24.10.14 Land Biomes

Part one: Land biomes

Hawaii biomes:

https://www.youtube.com/watch?v=ajpGScyuPiE

Download mod12-land_biomes.pdf (application/pdf, 6.2 MB)

Look:Here's what we learned so far:

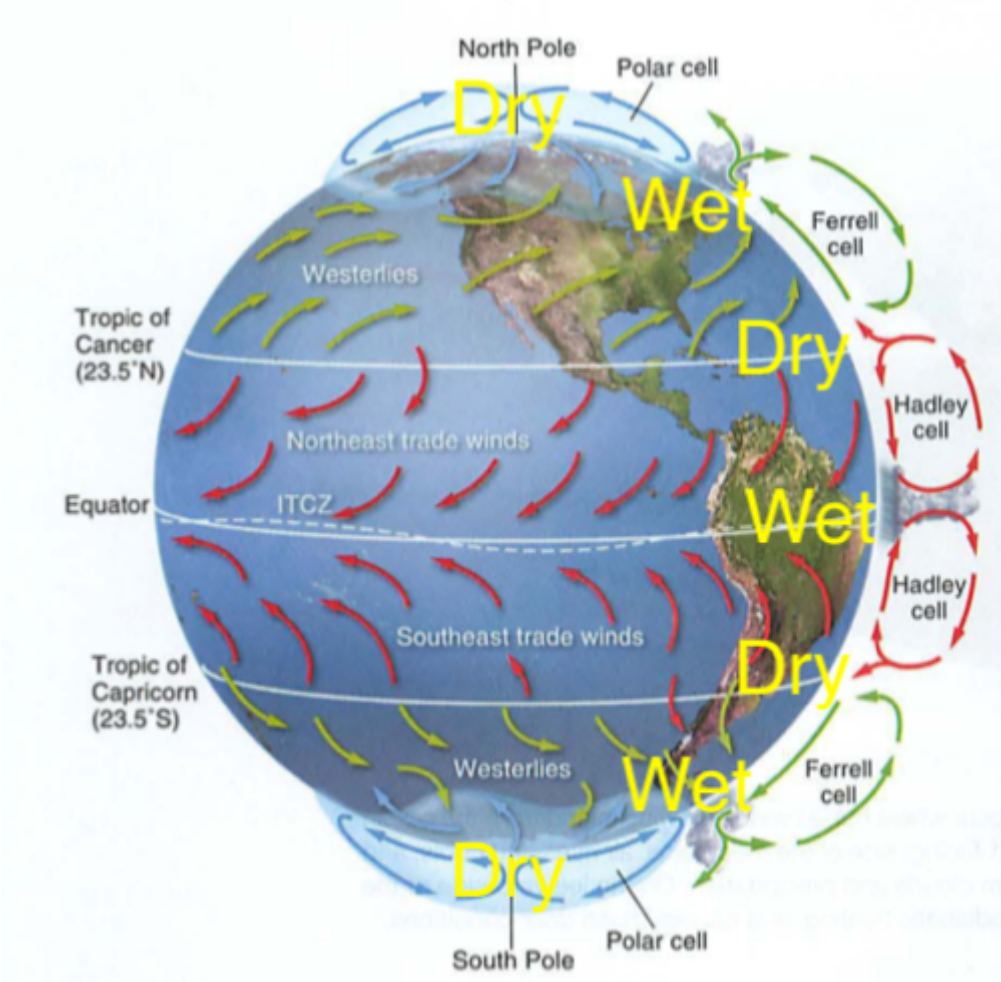


FIGURE 10.6 Prevailing wind patterns. Prevailing wind patterns around the world are produced by a combination of atmospheric convection currents and the Coriolis effect.

cd6cd.png

Now look at this map, and compare with your trusty globe:

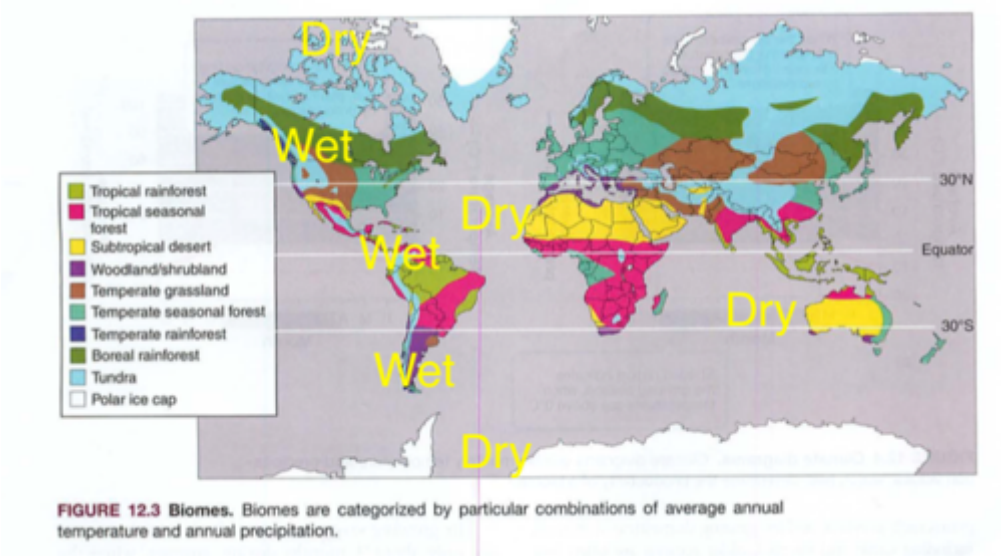


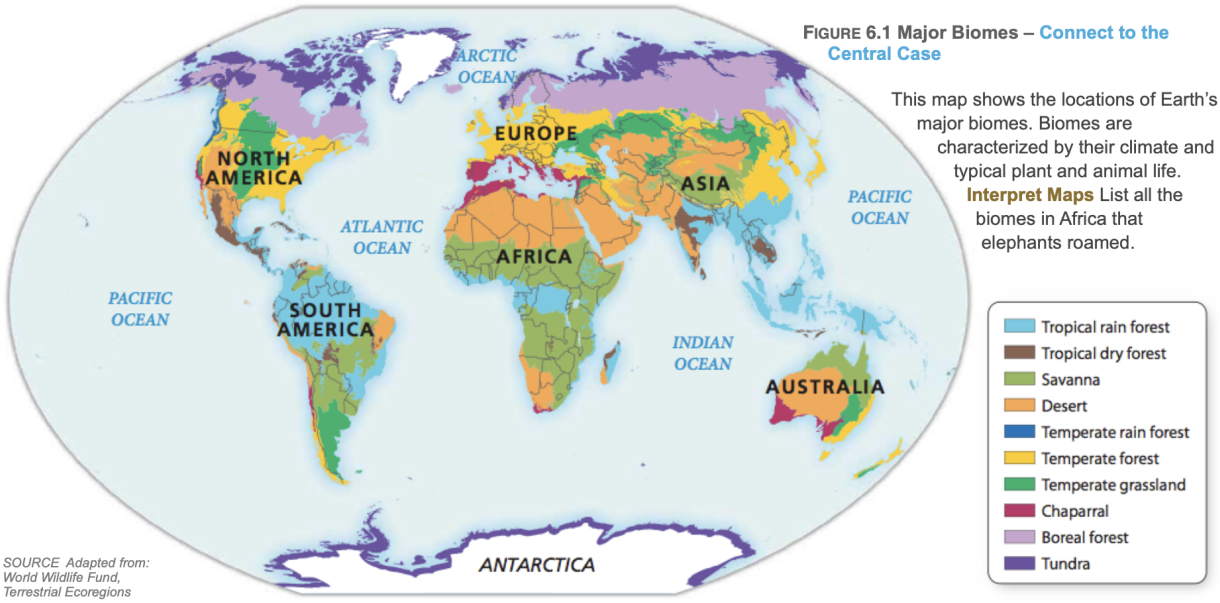
FIGURE 12.3 **Biomes.** Biomes are categorized by particular combinations of average annual temperature and annual precipitation.

6a22f.png

See the pattern? Pay close attention to cause and effect:

- onshore moist air from the Pacific ocean hits the mountains near Seattle=rainy there
- onshore moist air from the lower Atlantic ocean hits the amazon basin=rainy there
- dry air moving down from the Mediterranean moves over the Sahara Desert=dry there

Earth's Major Biomes Ecologists use similarities among ecosystems to classify them into broad categories called biomes. A **biome** is a group of ecosystems that share similar abiotic and biotic conditions. Although there are several different ways to categorize biomes, each varying slightly in the details, biomes are always primarily defined by their climate and typical plant and animal life. The world contains many biomes, each covering large areas. The major biomes discussed in this text are shown in the figure. The three main biomes in Southern Africa are desert, savanna, and chaparral. Succulent thicket is one of the ecosystems that makes up the chaparral biome. Succulent thicket is characterized by grasses and short fleshy plants.



SOURCE Adapted from: World Wildlife Fund, Terrestrial Ecoregions

FIGURE 6.1 Major Biomes – Connect to the Central Case

This map shows the locations of Earth's major biomes. Biomes are characterized by their climate and typical plant and animal life. **Interpret Maps** List all the biomes in Africa that elephants roamed.

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Biomes and Climate A region's climate largely determines which biome covers any particular portion of the planet. **Climate** describes the average conditions, including temperature and precipitation, over long periods in a given area. Climate is different from **weather,** the day-to-day conditions in Earth's atmosphere like "sunny and humid" or "cold and snowy." Scientists often use climate diagrams, or **climatographs,** to describe the conditions in a biome. This Harare, Zimbabwe climatograph is a typical climate diagram. You will see many examples of climatographs in the next lesson.

Because temperature and rainfall exert the greatest influence on biome classification, we can "plot" biomes according to these factors. Global climate patterns cause biomes to occur in large patches in different parts of the world. For instance, temperate forest is found in North America, north-central Europe, and eastern China. Note on the biome map that patches representing the same biome tend to occur at similar latitudes. This is due to the north–south gradient in temperature (temperatures get warmer toward the equator) and to atmospheric circulation patterns. You will learn more about these climate factors in a later chapter.

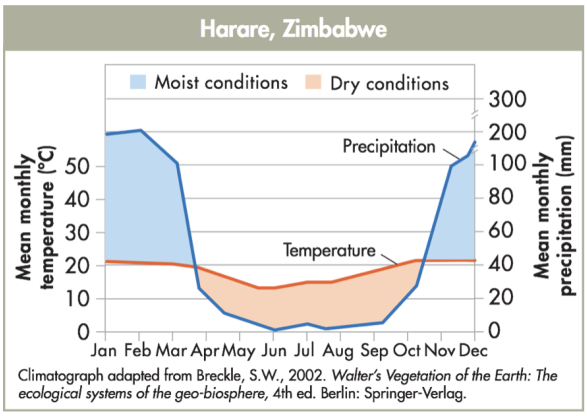


FIGURE 6.2 Biomes and Climate

Scientists use climate diagrams to illustrate an area's average monthly precipitation and temperature. The twin curves plotted on a climate diagram indicate trends in precipitation (blue) and in temperature (orange) from month to month. When the precipitation curve lies above the temperature curve, the region experiences relatively "moist" conditions, which we indicate with blue shading. Orange shading indicates relatively dry conditions.

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Biomes and Organisms Remember that natural selection results in the survival and reproduction of organisms best suited to their current environment. Although some organisms can thrive in a variety of conditions, each biome tends to have a suite of characteristic organisms adapted to its particular set of conditions. After all, organisms that thrive in the desert are not likely to do as well in the tropical rain forest! However, within any biome, there is some degree of variation among plant and animal communities.

The chaparral biome, for example, consists of a few different ecosystems, including the succulent thicket. Likewise, many different types of temperate forest, such as oak–hickory, beech–maple, and pine–oak forests, make up the temperate forest biome that covers most of the eastern United States. These variations within biomes can be caused by local differences such as soil type, elevation, or wind exposure.

YOUR WORLD, YOUR TURN

Find Out More

Use the Internet or other references to find the average monthly temperature and precipitation last year for your hometown or nearest large city. Plot both sets of data. In the next lesson, you can see if your graphs match the climatograph for your biome.

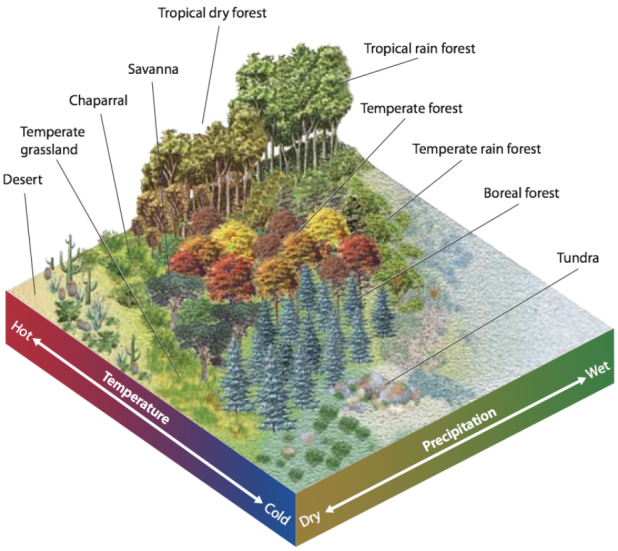


FIGURE 6.3 Biomes and Climate

Together, temperature and precipitation are the main factors that determine the biome in a given area. For instance, deserts occur in dry regions, tropical rain forests occur in warm wet regions, and tundra occurs in the coldest regions.

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There are about 9 Biomes, usually defined by **precipitation** (rain, fog, others) and **temperature**.

- The Big Island has 8 of the 9 biomes, or in the 12 biome model, we have 11/12, or 9 of 13, or 10 of 14 in another model.

- Many models...https://www.hawaiimagazine.com/content/hawaii-has-10-worlds-14-climate-zones-explorers-guide-each-them
- Traveling up a mountain is like crossing biomes. Check this out:

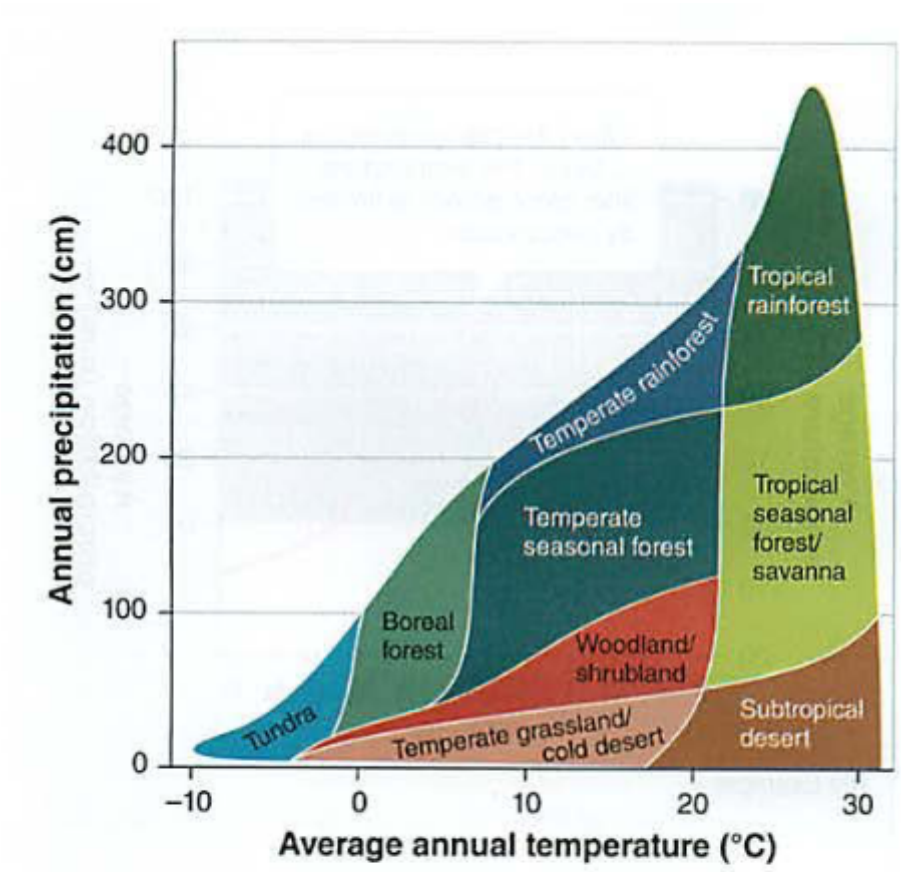


FIGURE 12.2 Locations of the world's biomes. Tundra and boreal biomes generally exist when the average annual temperature is less than 5°C (41°F). In contrast, temperate biomes exist in regions that experience average annual temperatures between 5°C and 20°C (41°F and 68°F). Tropical biomes exist in regions that experience average annual temperatures above 20°C.

302cd.png

- Imagine driving from Hamakua or Hilo up to the summit of Mauna Kea: tropical rain forest to temperate (mild) rain forest to boreal (north) forest to tundra.
- There is even a glacier up on Mauna Kea. Cool.
- This would be like starting in the upper right corner of the diagram and moving diagonally down and to the left.

Now check out the planet again:

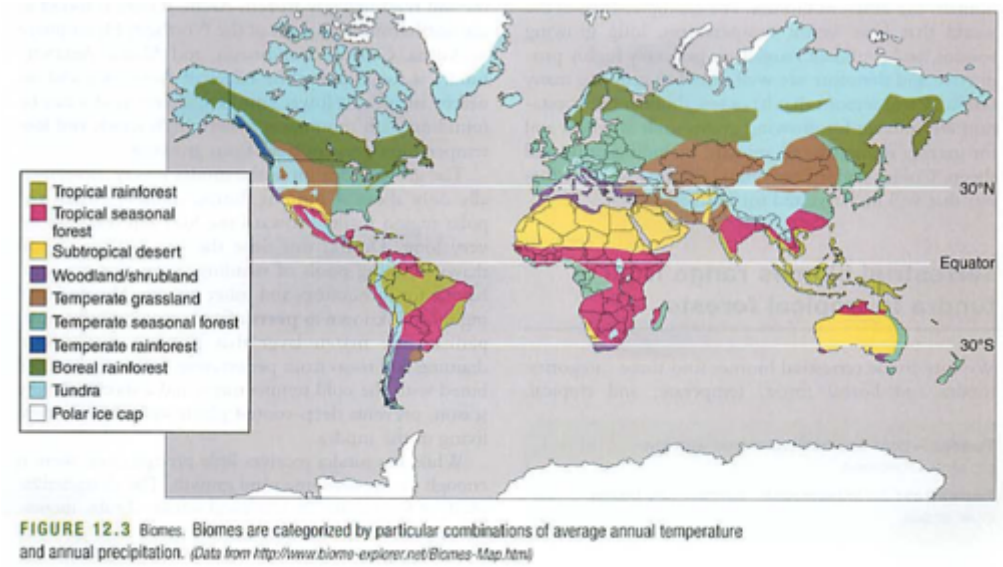


FIGURE 12.3 Biomes. Biomes are categorized by particular combinations of average annual temperature and annual precipitation. (Data from http://www.biome-explorer.net/Biomes-Map.html)

703d0.png

Notice the horizontal bands. If you've read "Guns Germs and Steel" you know that humans migrated horizontally, so their crops and livestock would thrive in similar biomes. See? Migrating north to south is tough.How is this changing?https://climate.nasa.gov/interactives/climate-time-machine

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Climate change and biomes

Find your home here:

https://impactlab.org/map/#usmeas=absolute&usyear=1986-2005&gyear=1986-2005

Then zoom ahead to when you are 100 years old in 2008 or so...

https://fitzlab.shinyapps.io/cityapp/

Biomes and biodiversity:

Biomes provide the physical and climatic framework, while biodiversity fills that framework with living systems. Warmer and wetter biomes usually support greater biodiversity, while harsher biomes restrict it.

Biodiversity is complex (genes, species, ecosystems), ecologists usually talk in **relative terms**: how species richness compares across biomes. I'll use the **classic global biodiversity gradient** (warm + wet = highest; cold + dry = lowest).

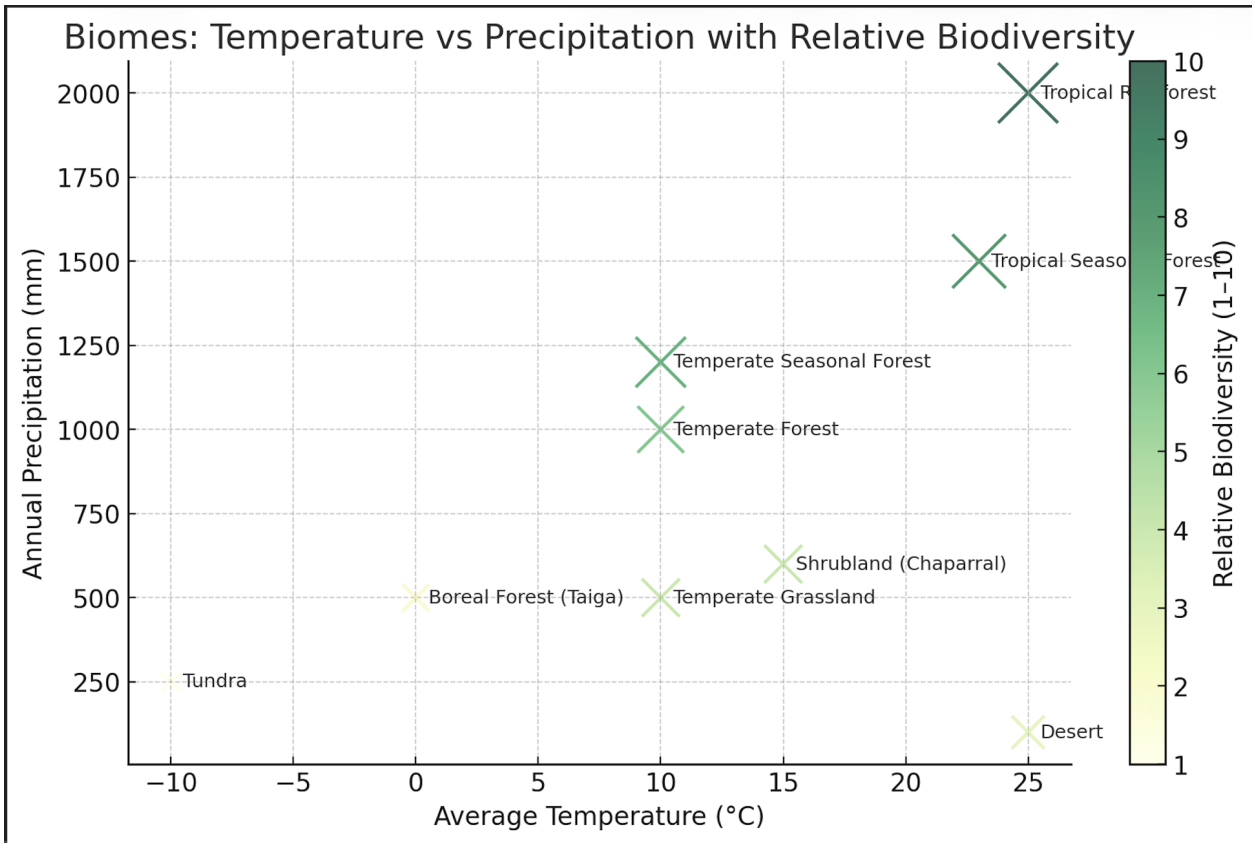
Relative Biodiversity by Biome

1 = very low diversity and **10 = very high diversity**, based on species richness patterns.

Biome	Relative Biodiversity (1–10)	Rationale
Tundra	1	Harsh climate (cold, dry, short growing season) → very few species.
Boreal Forest (Taiga)	2	Cold, conifer-dominated, acidic soils → moderate productivity but low species richness.
Temperate Grassland	4	Fewer plant species (mostly grasses), but supports large herbivore and predator diversity.
Shrubland (Chaparral)	4	Moderate climate, seasonal drought → adapted plant/animal communities, but limited overall richness.
Desert	3	Very low precipitation → low species count, though high specialization.
Temperate Forest	6	Mixed tree communities, moderate climate → higher diversity than grasslands/taiga.
Temperate Seasonal Forest	6–7	Deciduous dominance, rich soils, clear seasons → supports more species than conifer forests.
Tropical Seasonal Forest	8	High productivity, seasonal rainfall → slightly less rich than rainforests but still very diverse.
Tropical Rainforest	10	Highest biodiversity on Earth: stable warm/wet climate, extremely high productivity.

Key Patterns

1. **Latitude Gradient**: Biodiversity increases from poles (tundra) → tropics (rainforest).
2. **Precipitation Effect**: Wetter biomes generally support more plant species → more niches for animals.
3. **Seasonality vs. Stability**: Seasonal environments (temperate/seasonal forests, savannas) have moderate-high diversity, but not as high as stable, year-round productive environments (rainforests).
4. **Extremes Are Low**: Very cold (tundra) and very dry (deserts) are biodiversity "deserts."



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Decoding Climatograms:

You will need to understand these when you create your green dream home:

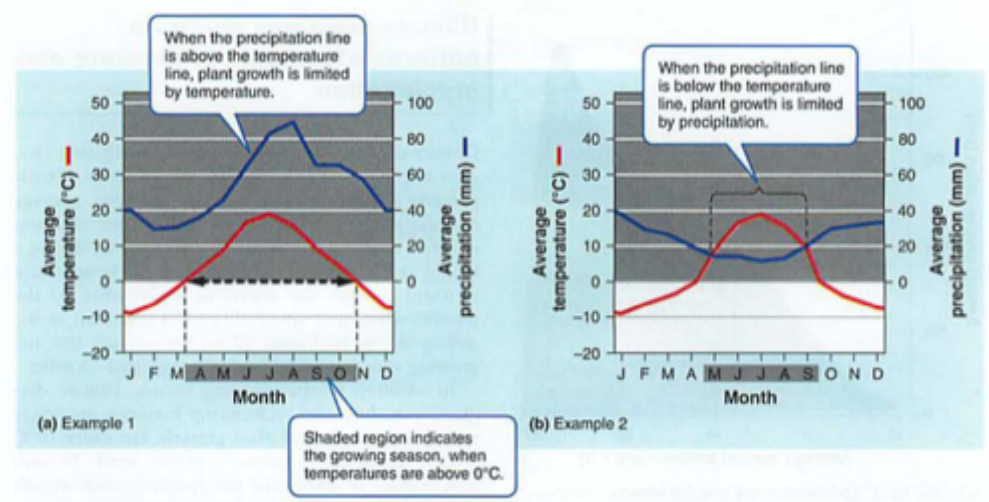
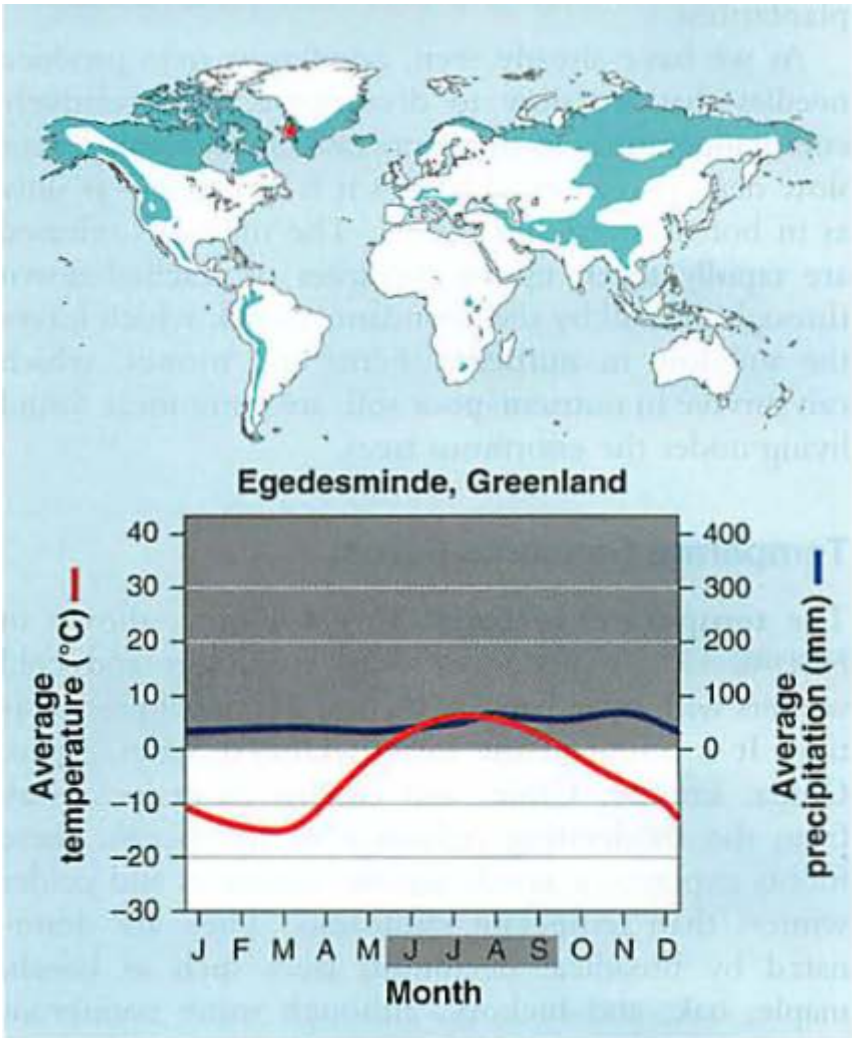


FIGURE 12.4 **Climate diagrams.** Climate diagrams display monthly temperature and precipitation values, which help determine the productivity of a biome.

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- These diagrams are how climatologists describe biomes without a cool map.
- The blue line is the amount of rainfall, with units on the RIGHT side of the graph.
- The red line is the temperature, with units on the LEFT side of the graph.
- The shaded region in the months below (jfmamjjasond) is the growing season when temperatures are above freezing.
- When the precipitation line is above the temperature line, growth is limited by temperature (e.g. freezing).
- When the blue line is below the red line, growth is limited by precipitation (e.g. the desert).
- Start with the north: Tundra is what you'd see in Alaska.
- Permafrost is soon to be in the news.
- It is made of permanently frozen ground a few feet below the surface.
- Even roots cannot penetrate it, so some trees grow in a stunted fashion.
- It is also composed of frozen organic matter, which when it melts will decompose, releasing CO2 and CH4 (methane), which is 20x as powerful as CO2 as a greenhouse gas.

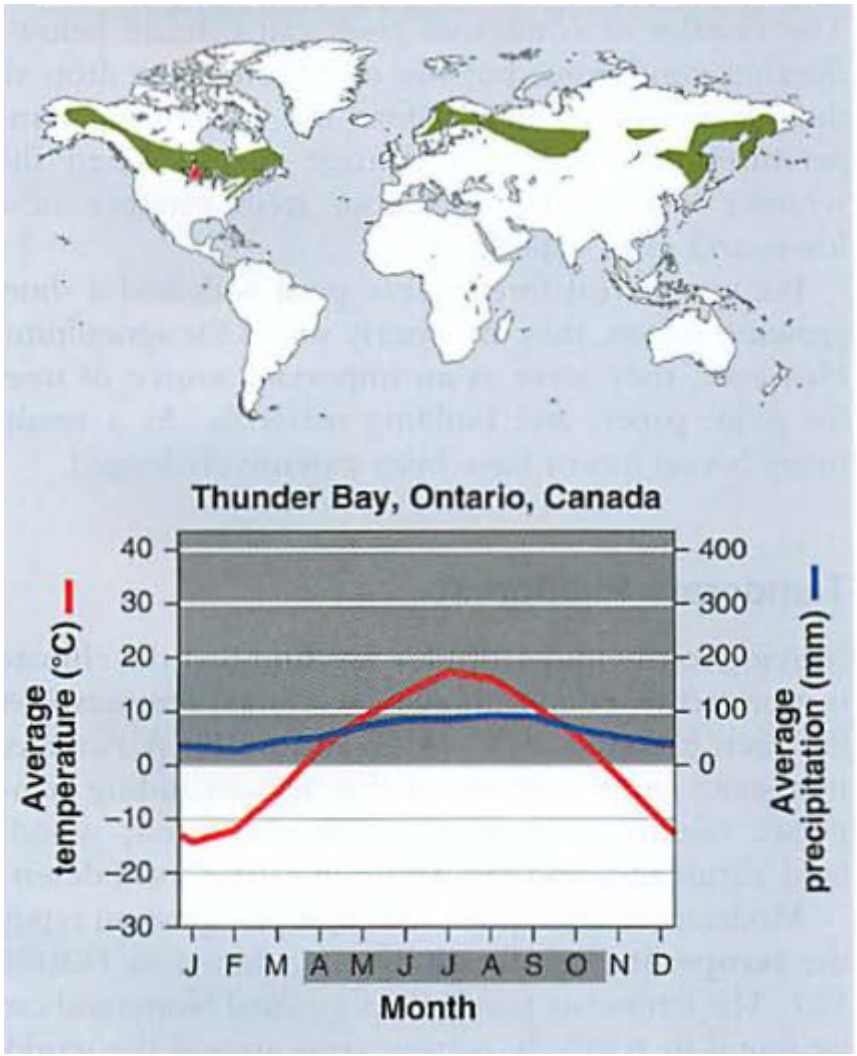
Tundra: (like in Palmer, Alaska, away from the water)



2879f.png

Note the cool temp, so growth is determined by temp, not rainfall. Lots of snow here, and little liquid water for plants, so yeah, mainly snow and glaciers.

Boreal (north) forest: (think of the aurora-lights, borealis-northern)
Contrast that with the boreal (north) forest:

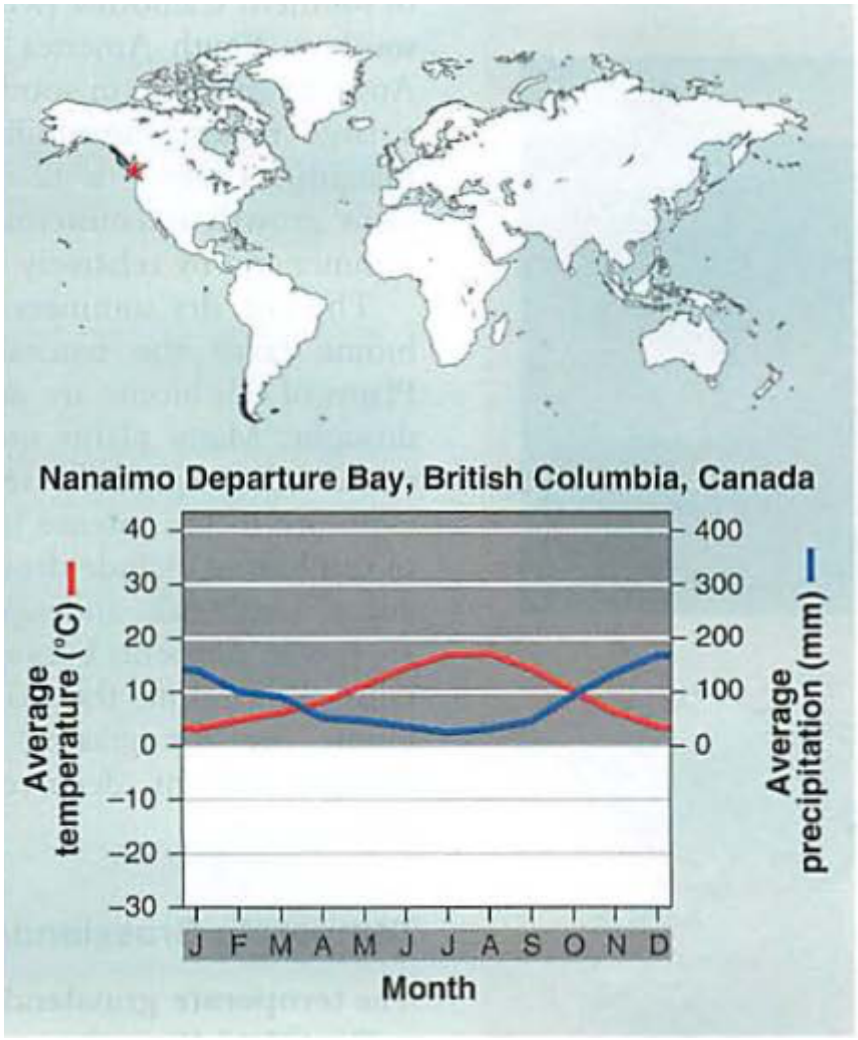


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- Note the short growing season.
- Any plants that survive usually have an oily sap (pine trees, evergreens) that does not freeze.
- Also note the serious cold in the winter-animals have to adapt to these (fur, hibernation, etc.)

Temperate (mild) forests: (maybe Skagway, AK, on the water)

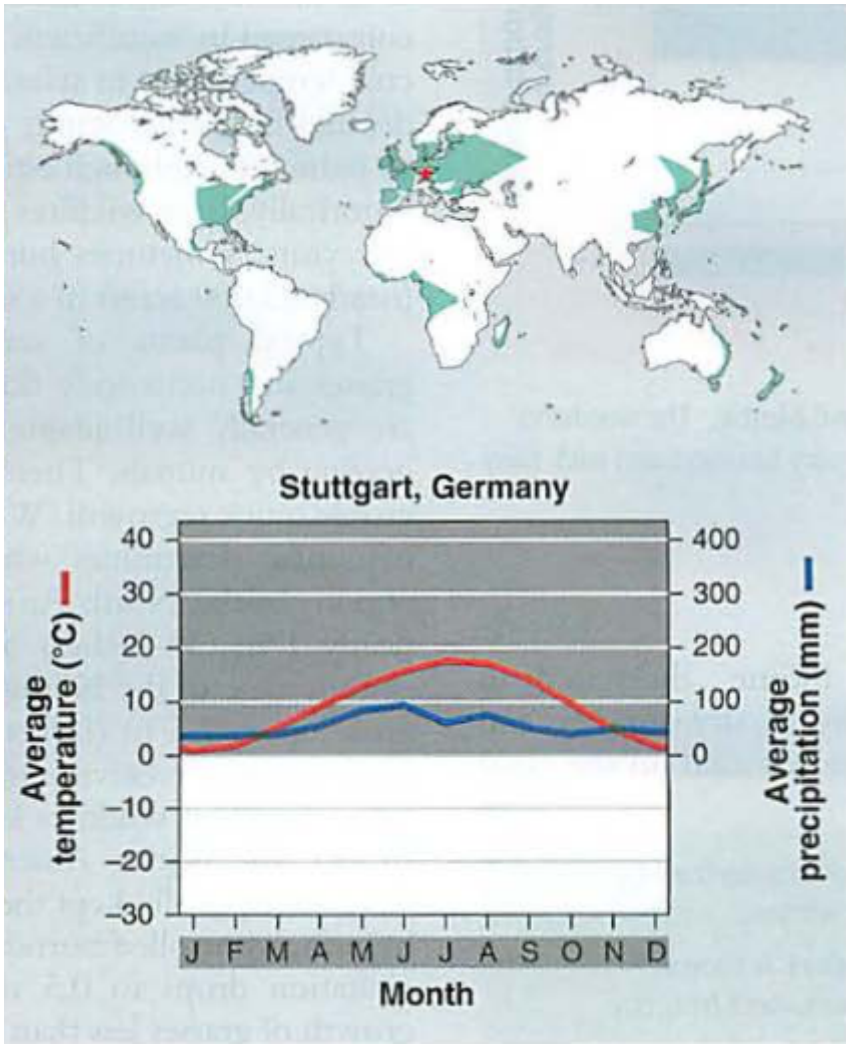
- Temperate (mild) forests are nicer, longer growing season, and rarely freeze.
- They are usually near the ocean, so they do not freeze (ocean is a huge heat sink).
- They often have lots of rain (think of Seattle).
- You may recall these are places where the surface parts of Ferrell and Polar cells converge, bringing in clouds and as these clouds rise into the atmosphere, they release their water as precipitation.



3e1cb.png

Temperate (mild) seasonal forest:

- Temperate (mild) seasonal forest actually has seasons
- Deciduous trees can live here, like maple and oak. It gets close to freezing, but no real dry season.



8028b.png

Woodland/shrubland

- Is like much of southern California, or the Mediterranean.
- Wine can grow here. It is also known as the mediterranean (medi=middle, terra=earth) biome.

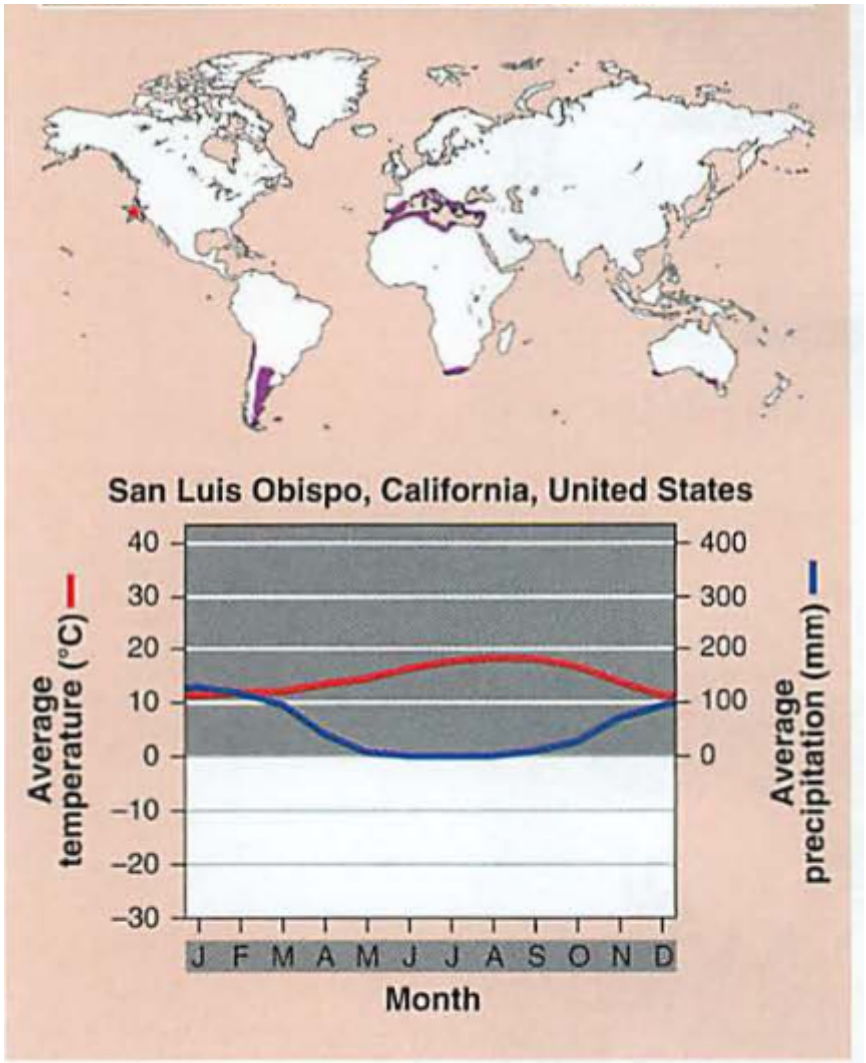


FIGURE 12.9 Woodland/shrubland biome. The woodland/shrubland biome is characterized by hot, dry summers and mild, rainy winters. *(Gary Crabbe/Enlightened Images)*

99264.png

Note it never really freezes, but growth is determined by precipitation (blue line is below the red line). This is also known as "chaparral" or the "fynbos" or "nice forest" in Afrikaans (South Africa). Look up the main wine regions of the world, they will fit this biome. Also consider how many Italians could start vineyards in northern California...

Temperate grassland/cold desert:

- Is a dry, grassy area, like Oklahoma, although it does get very cold there, so think more of Texas, or the Gobi desert.
- Again, growth is rain limited: (you may recall these are near Hadley/Ferrel cell subsidence, so dry air from space falls here).
- These areas tend to be far from large bodies of water, so they have more extreme temperatures than similar latitudes near water (e.g. Italy, France, California)

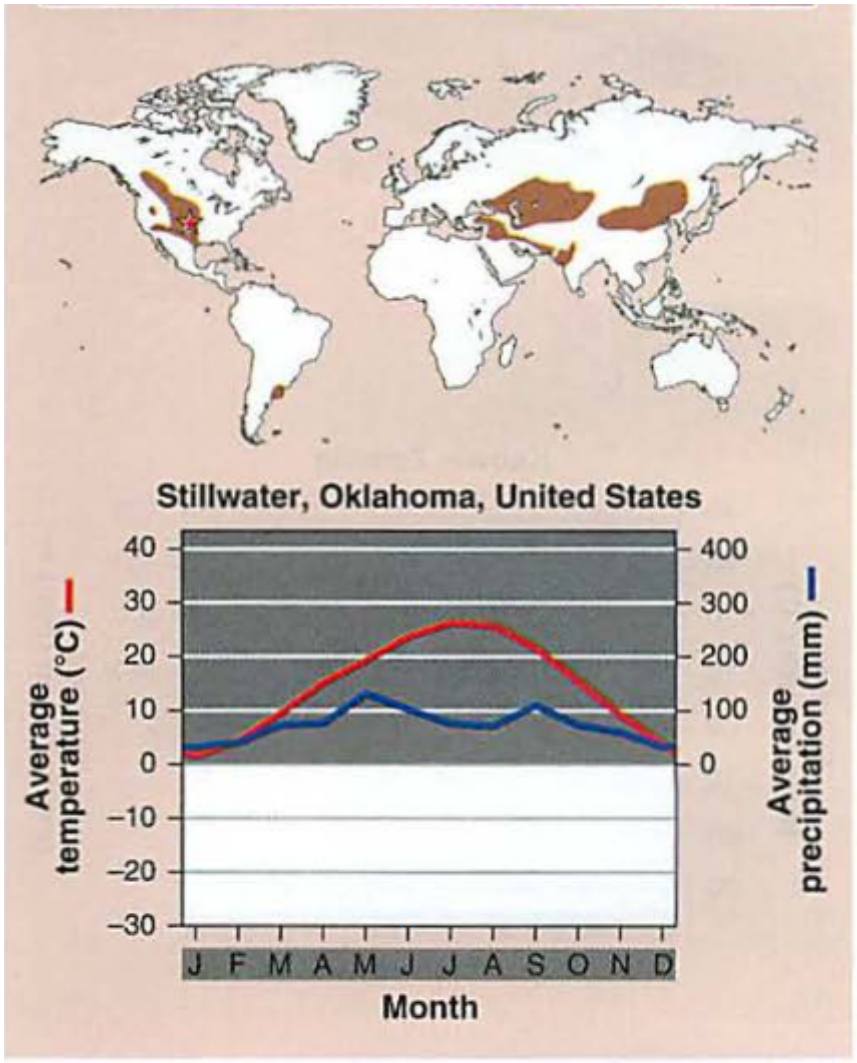


FIGURE 12.10 Temperate grassland/cold desert biome. The temperate grassland/cold desert biome has cold, harsh winters and hot, dry, summers that support grasses and nonwoody flowering plants. *(AP Photo/Brandi Simons)*

7e59f.png

Tropical rainforest

- Is the rainiest of them all, and much of our island has this near the shore.
- Warm temperatures, and paradoxically poor soil nutrition (all of the nutrients are in the plants).
- On Mt. Waialeale on Kauai, the rainfall is 480 INCHES per year, 2.5 times as high as the high point on the chart below:

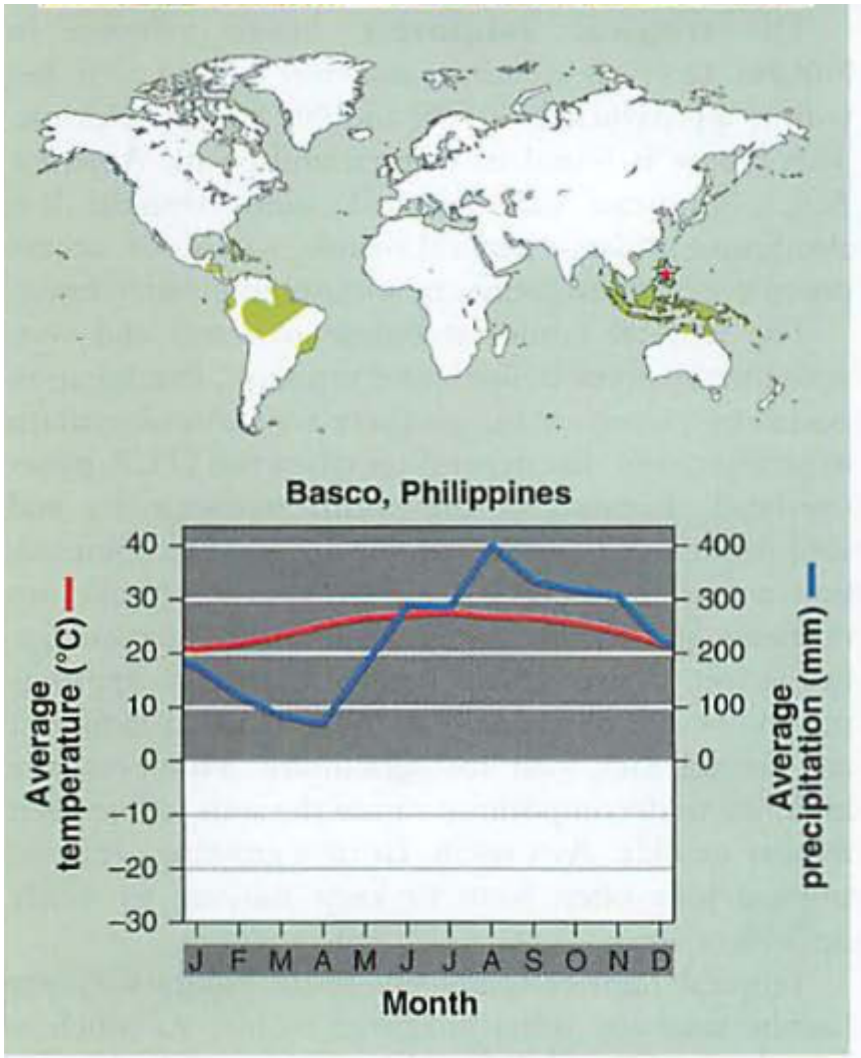


FIGURE 12.11 Tropical rainforest biome. Tropical rainforests are warm and wet, with little seasonal temperature variation. These forests are highly productive with several distinctive layers of vegetation. *(Doug Weschler/Earth Scenes/Animals Animals)*

4d9c8.png

Savanna or tropical seasonal forest:

- Africa and Brazil hold the next biome: **Savanna or tropical seasonal forest**.
- Think of Madagascar (the film): not many large trees, room for animals to roam, lots of grass, happy lions, maybe a bossy penguin or two...Growth dependent on rainfall: (blue line below red one)

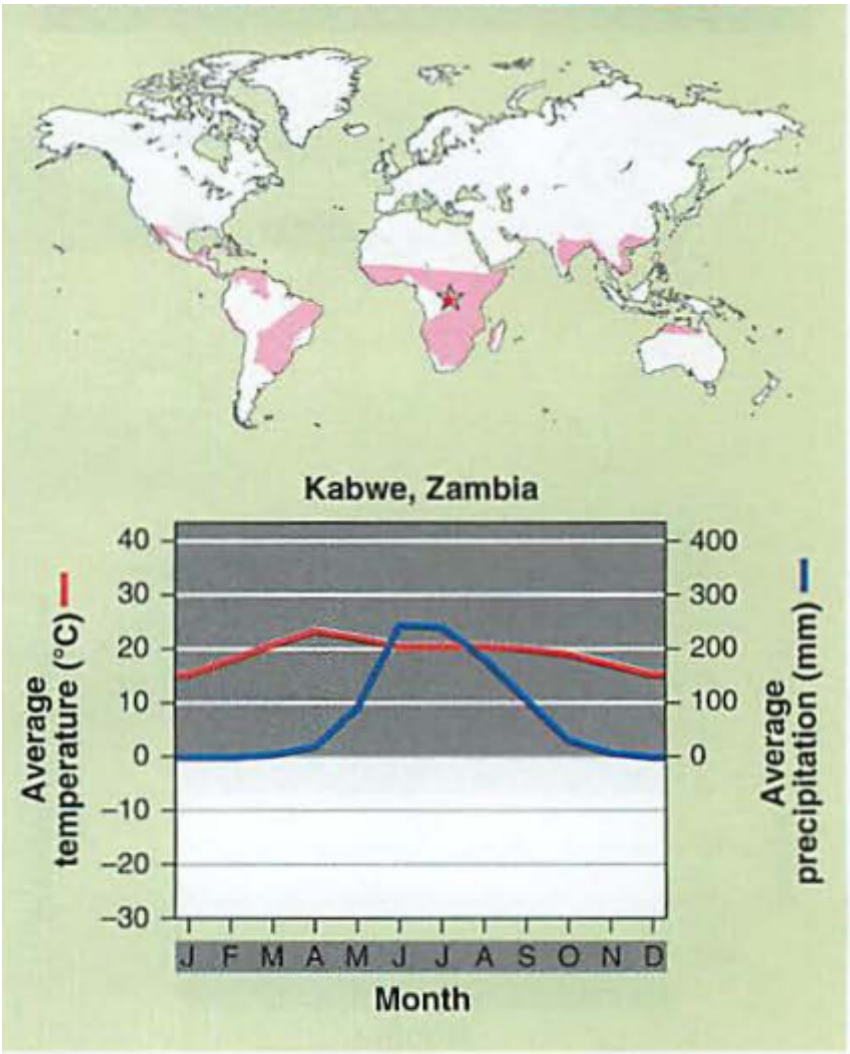


FIGURE 12.12 **Tropical seasonal forest/savanna biome.** Tropical seasonal forest and savannas have warm temperatures and distinct wet and dry seasons. Vegetation ranges from dense stands of shrubs and trees to relatively open landscapes dominated by grasses and scattered deciduous trees. *(John Warburton-Lee/DanitaDelimont.com)*

95665.png

Subtropical desert biome

- Finally, the **subtropical desert biome**, like what you'd see in the Sahara desert (another film), or most of Australia, the Atacama in Chile, the Mojave desert in California, and some of Mexico.
- Note the Gobi desert is not on this list-too cold. Again, note these areas are where dry air subsides (falls) from the Hadley and Ferrell cells.

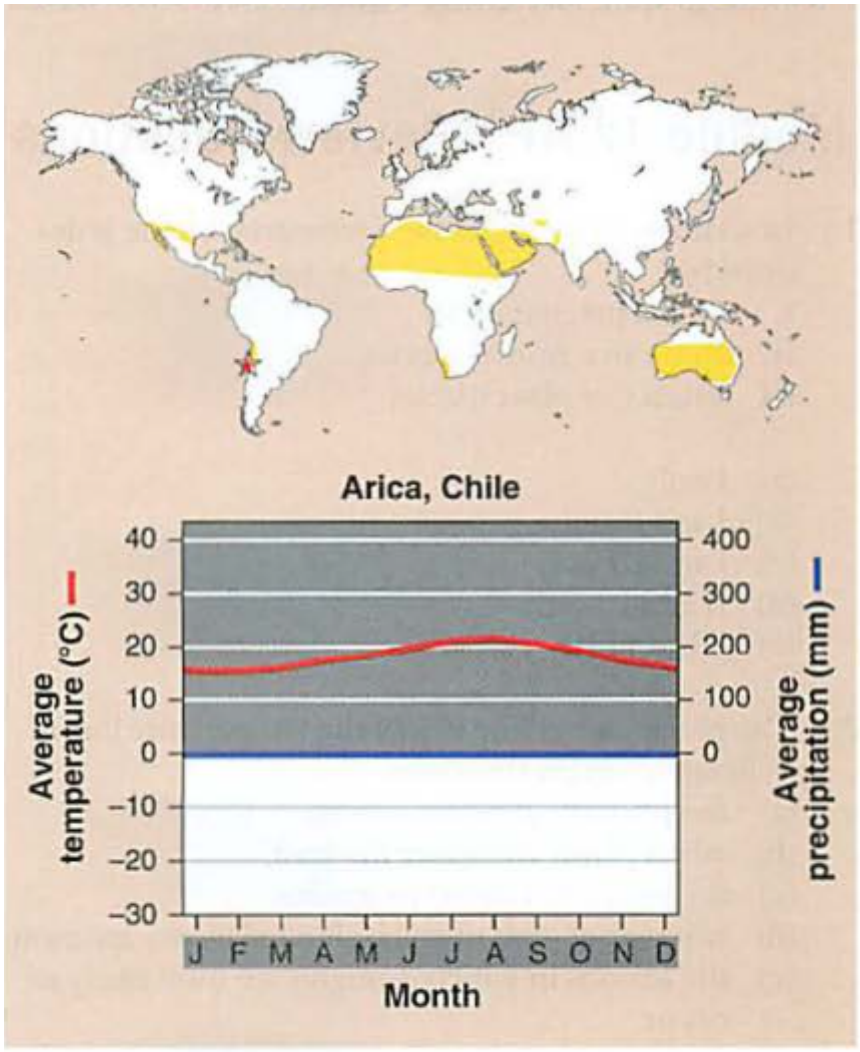


FIGURE 12.13 **Subtropical desert biome.** Subtropical deserts have hot temperatures, extremely dry conditions, and sparse vegetation. *(Topham/The Image Works)*

c48f1.png

Major Human Impacts by Biome

Tundra: Oil & gas drilling, pipelines, mining scars; melting permafrost releases greenhouse gases.

Boreal Forest (Taiga): Logging, oil extraction, mining; climate change → fires & pest outbreaks.

Temperate Forest: Deforestation, urban expansion, pollution (acid rain), invasive species.

Seasonal Temperate Forest: Habitat fragmentation, overhunting, climate change alters cycles.

Woodland–Shrubland: Urbanization & wildfires, overgrazing, agriculture (vineyards/olive groves).

Temperate Grassland: Converted to cropland, overgrazing causes erosion, fire suppression alters

balance.

Tropical Rainforest: Deforestation for logging, cattle, palm oil; mining & roads reduce biodiversity.

Tropical Soils: Slash-and-burn, monocultures deplete nutrients, fertilizer runoff pollutes water.

Savanna: Poaching, overgrazing → desertification, fire suppression disrupts ecosystem.

Subtropical Desert: Off-road vehicle damage, urban sprawl, water depletion from irrigation.

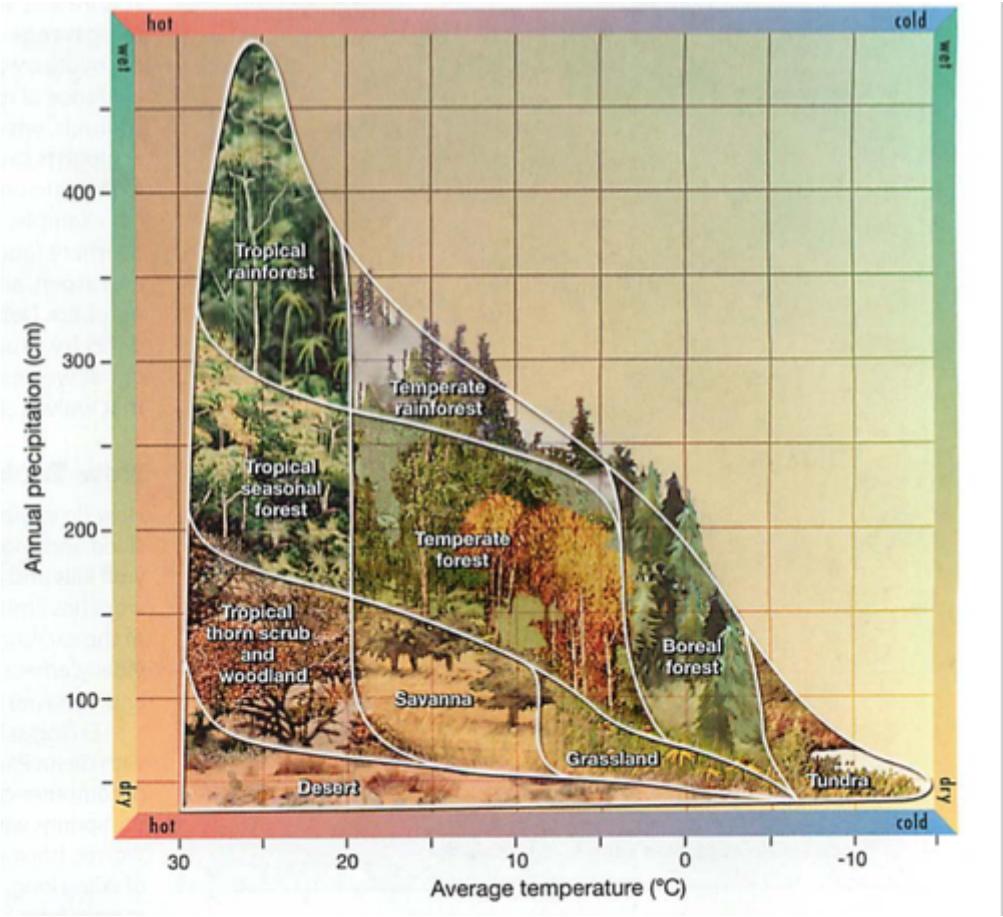
Aquatic Biomes: Pollution (plastic, fertilizer), overfishing, dams alter rivers, ocean acidification.

Chesapeake Bay: Agricultural runoff → eutrophication, overfishing, sediment pollution, sea level rise.

Download Biomes_Study_Sheet_with_Human_Impacts.pdf (application/pdf, 4.5 KB)

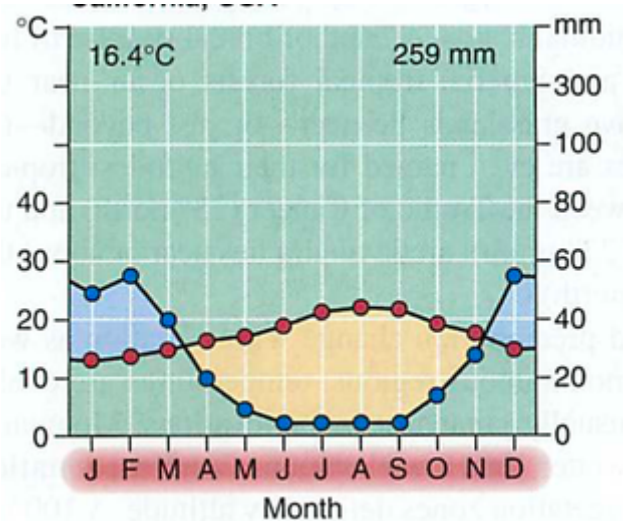
Biome Game:

Clues:

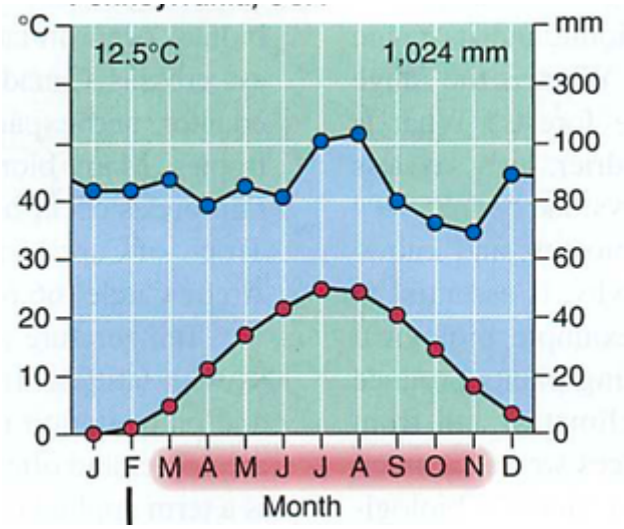


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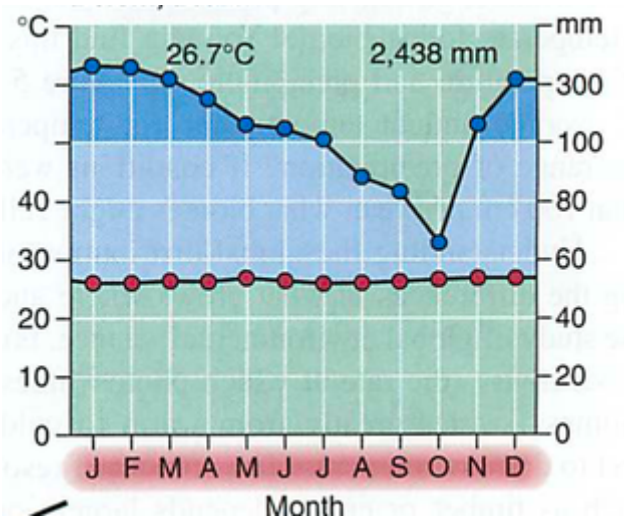
Find these places in the first three climatographs: Philadelphia, PennsylvaniaSan Diego, CaliforniaBelem, Brazil



de227.png



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