Tropical Forest & Woodland Biomes

Tropical Rain Forests: Climate

- Consistently warm & wet (year round growing season)
- Lack of seasonality

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Tropical Rain Forests:
A Biological Introduction

• High, year-round primary productivity
• Dense, species-rich canopies

Little light gets through mature Tropical Rain Forest canopy to the forest floor

Vines climb for light
Epiphytes grow on branches up in the canopy

Strategies for coping with a lack of light
Rich Canopy Fauna
largely undescribed

Canopy organisms commonly have adaptations for climbing

Insects are common & abundant

Costa Rican tree frog
Malaysian Lanternfly beetle

Photos: JLM Visuals

Tropical Dry Forests

Mexico & Central America
South America
Sub-Saharan (?), East & Central Africa

Tropical Dry Forest

Rich Canopy Fauna

• Temperature:
  Consistently warm year round

• Precipitation:
  Highly seasonal (varies from very wet to very dry)

• Growing Season:
  Year round (limited during seasonal drought)

Textbook Fig. 2.13
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Tropical Dry Forests: Climate

Seasonality of water availability leads to seasonal vegetation activity (drought-deciduous trees & shrubs) and seasonal activity of animals

Galapagos Islands: Tropical Dry Forest

Wet Season (summer-fall)
Dry Season (winter-spring)

Shorter dry periods -> more evergreen & year-round activity

Photos: Textbook

Tropical Dry Forests

Costa Rica

Wet Season (summer-fall)
Dry Season (winter-spring)
Tropical Savanna

- **Temperature:**
  Consistently warm (though a bit more seasonal than tropical forests)

- **Precipitation:**
  Highly seasonal
  (like tropical dry forests it varies from very wet to very dry)
  Wet period is very short (and/or soils poor for moisture)

- **Growing Season:**
  Year round (limited during seasonal drought)

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**Tropical Savanna: Climate**

- Temperature:
  Consistently warm (though a bit more seasonal than tropical forests)

- Precipitation:
  Highly seasonal
  (like tropical dry forests it varies from very wet to very dry)
  Wet period is very short (and/or soils poor for moisture)

- Growing Season:
  Year round (limited during seasonal drought)

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**Savannas**

- Prolonged period with a lack of soil moisture favors grasses relative to trees

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**Savannas**

- The longer the dry period the fewer the trees
  Savannas grade into dry grasslands

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**Savannas**

- Low plant diversity – a few highly adapted plant species dominate
  Moderate animal diversity - supported by high seasonal plant productivity

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**Savanna grassland in Tanzania**

Photo: JLM Visuals

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**Acacia savanna in Tanzania**

Photo: Purves et al. 1998
**Savannas**
Moderate animal diversity - supported by high seasonal plant productivity

**Herbivores**

**Carnivores**

Savannas can occur in temperate latitudes where seasonality of climate is similar.

**Oak savanna - central California**

**Hot Desert Biome**

**Hot Desert : Climate**

- **Temperature**: Hot conditions dominate (though often seasonal)
- **Precipitation**: Little precipitation (dominated by long dry periods sometimes with brief wet periods)
- **Growing Season**: Year round (limited during seasonal drought)

**Textbook Fig. 2.19**
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**Hot Deserts**

There are extreme hot deserts (most equatorial) like the Taklimakan Desert in western China

**Hot Deserts**

Less extreme, more seasonal hot deserts exist at more temperate latitudes

All hot deserts are characterized by low primary productivity and low - moderate species richness

Sonoran Desert, Arizona

Photos: JLM Visuals
Hot Deserts
All hot deserts are characterized by low primary productivity and low - moderate species richness.

Organisms exhibit many specialized adaptations to these environments of extreme drought and high temperatures.

- Saguaro cactus
- Joshua tree
- Kangaroo rat
- Bleached lessor earless lizard
- Barrel cactus
- Jumping cholla
- Annual plants
- Sonoran Desert

Temperate Shrubland & Grassland Biomes

- Chaparral
- Cold Desert
- Temperate Grasslands

Chaparral Biome

- Mediterranean Climate
  - 2 alternating seasons:
    - Warm - dry
    - Cool - wet
  - Coastal location keeps temperatures moderate (with some summertime exceptions)
  - Thus the growing season is year-round

Chaparral : Climate

Map: Mediterranean Climate

Textbook Fig.2.22
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**Chaparral**

6 – 10 foot high dense tangle of drought-tolerant shrubs with rigid branches & evergreen sclerophyllous leaves

Los Gatos, California

**Chaparral**

Supports a rich community of rodents, reptiles and insects (dense & thorny vegetation provides protection from predators)

Western Fence Lizard

Brown Tarantula

Screech Owl (Collared) Agy

Grey fox

Pack rat

**Chaparral**

Fire is a frequent event. Many organisms are highly adapted to withstand and even promote fire

Photos: US Forest Service

**Chaparral**

Shrub communities sometimes intermixed with Chaparral grasslands and woodlands

Chaparral serpentine grassland

Chaparral oak woodlands often in moist draws & N-facing slopes

**Cold Desert Biome**

Intermountain West (Great Basin)

Mongolia & Central Asia

Cold Desert

**Cold Desert : Climate**

- **Temperature:** Extreme fluctuations from hot summers to cold winters
- **Precipitation:** Low and reasonably consistent (though many locations show late summer to autumn peak)
- **Growing Season:** Short and hot (creating droughty conditions)

Textbook Fig. 2.19
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Cold Deserts
Often called Shrub-steppe
Characterized by low primary productivity and low - moderate species richness

Cold Deserts
Often in enclosed basins with saline soils
Halophytic vegetation (salt-tolerant)
Low primary productivity & species richness

Cold Deserts
Less extreme areas support more steppe (arid grassland) vegetation

Cold Deserts
Fire is often an important feature of cold desert areas.
Grazing can be important (Asian cold deserts) but not always (North American Great Basin)

Temperate Grassland Biome

Temperate Grasslands: Climate
- Temperature: Large fluctuations from hot summers to cold winters
- Precipitation: Moderate to high with peaks during warm season
- Growing Season: Moderate to long

Higher productivity than
- Chaparral due to greater precipitation
- Cold desert due to greater summer precipitation & longer growing season

Textbook Fig. 2.25
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The type of grassland and transition to forest is determined by moisture (precipitation). Temperate Grasslands

- Short grass prairie
- Mid grass prairie
- Tall grass prairie
- Forests

Colorado Short grass prairie

Nebraska Mid grass prairie

Trees often present in sites with more moisture. N-facing slope

Palouse prairie

Grazing is historically important in Midwest prairies of North America

Bison grazing in Wyoming midgrass prairie

Photo: USPS
Grazing is historically important in Asian steppe.

Camels grazing in Pamir Mountains, central Asia

Temperate Forest Biomes

- **Temperate Deciduous Forests**
  - Climate:
    - **Temperature:** Moderate (sometimes large) fluctuations from warm (hot) summers to cold winters
    - **Precipitation:** High and consistent
    - **Growing Season:** Moderate to long & moist (thus highly productive)

- **Temperate Evergreen Forests**

Textbook Fig. 2.28
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Temperate Deciduous Forest Biome

- High richness of trees & shrubs
- Seasonal changes in plant community
- Rich fauna of amphibians, insects & birds (seasonal)

Seasonality of temperatures lead to leaf drop

Photo: JLM Visuals
Photo: Raven & Berg 2003
**Temperate Deciduous Forests**

*Summer*  
[Image of deciduous forest in summer]

*Winter*  
[Image of deciduous forest in winter]

Rhode Island Deciduous Forest

Photos: Purves et al. 1998

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**Temperate Deciduous Forests**

Springtime period before trees leaf out is critical for ground layer plant productivity and insect activity

*Spring*  
[Image of deciduous forest in spring]

*Summer*  
[Image of deciduous forest in summer]

Maryland Deciduous Forest

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**Temperate Evergreen Forest Biome**

- Temperate Evergreen Forests
  - PNW Coast
  - E Australia & N New Zealand

**Temperate Evergreen Forests: Climate**

- **Temperature:**
  - Moderate fluctuations (coastal locations) from warm summers to cool winters
- **Precipitation:**
  - High and very seasonal  
  - Warm-dry / Cool-wet
- **Growing Season:**
  - Long to year-round but moisture limited in summer (highly productive due to long growing season)

Dominated by evergreens due to summer drought

Textbook Fig. 2.28  
Page 35

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**Temperate Evergreen Forests**

- Low diversity of trees & shrubs
  - Dominated by large, old trees (disturbance infrequent)
  - Seasonal changes in plant community
  - Rich fauna of amphibians, insects & birds (seasonal)

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**Temperate Evergreen Forests**

- Young forests highly productive  
  - (year-round growth; high light; low nutrient demand)
- Following canopy closure, forest floor constantly in deep shade,
- Soils remain cool
- Soil organisms and processes are slow (reduced rates of nutrient cycling)
Temperate Evergreen Forests

- Rich in fungi, epiphytes
- Species highly adapted for life with a chronic shortage of light
- Dead material (woody debris) is critical to the ecological function of organisms

Deciduous forest pockets present in areas of greater water and light availability
- Streamsides
- Disturbed moist slopes

Boreal Forest Biome

- Canada
- Patagonia
- Russia

Boreal Forests: Climate

- Temperature:
  Moderate (sometimes large) fluctuations from warm summers to very cold winters
- Precipitation:
  Low / moderate and consistent
  Most precipitation in form of snow
  But, drought uncommon due to low water loss (little drainage or evaporation)
- Growing Season:
  Short to moderate
  (thus generally low productivity – summers too short for most temperate trees)

Boreal Forests

- Often called Taiga
- World’s largest forest biome in areal extent (>11% land area of Earth)
Boreal Forests

Low plant productivity & cool short summers lead to poorly developed, shallow soils

Much of soil profile is permanently frozen (permafrost) or seasonally frozen

Shallow soils underlain by impermeable granite bedrock in many places

Limited horizontal water loss:
Abundant snowmelt
Rolling topography

Boreal Forests

Slow growing evergreen trees dominate
Spruce, fir, pine

Limited forest layers - few shrubs
Understory dominated by groundcover of mosses & lichens

Deciduous trees more locally abundant
Birch & poplar common in disturbed areas and further south
Larch (deciduous conifer) dominates in Siberian taiga

Limited vertical water loss:
Evaporation limited by cool temperatures
Soil drainage limited by permafrost and bedrock

Boreal Forests

Herbivores

Rodents
Beaver
Flying squirrel

Mammals
Moose
Woodland Caribou
White tailed deer
Snowshoe hare

Not pictured: Birds, insects, aquatic organisms

Boreal Forests

Carnivores / Omnivores

Timber wolf
Black bear

Pine martin
Fisher
Lynx

Industrial forestry threatens taiga, especially in Russia and southern Canada & Alaska

Logging of boreal forest near Ural Mountains, Russia
Boreal forest reaches furthest northern extent in Alaska in protected valleys of the Brooks Range.

Northern extent of boreal forest in eastern Russia

Arctic Tundra Biome

Biome usually divided into
Low Arctic
“Low arctic tundra”
High Arctic
“High arctic polar deserts & semi-deserts”

Low Arctic Tundra: Climate

- Temperature:
  Moderate fluctuations from cool summers to very cold winters

- Precipitation:
  Low to very low and consistent
  Most precipitation in form of snow
  But, drought uncommon due to low water loss (little drainage or evaporation)

- Growing Season:
  Short to very short
  (thus very low productivity – summers too short and cool for much productivity)
**Low Arctic Tundra**

Grass (hummock) tundra dominated by grasses & sedges with some very low shrubs.

Tundra surface wet for same reasons as Boreal forests.

Cool, short growing season – low productivity
Low species richness

**Low Arctic Tundra**

Migratory herbivores can be locally plentiful during brief summers (birds, ungulates).

Reindeer on Kolguev Island, Russia

**Low Arctic Tundra**

Migratory herbivores can be locally plentiful during brief summers (birds, ungulates).

Caribou, northern Alaska

**Low Arctic Tundra**

Low herbivore productivity and residence supports even fewer carnivores (polar bear, fox, some birds, etc.)

**High Arctic Polar Deserts**

Devon Island, Canada (early July)

Climate similar to Low Arctic tundra, just more extreme
Colder, shorter growing season
Timing of precipitation varies with region

**High Arctic Polar Deserts**

Devon Island, Canada (early August)
High Arctic Polar Deserts
Devon Island, Canada (late August)

Short, cold growing season leads to highly limited plant productivity. Few species can adapt / survive.

High Arctic Polar Deserts

Plants are small, non-woody, slow-growing and long lived.

Cool, short summer and lack of plant production leads to poor soils. Nutrient limitations to productivity during brief favorable period are severe. Sites of greater productivity are associated with nutrient concentrations (animal dens, dead animals).

Lemming den site

Lemming den site

Coastal polar oases exist that have tundra & productivity like the Low Arctic.

High Arctic Animals

Herbivores
- Muskox
- Ptarmigan
- Migratory waterfowl (Red-throated loon)

Carnivores
- Arctic hare
- Arctic fox
- Polar Bear

Mountains

Not a distinct biome, but a compact collection of different biomes with elevation.
Mountains: Global distribution of major ranges

Textbook Fig. 2.37
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Mountains: Climate change with elevation

Temperature: decreases with elevation
Precipitation: increases with elevation (but increase mostly due to snowfall)
Growing season: decreases dramatically with elevation

Textbook Fig. 2.38
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Mountains: Biome distributions on mountains with elevation parallel those of biome changes with latitude

Figure from Raven & Berg (2004)

Mountains: Elevational changes in ecosystems

Temperate coniferous forest (low elevation)
Temperate coniferous forest (montane)
Temperate coniferous forest (subalpine)
Alpine tundra

Mountains: Some unique environmental challenges at high elevation

Natural Disturbances

Avalanches
Needle ice
Slope movement (solifluction) & rockfall
Alpine Tundra: land above the trees

Cool, short summers result in limited productivity and low species diversity

Alpine tundra communities: Variation in productivity

Productivity is limited by
- Too much snow (growing season too short)
- Too little snow (limited summer moisture & winter protection)

Productivity is maximized
- At intermediate snow levels (e.g., on moist slopes below persistent melting snowbanks)

Mesotopographic gradient at 14,800 feet

Extreme Communities above 18,000 feet

Surviving the Extremes
- Light color & pubescence
- Cushion plant growth form
- Pikas: masters of food storage

Cushion plant growth form

Pikas:
masters of food storage

Light color & pubescence