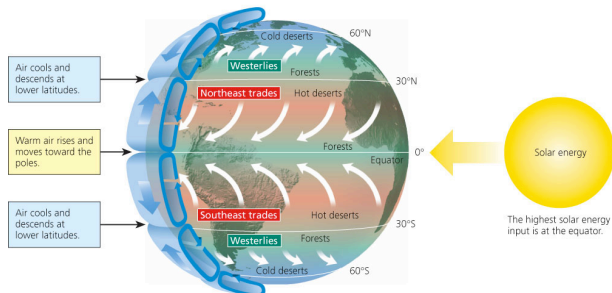


Fig. 7-3

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Rotation of the earth on its axis

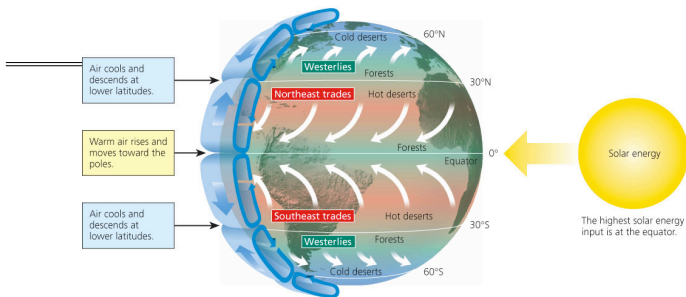


Fig. 7-3

- ✦ The equator spins faster than the polar regions.
 - ✦ This causes the air that rises above the equator and moves north or south to cooler areas to be deflected east and west. These areas are called **cells**. The direction the air moves are called the **prevailing winds**.

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Properties of air, water, and land

- ✦ Heat from the sun evaporates ocean water and transfers heat from the oceans to the atmosphere (especially near the equator)
- ✦ This creates giant convection cells that circulate, air, heat, and moisture both vertically and from place to place

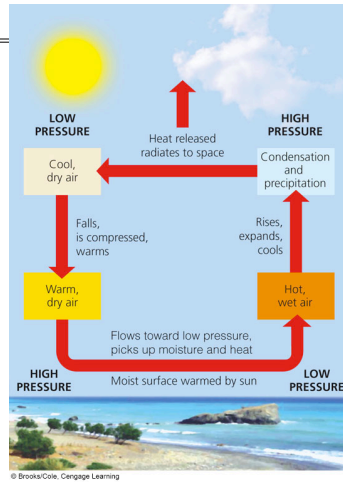


Fig. 7-4

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Currents

- ✦ Currents - prevailing winds blowing over the ocean produce movement of surface water
- ✦ These currents are also driven by the earth's rotation.
- ✦ The currents redistribute heat and greatly influence coastal areas.
- ✦ Oceans absorb heat from the sun and air movement.
- ✦ Heat and differences in water density create warm and cold currents that flow in circular patterns (clockwise in the northern hemisphere, and counterclockwise in the southern hemisphere)

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Currents and Density

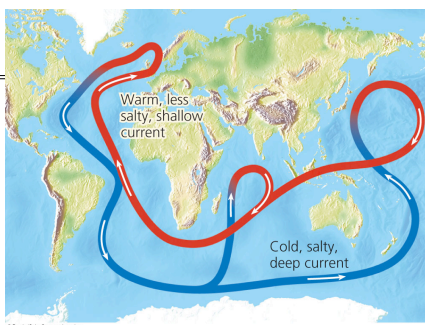


Fig. 7-5

- ✦ Cold seawater has a higher density, thus it sinks
- ✦ This causes a loop of deep and shallow ocean currents
- ✦ This world-wide conveyor belt moves heat to and from the deep sea and surface as well as tropics to poles

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El-Niño

- * Occurs every few years when prevailing winds in the tropical Pacific Ocean weaken and change direction
- * This causes above average warming of the Pacific Ocean which impacts marine species by changing the distribution of nutrients
- * Also alters the weather of the two-thirds of the planet for one or two years.

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Convection Cells

- * Six giant convection cells in the lower atmosphere (3 north of the equator and 3 south of the equator)
- * Warm, moist air rises and cools
- * Cool, dry air sinks
- * This leads to the distribution of climates

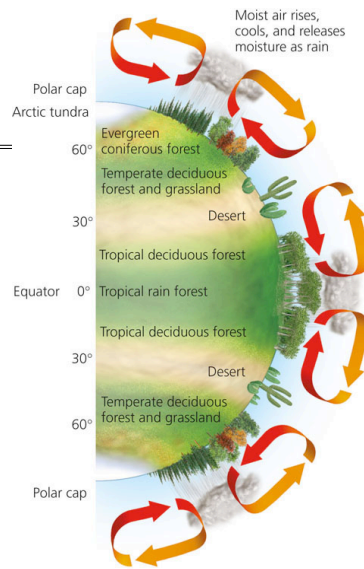


Fig. 7-6

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Greenhouse Gasses

- * Greenhouse gases - allow mostly visible and some infrared and ultraviolet radiation to pass through the atmosphere
 - * This heat is then transformed into lower wavelength IR radiation (heat) back to the atmosphere
 - * Some of the heat escapes into space, but some is absorbed by the greenhouse gasses
- * Greenhouse effect - natural warming of the troposphere
- * Without the natural greenhouse effect, life would not be possible on earth.

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Human-Enhanced Global Warming

- ✦ Humans input large amounts of greenhouse gasses into the atmosphere
- ✦ These additional gasses trap even more heat which causes the planet to further warm.
- ✦ This can alter precipitation patters, raise sea levels, and shift habitats

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Earth's Surface Features

- ✦ Heat is released more slowly by water than land
 - ✦ This creates land and sea breezes and allows bodies of water to moderate the temperature in coastal areas.
- ✦ Rain Shadow:
 - ✦ When moist air blows inland from an ocean and hits a mountain range, it is forced upward.
 - ✦ The air cools as it rises which causes rain and snow to fall on the mountain.
 - ✦ The now drier air passes over the mountaintop and warms which allows it to suck up moisture from plants and soil

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Rain Shadow

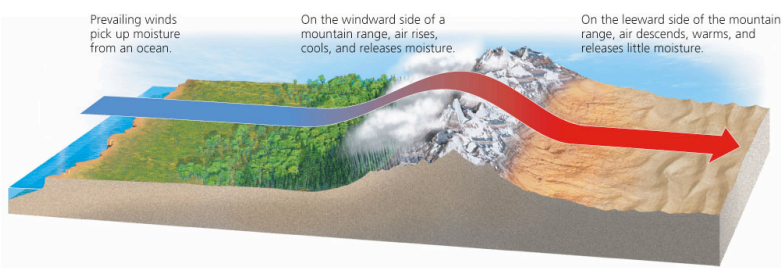


Fig. 7-7

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Cities and Climate

- * Bricks, concrete, asphalt, and other building materials absorb and hold heat.
- * Buildings also block and reroute wind flow
- * Automobiles and industries release large amounts of pollution and heat
- * All of this causes cities to have more haze and smog

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Biomes

- * Biomes - large terrestrial regions characterized by the similar climate, soil, plants, and animals regardless of where they are found

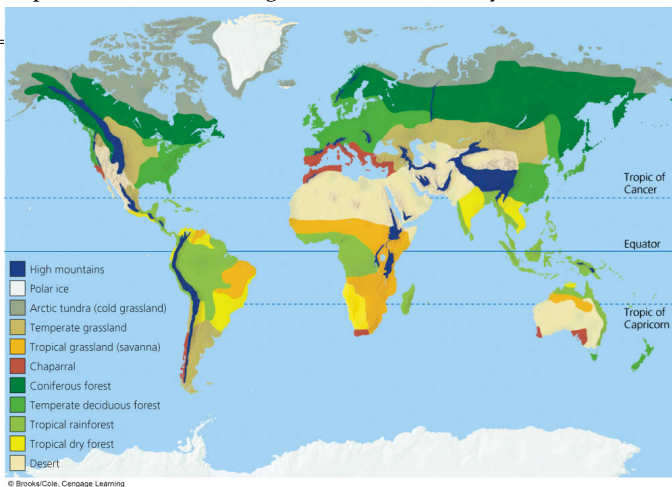


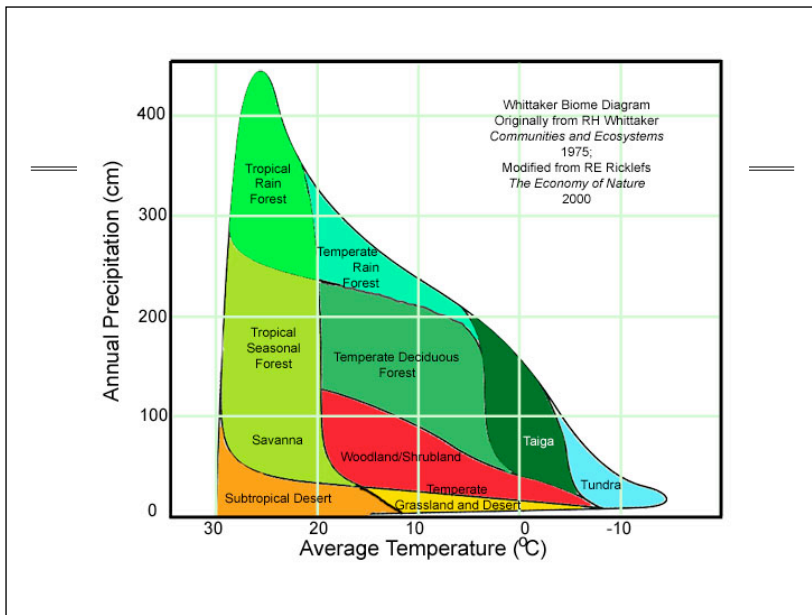
Fig.
7-8

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Biomes

- * Biomes are not as easily defined as they seem on a map. Each community is different, but they at least have similarities
- * Many of the differences occur because humans have impacted the environment and removed or altered vegetation.

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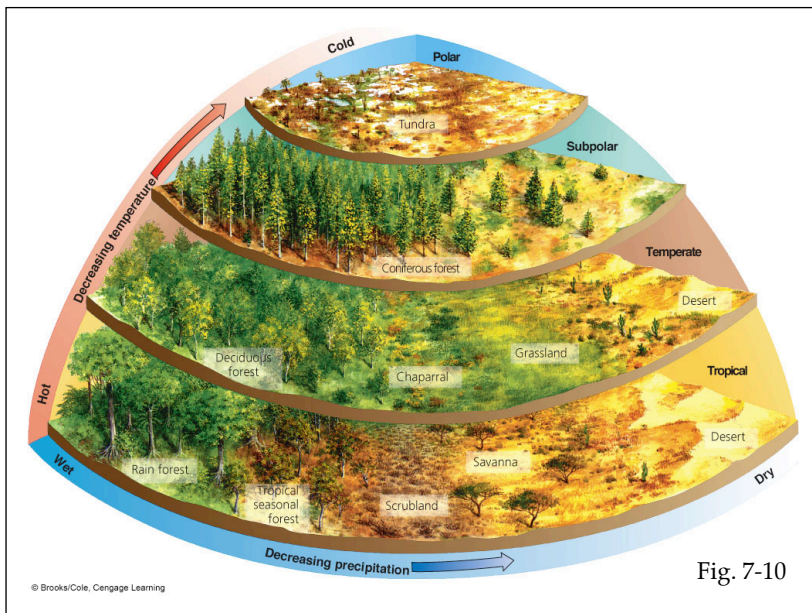
Biomes

Fig. 7-9

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- * Climate and vegetation vary with latitude and elevation changes
- * Climbing a mountain will allow you to see the same changes that would be evident by traveling from the equator to the poles.

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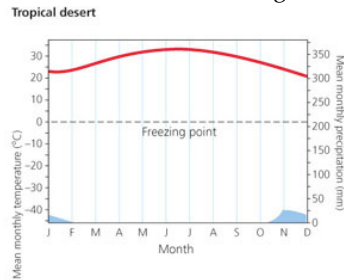
Desert

✦ Characteristics:

- ✦ Annual precipitation is low and scattered unevenly.
- ✦ Very little vegetation and moisture in the soil.
- ✦ During the day, the sun warms the ground and causes evaporation from plant leaves and soil.
- ✦ During the night, the heat stored in the ground radiates into the atmosphere.
- ✦ Three types of deserts: tropical, temperate, and cold

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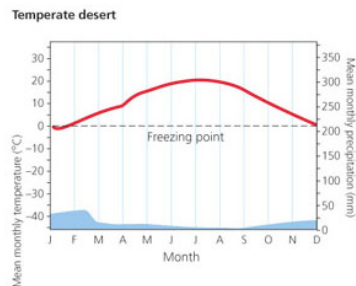
Tropical Desert



- ✦ Hot and dry most of the year
- ✦ Few plants
- ✦ Sand storms have increased because of overgrazing and vehicles breaking the surface crust

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Temperate Desert

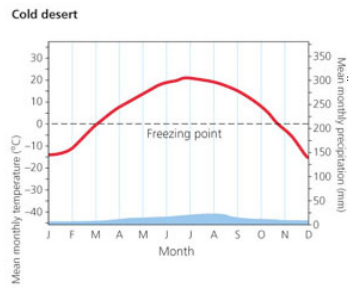


- ✦ Daytime temps are high in summer and low in winter
- ✦ More precipitation than tropical deserts
- ✦ Drought resistant shrubs

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Cold Desert

Fig. 7-11



- * Sparse vegetation
- * Winters are cold, summers are warm or hot
- * Precipitation is low

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Deserts are fragile ecosystems

- * Soil takes decades or hundreds of years to recover from disturbances like off-road vehicles
- * This is because of slow plant growth, low species diversity, slow nutrient cycles (because of low biological activities) and they lack water

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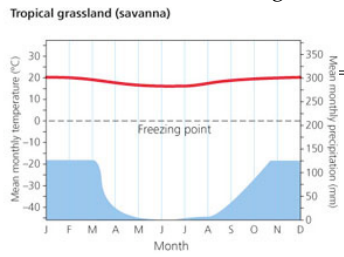
Grasslands

- * Characteristics:
 - * Usually in the interiors of continents
 - * Areas too moist for deserts and too dry for forests
 - * Seasonal drought
 - * Grazing by large herbivores
 - * Occasional fires (keep large trees and shrubs from growing)
- * Three types: tropical, temperate, cold

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Tropical Grasslands

Fig. 7-12



- * Called **Savanna**
- * widely scattered trees (ex. Acacia, a tree covered in thorns to stop herbivores from eating it)
- * warm temps year round
- * alternating wet and dry seasons

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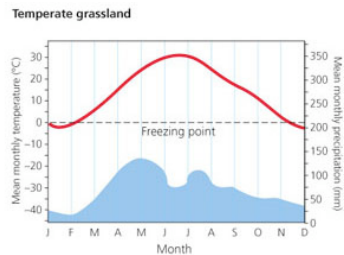
Tropical Grassland Biodiversity

- * Example: East Africa
 - * Herds of grazing and browsing hoofed animals (wildebeests, gazelles, zebras, giraffes)
 - * Predators (lions, hyenas, humans)
 - * Migration in response to seasonal and year-to-year rainfall differences
 - * Specialized roles (**niches**):
 - * Giraffes eat from tops of trees, elephants eat leaves farther down
 - * Wildebeests eat short grasses, zebras eat longer grasses
 - * Grasses have deep roots to minimize the impact of drought

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Temperate Grassland

Fig. 7-12



- * Bitterly cold winters, hot and dry summers
- * Precipitation is sparse and uneven
- * Deep fertile soil because of decomposing grass (high levels of organic matter)
- * Grasses are adapted to fire

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Temperate Grassland

- * Two types:
 - * Tall-grass prairies
 - * 88 cm (35 in) rain per year
 - * Deep roots
 - * Short-grass prairies
 - * 25 cm (10 in) rain per year
 - * Short roots
- * All prairies:
 - * Wind blows almost continuously
 - * Evaporation is rapid
 - * Fires hinder tree growth
 - * Many have disappeared because the land is used for crops

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Temperate Grassland

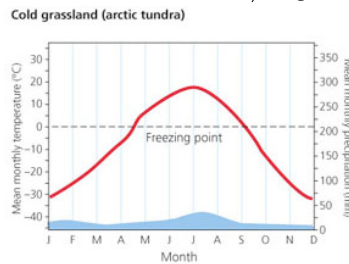
Fig. 7-13

- * Removal of the biologically diverse species with monoculture crops causes natural capital degradation
- * When humans remove the roots networks of natural grasses the topsoil is eaten away by wind erosion



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Cold Grassland (Arctic Tundra) Fig. 7-12



- * South of the arctic polar ice cap
- * Bitterly cold with frigid winds, covered by ice and snow
- * Long, dark winters
- * Precipitation falls mostly as snow (dry climate)

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Cold Grassland

- * Vegetation:
 - * Thick mat of low-growing plants (grasses, mosses, lichens, dwarf shrubs)
 - * Trees and tall plants cannot survive (lose too much heat)
 - * Growth occurs in the 7 or 8 week summer (sun shines 24/7)
- * Animals:
 - * Need thick coats (arctic wolf, arctic fox, musk oxen), or thick feathers (snowy owl)
 - * Live underground (arctic lemming)
 - * Migration (caribou)

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Cold Grassland

- * Permafrost - soil where water stays frozen for more than two consecutive years
 - * Keeps melted snow and ice from soaking into the ground in summer
 - * Causes seasonal lakes and wetlands to form which attract mosquitos, flies and other insects that serve as food for migratory birds
 - * Global warming is causing the permafrost to melt which disrupts ecosystems, releases methane and carbon dioxide trapped in the soil (which leads to even more global warming)
 - * Global warming also causes the soil to sink (subsidence) which damages buildings, roads...

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Cold Grassland

- * Tundra is a fragile biome
 - * Soils formed 17,000 years ago after the last ice age
 - * These soils are nutrient poor and have very little detritus
 - * Soil and vegetation recover very slowly because of the short growing season (especially evident around oil drilling sites)

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Cold Grassland (Alpine Tundra)

- ✦ Occurs above the tree line, but below the permanent snow line on high mountains
- ✦ Vegetation very similar to arctic tundra
- ✦ Receives more sunlight than arctic tundra

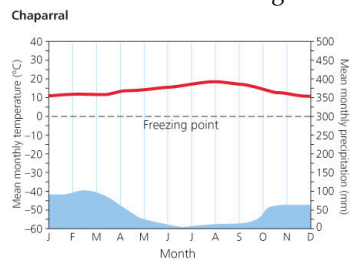
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Temperate Shrubland

Fig. 7-14



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- ✦ Also called chaparral
- ✦ Coastal regions that border on deserts
- ✦ Slightly longer winter rainy season than temperate deserts

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Temperate Shrubland

- ✦ Dense growths low-growing evergreen shrubs and some small trees
- ✦ Soil is thin and not very fertile
- ✦ Animals: mule deer, chipmunks, jackrabbits, lizards, and birds
- ✦ Dry summers lead to many fast-moving fires
- ✦ Plants are adapted to fire (food reserves in fire resistant roots and seeds that only sprout after a fire)
- ✦ People move here because of the moderate climate
 - ✦ Frequent fires in the dry season and mud slides during rainy season make living here difficult.

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Forests

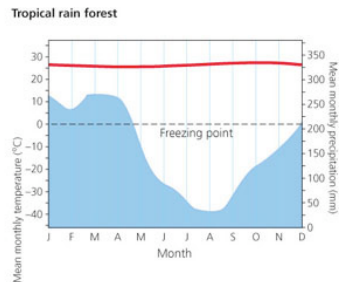
- ✦ Characteristics:

- ✦ Dominated by trees
- ✦ Three main types:
 - ✦ Tropical
 - ✦ Temperate
 - ✦ Cold (northern coniferous and boreal)

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Tropical Rain Forests

Fig. 7-15



- ✦ Found near the equator
- ✦ Year-round warm temperatures
- ✦ High humidity and heavy rainfall (almost daily)
- ✦ Dominated by broadleaf evergreen plants that create a canopy that blocks out most sunlight from the forest floor

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Tropical Rain Forests

- ✦ Competition for sunlight

- ✦ Plants must grow quickly to take advantage of holes opened up in the canopy from a fallen tree

- ✦ Some trees draped with vines

- ✦ High NPP

- ✦ huge amounts of biological diversity
- ✦ 2% of the earth's surface but may contain at least half of the earth's known terrestrial plant and animal species
- ✦ One tree may support thousands of insect species

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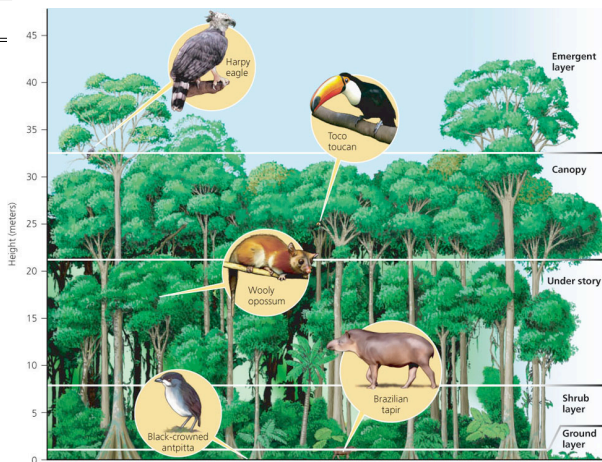
Tropical Rain Forests

- ✦ Daily rainfall causes many nutrients to be leached out from the soil.
- ✦ Most tropical rain forest soils contain very little plant nutrients
- ✦ This is why rain forest soils are not good for growing crops or animal grazing
- ✦ Even though these soils are not ideal, huge areas are cleared every year for these purposes.
- ✦ At least half of these forests have been destroyed by humans.

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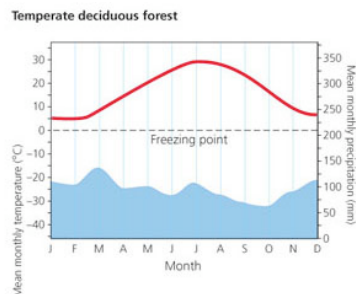
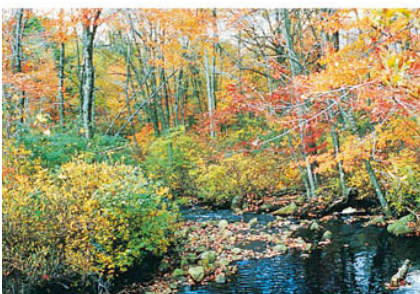
Tropical Rain Forest Niches

Fig. 7-17



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Temperate Deciduous Forests Fig. 7-12



- ✦ Moderate average temperatures that change significantly with seasons
- ✦ Long warm summers and cold but not severe winters
- ✦ Abundant precipitation spread fairly evenly throughout the year
- ✦ Broadleaf deciduous trees: oak, hickory, maple, poplar, and beech

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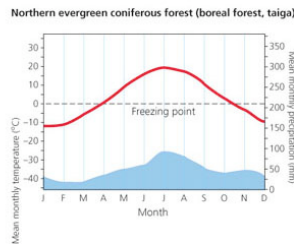
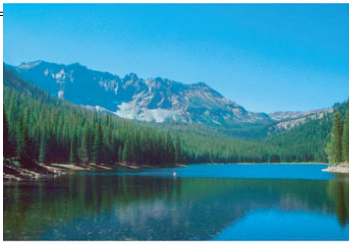
Temperate Deciduous Forests

- ✦ Slow rate of decomposition causes thick layers of organic matter in soil
- ✦ This biome has been disturbed by humans more than any other biome
- ✦ Within 100-200 years, disturbed lands can return to a deciduous forest through secondary succession
- ✦ United States: Once home to large predators (bears, wolves), most of these have been killed or displaced causing the dominant mammal to be the white-tailed deer.

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Cold Forests (Evergreen Coniferous Forests)

Fig. 7-12



- ✦ Also called boreal forests or taigas
- ✦ Found just south of arctic tundra
- ✦ Winters are long, dry, and extremely cold (6-8 hrs sun per day)
- ✦ Summers are short, cool (about 19 hrs sun per day)

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Cold Forests (Evergreen Coniferous Forests)

- ✦ Dominated by a few species of coniferous trees (spruce, fir, cedar)
- ✦ Needle-shaped, waxy-coated leaves withstand cold and drought of winter
- ✦ Plant diversity is low because few species can survive the winter
- ✦ Decomposition of leaf litter is slow because of low temperatures and high soil acidity
- ✦ Acidic, nutrient-poor soil prevents most plants from growing
- ✦ Variety of animals: bears, wolves, moose, rodents

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Coastal Coniferous Forests (Temperate Rain Forests)

Fig. 7-18

- ✦ Coastal temperate areas
- ✦ Ample rainfall or dense ocean fogs
- ✦ Vegetation: large conifers (Douglas fir, redwoods)



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Mountains

- ✦ Contain a majority of the earth's forests (plant and animal biodiversity)
- ✦ Regulate the earth's climate
 - ✦ Snow reflects radiation back to space (cools the earth)
 - ✦ Glaciers reflect radiation, but they are melting and the exposed rock absorbs radiation which speeds up global warming (positive feedback loop)
- ✦ Melting glaciers will also increase sea levels

Fig. 7-19



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Human Impact

- ✦ Estimated 62% of world's major terrestrial ecosystems are being used unsustainably



Fig. 7-20