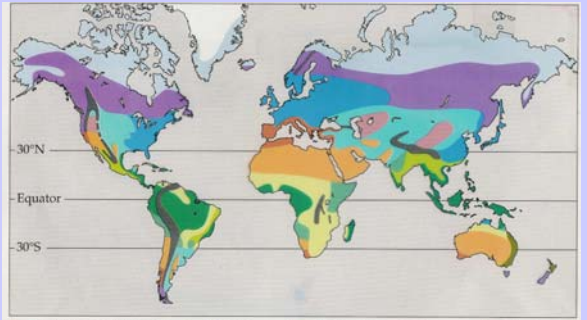


# Terrestrial Biomes of the World

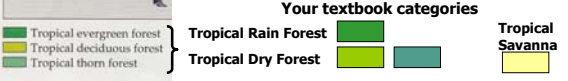
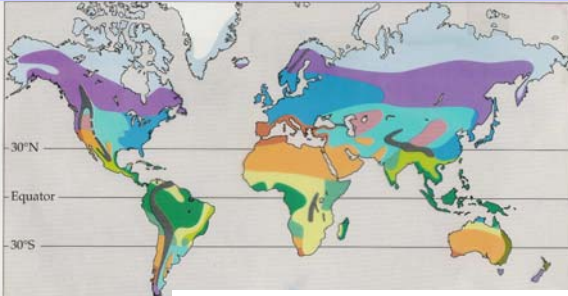


# Biomes of the World

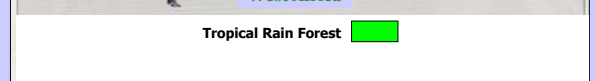
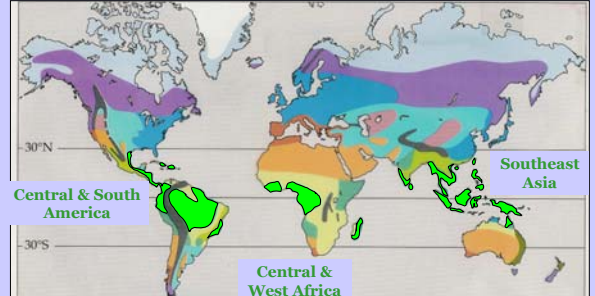
See attached color map  
At back of handout



# Tropical Forest & Woodland Biomes

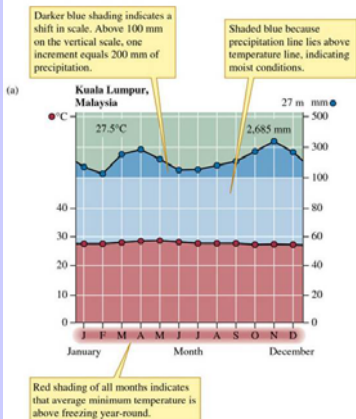


# Tropical Rain Forest

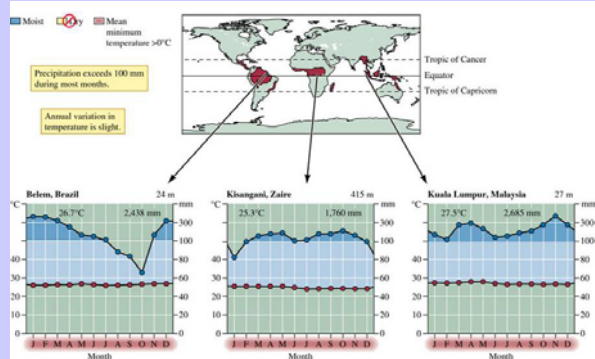


# Tropical Rain Forests : Climate

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



# Tropical Rain Forests : Climate



## Tropical Rain Forests: A Biological Introduction

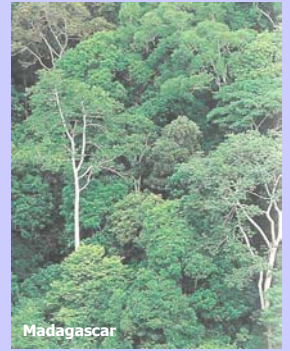


## Tropical Rain Forests:

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



Uganda



Madagascar

Photos: Purves et al. 1998

## Dense Tropical Rain Forest Canopy

## Brazilian Amazon



Dense upper canopy layer

## Dense Tropical Rain Forest Canopies are multilayered



Dense sub canopy layer

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



## Strategies for coping with a lack of light

### Vines climb for light

### Epiphytes grow on branches up in the canopy



Photos: JLM Visuals

## Rich Canopy Fauna

*largely undescribed*

Canopy organisms commonly have adaptations for climbing

Insects are common & abundant



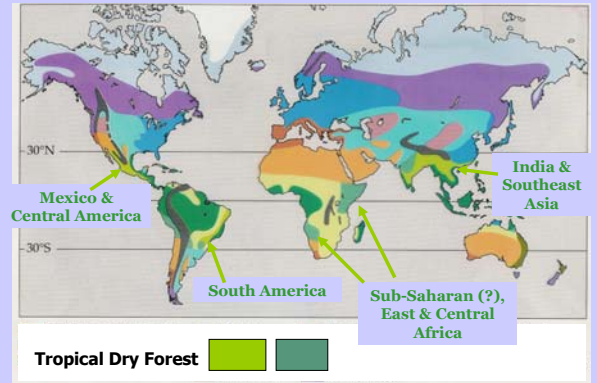
Costa Rican tree frog



Malaysian Lanternfly beetle

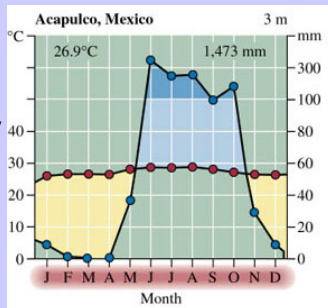
Photos: JLM Visuals

## Tropical Dry Forests



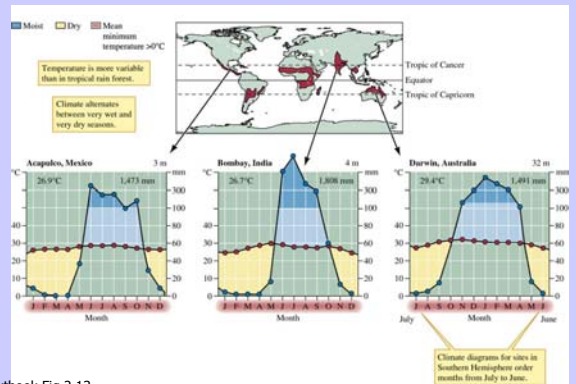
## Tropical Dry Forests : Climate

- **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  
Page 24

## Tropical Dry Forests : Climate



Textbook Fig.2.13  
Page 24

## Tropical Dry Forests

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

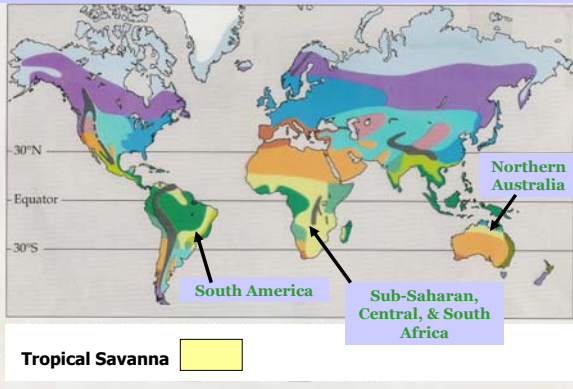
Wet Season  
(summer-fall)



Dry Season  
(winter-spring)

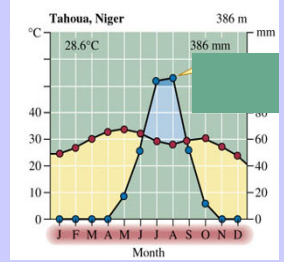


## Tropical Savanna



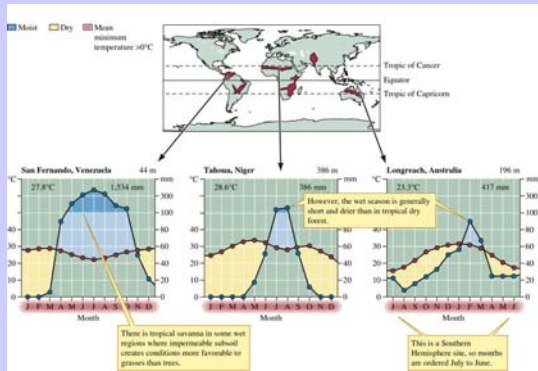
## Tropical Savanna : Climate

- **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)



Textbook Fig.2.16  
Page 26

## Tropical Savanna: Climate



Textbook Fig.2.16  
Page 26

## Savannas

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



## Savannas

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



Savanna grassland in Tanzania

Photo: JLM Visuals

## Savannas

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



Acacia savanna in Tanzania

Photo: Purves et al. 1998

## Savannas

Moderate animal diversity - supported by high seasonal plant productivity

### Herbivores



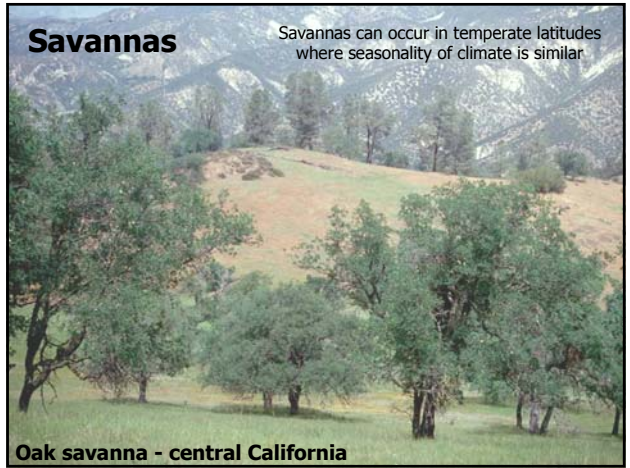
### Carnivores



Photos: JLM Visuals

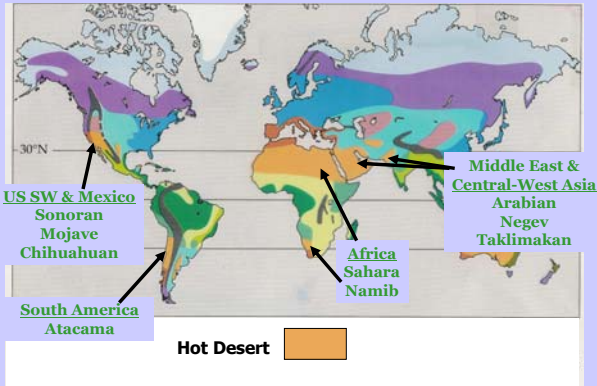
## Savannas

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



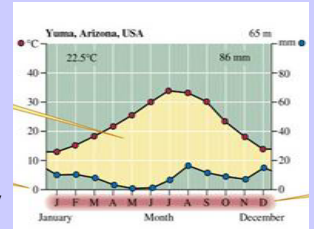
Oak savanna - central California

## 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)  
All hot deserts characterized by prolonged extreme soil drought
- **Growing Season:**  
Year round (limited during seasonal drought)



Textbook Fig.2.19  
Page 28

## 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

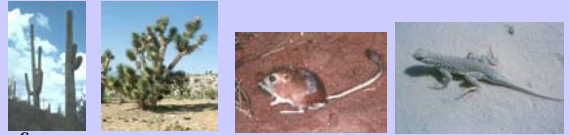
# Hot Deserts

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



# Hot Deserts

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



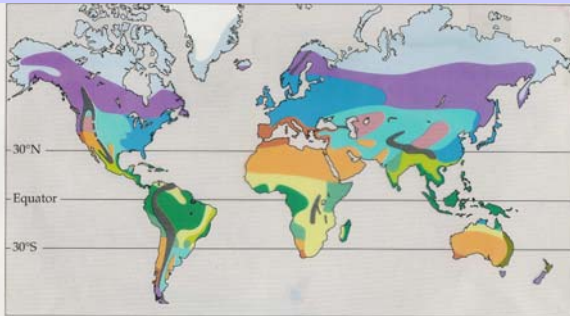
Saguaro cactus      Joshua tree      Kangaroo rat      Bleached lesser earless lizard



Barrel cactus      Jumping cholla      Annual plants

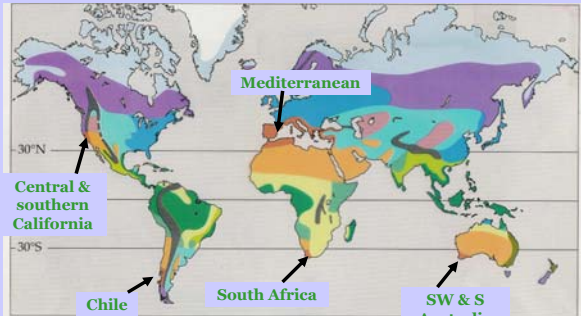
Sonoran Desert

# Temperate Shrubland & Grassland Biomes



**Chaparral**      **Cold Desert**      **Temperate Grasslands**

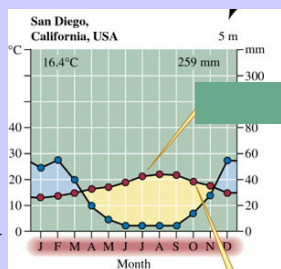
# Chaparral Biome



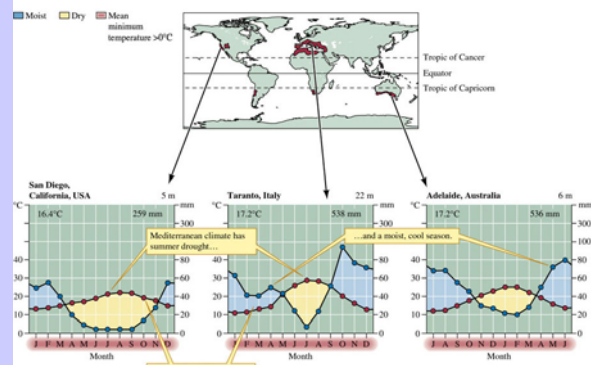
**Chaparral**

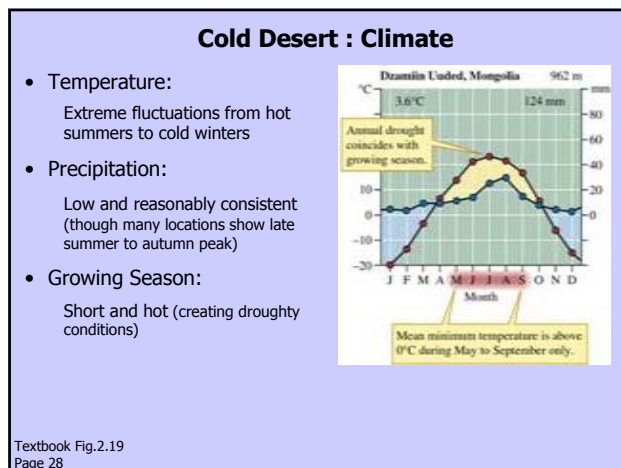
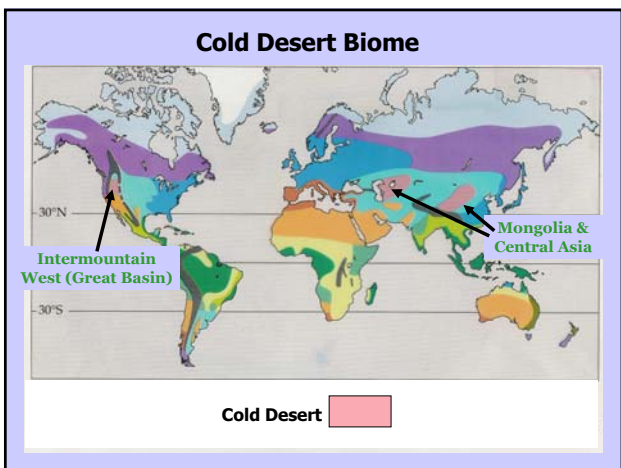
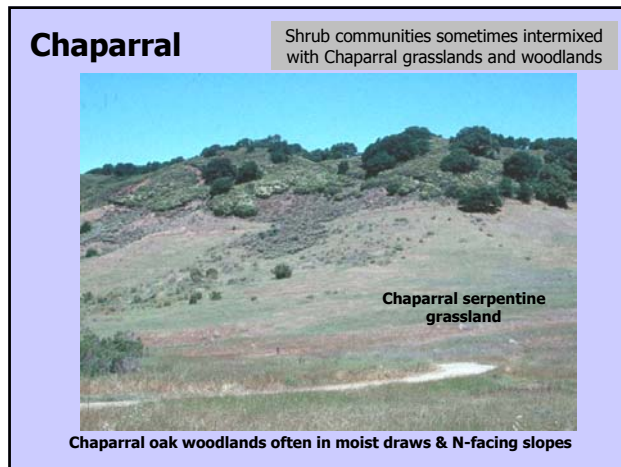
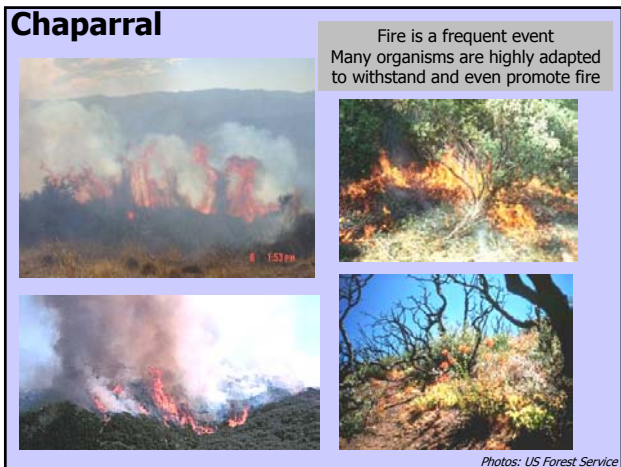
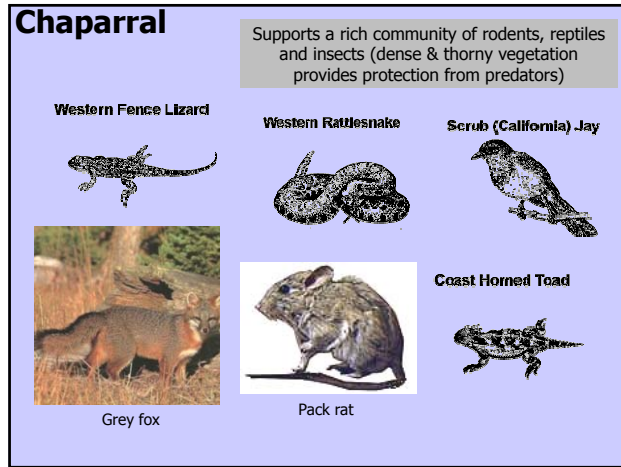
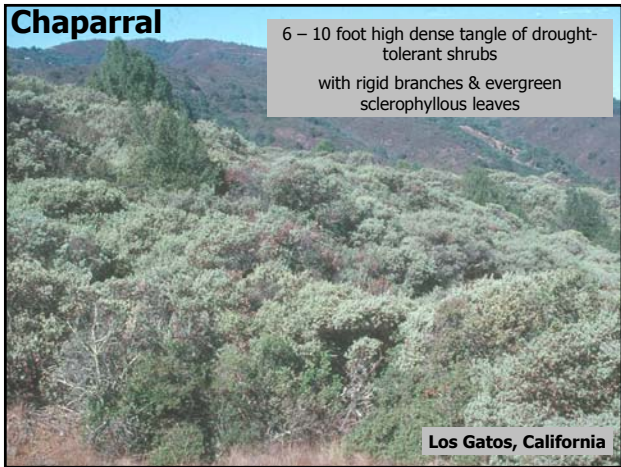
# Chaparral : Climate

- 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





## 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



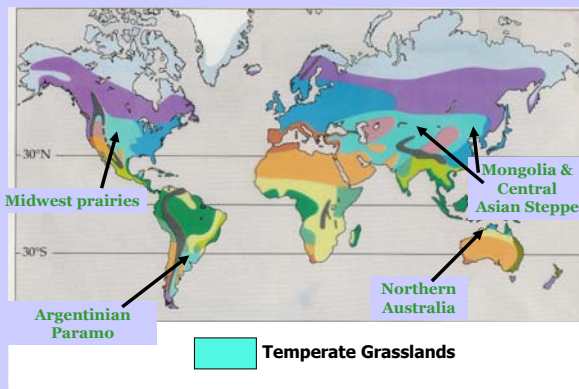
## Cold Deserts

Fire is often an important feature of cold desert areas.



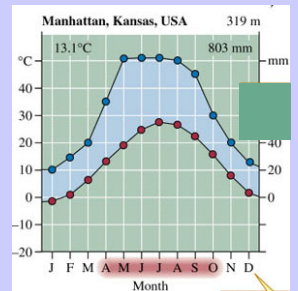
Grazing can be important (Asian cold deserts) but not always (North American Great Basin)

## 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

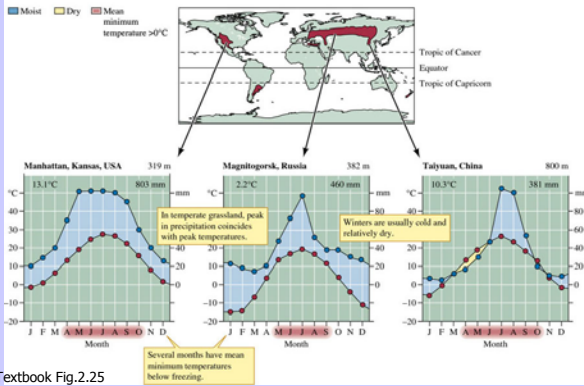


### Higher productivity than

Chaparral due to greater precipitation  
 Cold desert due to greater summer precipitation & longer growing season



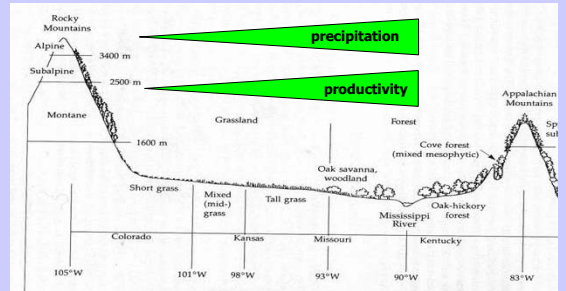
## Temperate Grasslands : Climate



Textbook Fig.2.25  
Page 33

## Temperate Grasslands

The type of grassland and transition to forest is determined by moisture (precipitation)

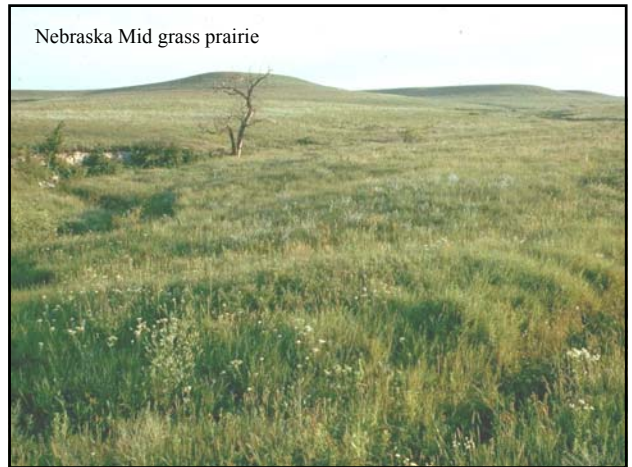


Short grass prairie Mid grass prairie Tall grass prairie Forests

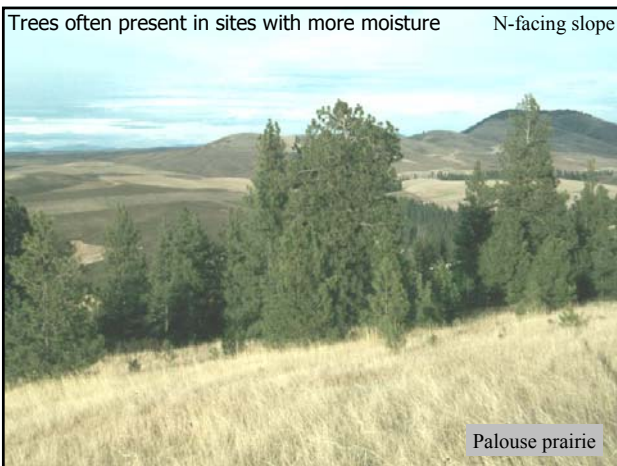
Colorado Short grass prairie



Nebraska Mid grass prairie



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



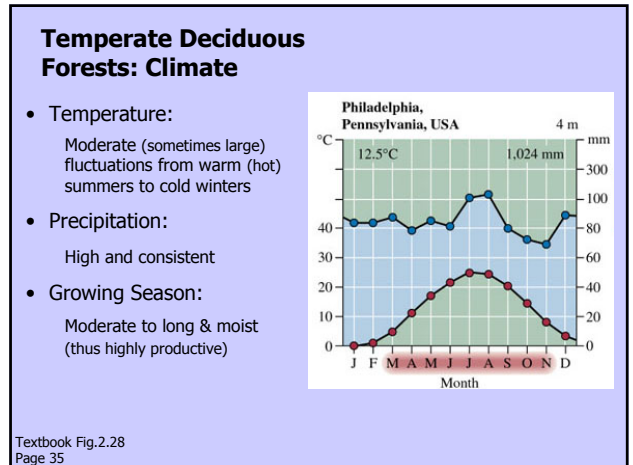
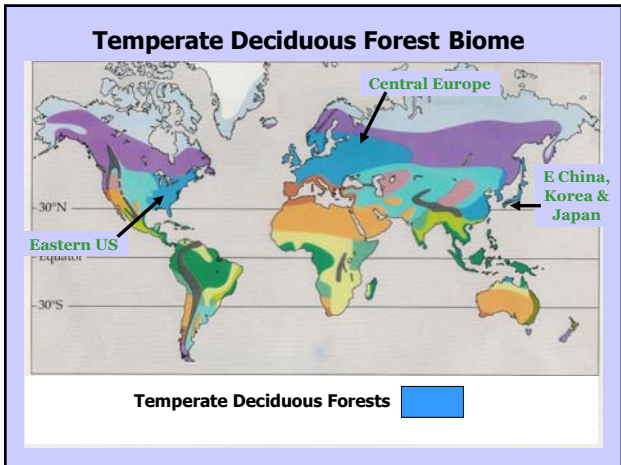
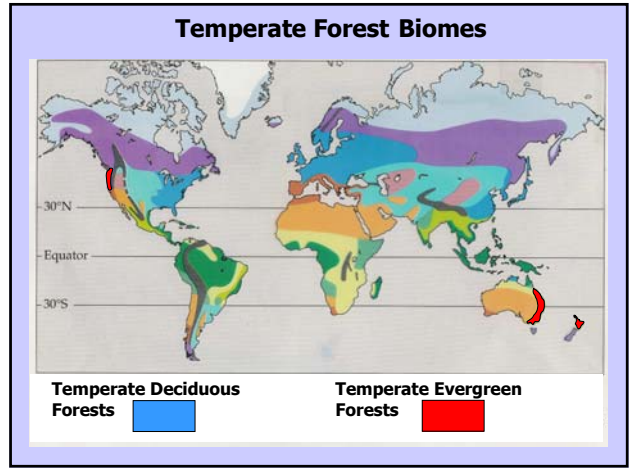
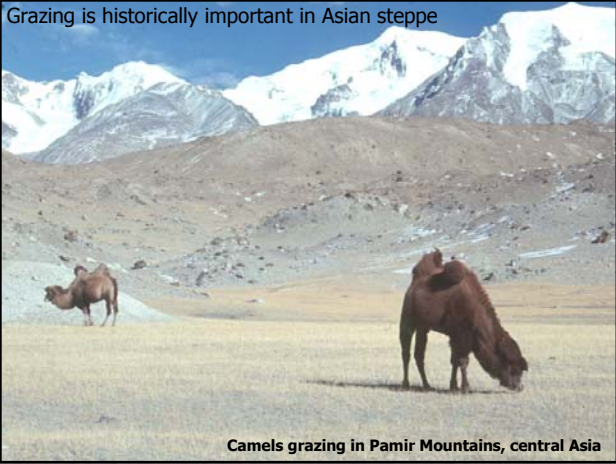
Palouse prairie

Grazing is historically important in Midwest prairies of North America

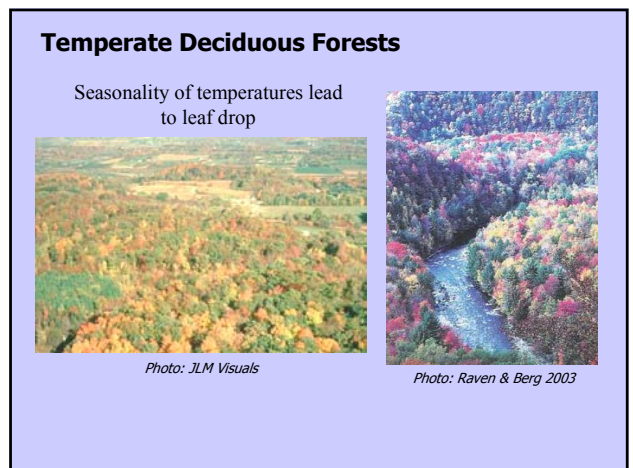
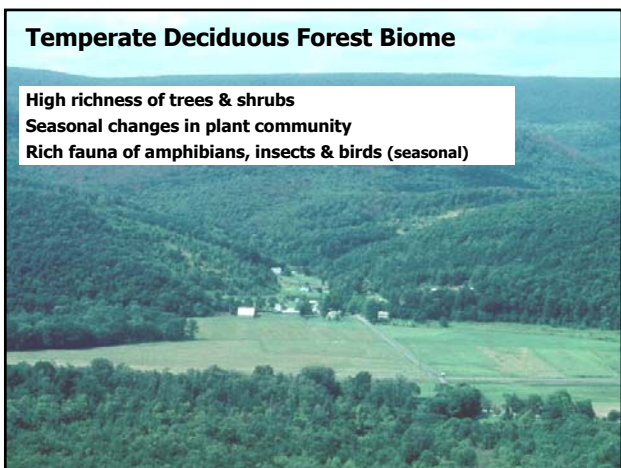


Photo: USPS

Bison grazing in Wyoming midgrass prairie



Textbook Fig. 2.28  
Page 35



## Temperate Deciduous Forests

Summer

Winter



Rhode Island Deciduous Forest

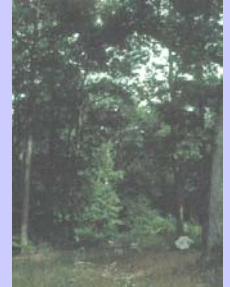
Photos: Purves et al. 1998

## Temperate Deciduous Forests

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

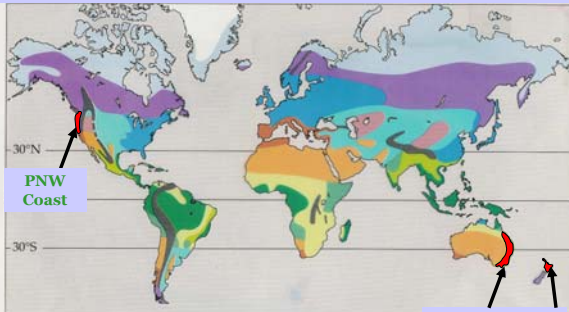
Spring

Summer



Maryland Deciduous Forest

## Temperate Evergreen Forest Biome

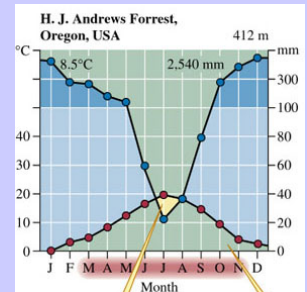


Temperate Evergreen Forests

E Australia & N New Zealand

## Temperate Evergreen Forests: Climate

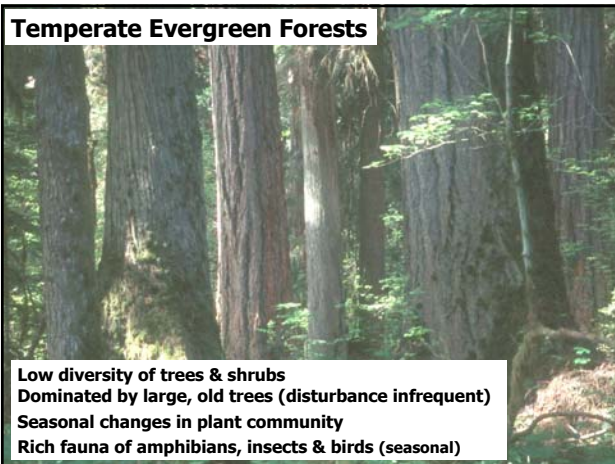
- **Temperature:**  
Moderate fluctuations (coastal locations) from warm summers to cool winters
- **Precipitation:**  
High and very seasonal  
Warm-dry / Cool-wet
- **Growing Season:**  
Long to year-round but moisture limited in summer (highly productive due to long growing season)



Dominated by evergreens due to summer drought

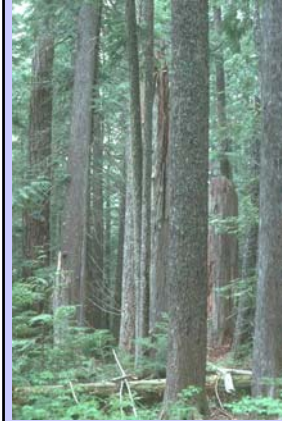
Textbook Fig. 2.28  
Page 35

## 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)

## 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



## Temperate Evergreen Forests

Dead material (woody debris) is critical to the ecological function of organisms



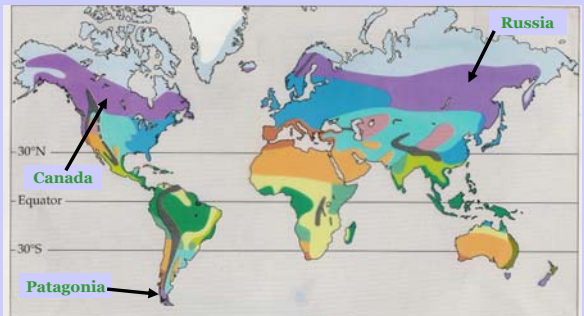
## Temperate Evergreen Forests

Deciduous forest pockets present in areas of greater water and light availability

- Streamsides
- Disturbed moist slopes



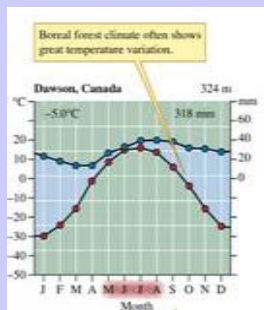
## Boreal Forest Biome



Boreal Forests

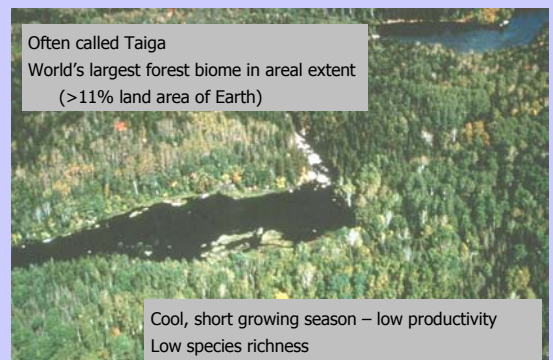
## Boreal Forests: Climate

- 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)



Textbook Fig. 2.31  
Page 37

## Boreal Forests



## 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



## Boreal Forests

Lakes and Bogs are common features

Water is retained on the surface



### Limited vertical water loss:

Evaporation limited by cool temperatures  
Soil drainage limited by permafrost and bedrock

### 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



JLM Visuals



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

## Boreal Forests

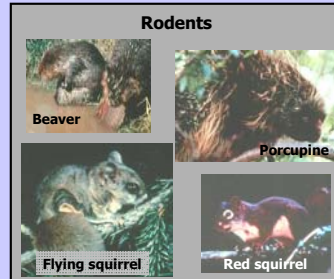
### Herbivores



Moose



Woodland Caribou



### Rodents

Beaver

Porcupine

Flying squirrel

Red squirrel



Snowshoe hare

White tailed deer



Photos (except hare): JLM Visuals

## Boreal Forests Carnivores / Omnivores



Pine marten



Fisher

Timber wolf



Lynx



Black bear

Not pictured: Birds, insects, aquatic organisms

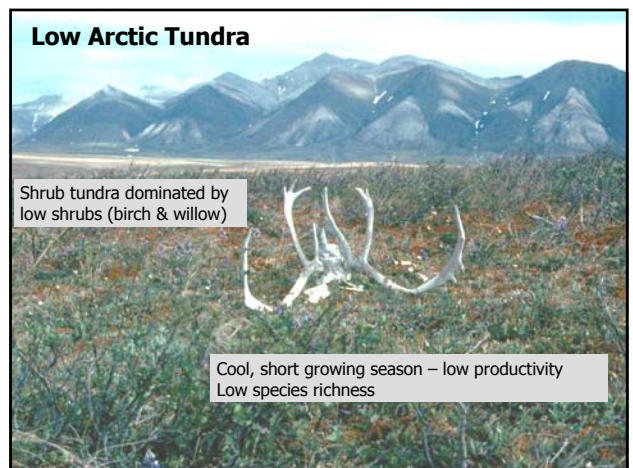
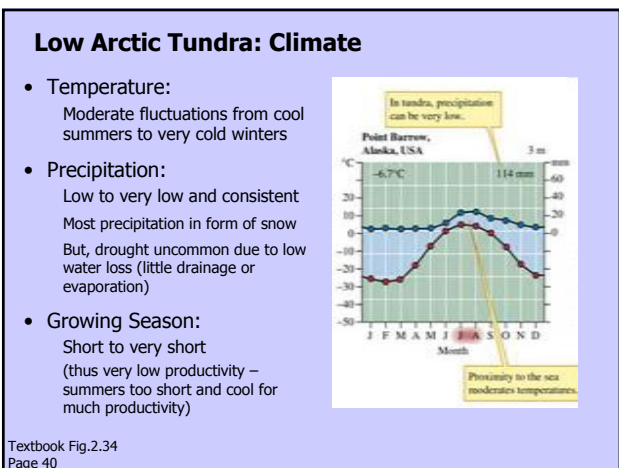
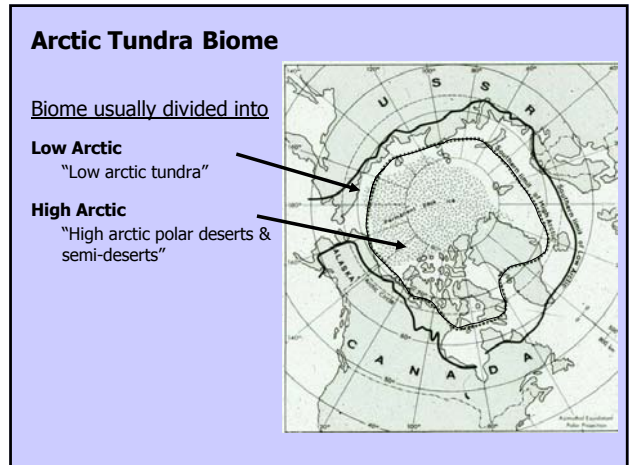
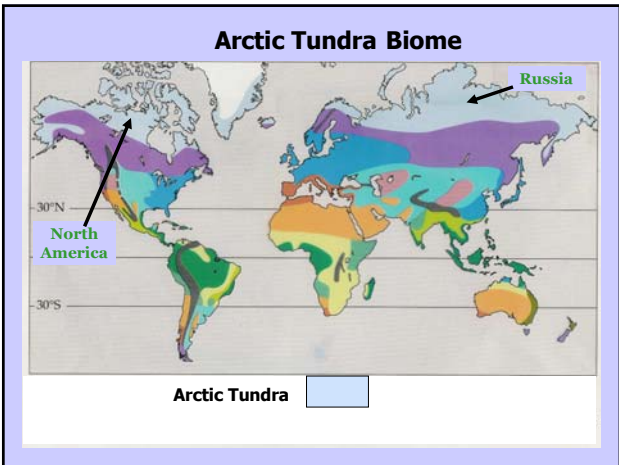
Photos (except bear): JLM Visuals

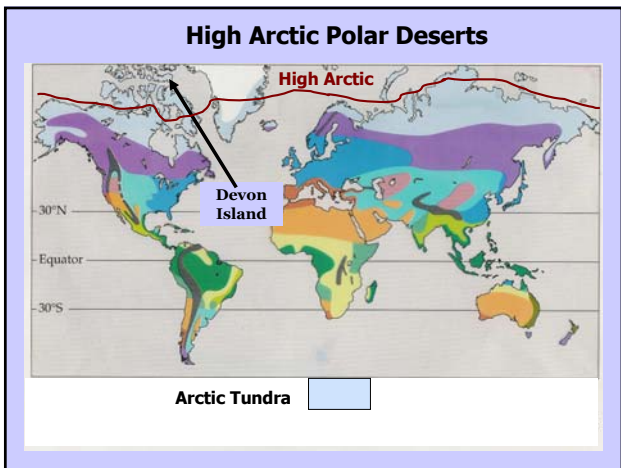
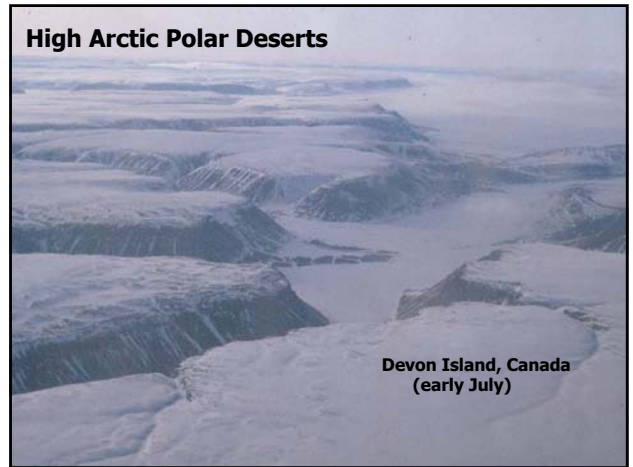
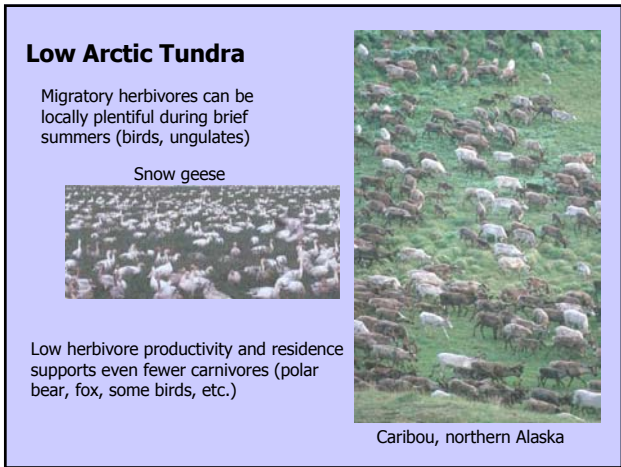
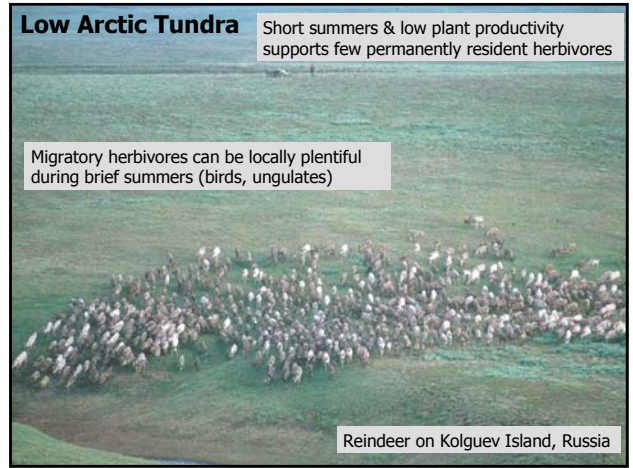
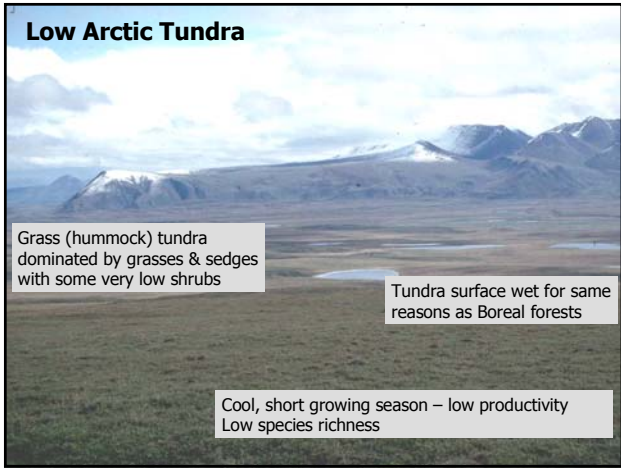
## Boreal Forests

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



Logging of boreal forest near Ural Mountains, Russia





## 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



## High Arctic Polar Deserts

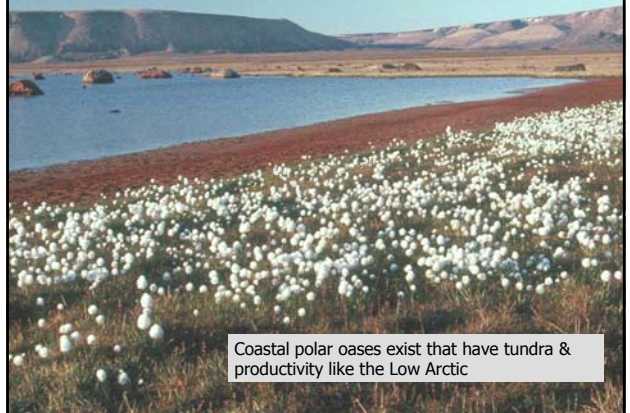
Cool, short summer and lack of plant production leads to poor soils

Nutrient limitations to productivity during brief favorable period are severe

Sites of greater productivity are associated with nutrient concentrations (animal dens, dead animals)



## High Arctic Polar Deserts



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

## High Arctic Animals

Herbivores



Muskox



Ptarmigan



Migratory waterfowl  
(Red-throated loon)

Carnivores

Little herbivore productivity supports few carnivores



Arctic hare



Arctic fox



Polar Bear

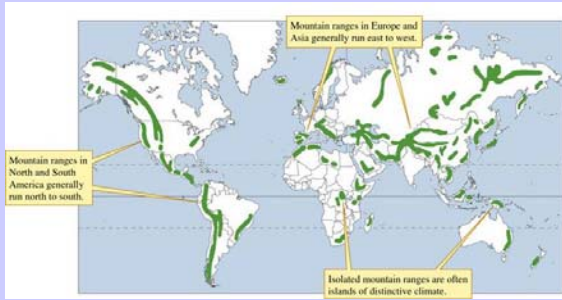
## Mountains

Not a distinct biome, but a compact collection of different biomes with elevation



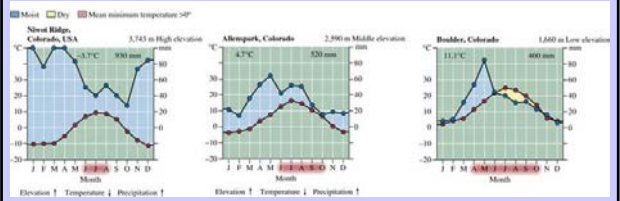


## Mountains : Global distribution of major ranges



Textbook Fig.2.37  
Page 42

## 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

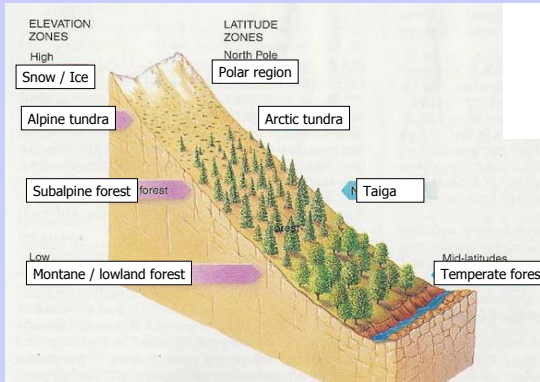
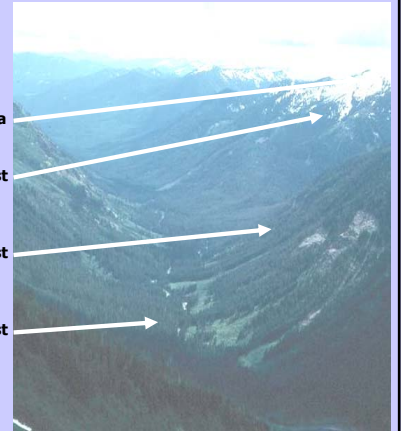


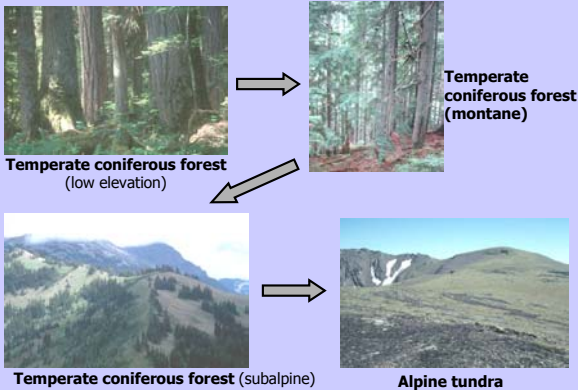
Figure from Raven & Berg (2004)

## Mountains: Elevational changes in ecosystems

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



## Mountains: Elevational changes in ecosystems



## 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)



Basins and lee slopes

Too little snow  
(limited summer moisture & winter protection)



Ridge tops

**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